ICT and e-Business Impact in the Glass, Ceramics and Cement Industry

Sectoral e-Business Watch
Study Report No. 02/2009

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e-Business W@tch

European Commission, DG Enterprise & Industry

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ICT and e-Business Impact in the Glass, Ceramics & Cement Industry

A Sectoral e-Business Watch study by

empirica GmbH

Final Report

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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 DIW Berlin, IDC EMEA, Ipsos and GOPA-Cartermill 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) in 2007 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 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 at the SeBW website (http://www.ebusiness-watch.org).

This is a sector impact study, focusing on electronic business in the glass, ceramic and cement 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 analyses the use of information and communication technology (ICT) and e-business in the glass, ceramics and cement (GCC) industries. The objectives are to assess the business implications for companies and the economic impact of ICT for the sector as a whole, and to suggest action lines for strategic responses, addressed to industry and policy.

The study is based on **micro and macro-data**, primary and secondary sources (Section 1.4). Micro-data about the e-business activity of firms have been collected through a representative ICT decision-maker survey among 676 enterprises from six EU countries (see Chapter 3) and through case studies (Chapter 4). The macro-economic analysis is based on aggregate industry accounts extracted from the EU KLEMS growth and productivity accounts database (Chapter 5).

The sector at stake

The GCC industries as defined for this study cover business activities specified in NACE Rev. 2 Division 23 as the "manufacture of **other non-metallic mineral products**". The study focuses on Groups 23.1 to 23.6, which broadly comprise the manufacture of glass, ceramics, cement, concrete, lime and plaster, and of products made of these materials. According to Eurostat, the sector[1] employs about 1.3 million[2] in the EU and comprises about 65,000 enterprises (see Section 2.1).

The GCC industries are a long-established, traditional manufacturing sector in the EU and an important **supplier to other industries**: the sector produces raw materials and components for the building and construction industry, packaging solutions (container glass) for the consumer goods industry, and specific materials or components used, for example, in the aerospace, automobile, electronics and medical industries. The sector also produces **household goods** such as glass and ceramics tableware and cookware.

The EU still has a **trade surplus** in international trade. However, especially imports of flat and container glass have surged in the past five years, with China being a major competitor (see Section 2.1).

The glass, ceramics and cement production have in common that non-metallic raw material inputs are blended before a heating process takes place to create these materials. This process transforming is **energy intensive** and inevitably leads to significant carbon dioxide emissions. Coping with **environmental objectives** is therefore a key issue and challenge for the sector's competitiveness (Section 2.2).

A. Micro-economic analysis: the ICT use by companies

The 'e-Readiness' of companies

e-Readiness comprises three main dimensions which are discussed in this study: the technical **infrastructure**, ICT **skills**, and the financial aspect, i.e. the capacity and willingness to make investments in ICT (see Section 3.1).

ICT infrastructure and skills

Basic technical infrastructure is no longer a critical barrier for the use of e-business. More than 80% of the companies, small ones included, have **broadband internet access**. About 60% of all employees work in companies which enable employees to **remotely access** files on the company's computer network (e.g. from home or when travelling).

With regard to ICT skills (see Section 3.1.2), figures indicate that the vast majority of companies in the GCC industries is currently not directly affected by a shortage of **ICT practitioners** (i.e. staff with the specialised skills and tasks of planning, implementing and

[1] These figures are still based on the NACE Rev. 1.1 classification, Division 26 (whole sector).

[2] Employment statistics provided by the European industry federations of the GCC industries for their members tend to be lower than those in official statistics.

maintaining ICT infrastructure). However, many of the small companies lack e-business skills.

ICT expenditure

The general climate for **ICT investments** has significantly changed due to the economic crisis since late 2007 (see Section 3.1.3). Many large companies are cutting their ICT budgets or cancelling projects. In total, more than 40% of the GCC companies said that the crisis would affect their ICT investments. More than 20% had already downsized or cancelled existing projects, and 20% said that they planned to cut down on their budget. This was the highest trend towards decreasing ICT budgets ever recorded by e-Business Watch (in any sector) since this type of survey was first conducted back in 2002.

About 16% of the companies interviewed in 2009 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).

'e-Activity': the digitisation of business processes

e-Business is about automating formerly paper-based document exchanges and their manual processing through electronic exchanges, both between and within companies. Most companies in the GCC industry focus on the use of ICT for optimising **internal processes** rather than on data exchanges with suppliers and customers.

Focus on efficient production processes

A central application area for ICT systems in this sector is the **support of production processes** (e.g. demand planning) and their links with the supply chain (see Section 3.2.2). CAD/CAM systems are widely used in the sector. Some of the large companies use innovative RFID-based applications for many purposes, indicating the future potential of this technology.

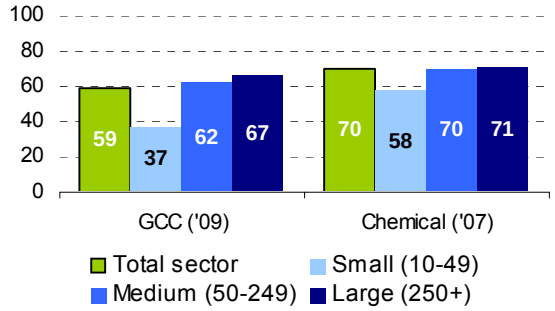
All in all, most companies (70%) said that **at least some** of their processes were conducted electronically in 2009. About 15% see themselves as intensive users, where e-business accounts for "most" or "a good deal" of their business activity (see Section 3.2.1). These results are comparable to those of other manufacturing sectors. **Electronic invoicing**, a specific example for the digitisation of paper-based processes, is already widely used.

Supply-side e-business

Improving the efficiency of **supply chain processes** is an important objective for all manufacturing businesses. ICT can support this objective by facilitating data exchanges with suppliers and improving the transparency of procurement processes.

In the GCC industries, companies representing about 60% of employment (in the six countries surveyed) said that they placed at least some orders to suppliers online. Adoption among small companies, however, is below the levels of other sectors. Large companies also procure, on average, a higher share of their supplies online than smaller ones (see Section 3.2.3).

% of companies placing orders to suppliers online in the GCC industries and the chemical, rubber and plastics industry



Companies use different approaches for connecting with their suppliers. Electronic data exchange via **EDI** is still among the preferred methods. A quarter of all companies (by their share of employment) said that they had access to the extranet of a supplier. More than 40% buy supplies by directly ordering from websites of suppliers. This is the most simple method of online ordering as there are no technical requirements other than having internet access.

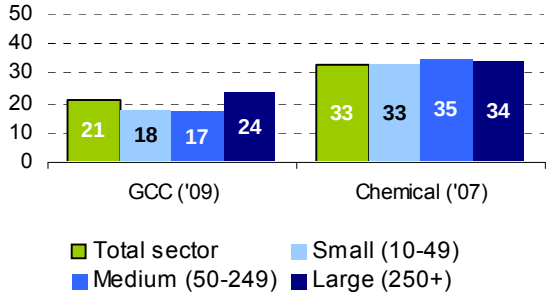
More advanced methods include the use of specific ICT systems to coordinate the purchasing activities of different units, and e-procurement by conducting online auctions among selected suppliers. The case studies provide examples of such practices.

e-Marketing and sales

e-Commerce with customers is not widespread in the GCC sectors, although web-based marketing would pose opportunities in particular

for the smaller companies, notably those in B2C sectors. Only about 20% of all companies active in the GCC industries enabled customers to order their products online in 2009. In these companies, online sales account on average for about **15-20% of total sales** (see Section 3.2.4). EDI is still one of the main channels for B2B data exchanges with suppliers and customers. Only few companies offer e-commerce on their website.

% of companies letting customers order products online: glass/ceramics/cement (GCC) vs. chemical/rubber/plastics industry



Many of the small, traditional companies, typically those in labour intensive segments of the sector, believe that ICT (other than e-mail) does not present a business opportunity for them, neither for improving the products nor for providing a better service to customers. The dilemma is that they are caught in a **vicious cycle**: the enormous business challenges and pressure in their daily routines does not give them the time to consider the issue and become knowledgeable about ICT – this, in turn, leaves ICT-based opportunities unexploited and the pressure increases further.

The 'enabling role' of ICT

ICT and innovation

The **capability for innovation** is considered very important by European companies in the GCC industries in order to face global competition and to keep their position in higher market segments, which rely on differentiation and quality (cf. ECORYS SCS Group, 2008a). This study explored to what extent ICT enables innovation activities in the GCC industries.

Results broadly confirm the picture found in earlier years for most manufacturing industries. The majority of **process innovations** in the industry, according to the innovating companies, are linked in one way or the other with ICT usage, at least in larger companies. For product innovation, ICT matters as well, but to a lesser extent.

ICT as a means to improve environmental sustainability

Rising **energy costs** are a business concern in the GCC industries. 50% of the companies interviewed said that energy costs represented a "very important" factor for their competitiveness. To counteract rising energy costs, the industry has already made enormous efforts to become more energy efficient in production.

There is hope that special ICT systems might enable companies to further increase their energy efficiency, even if opinions about the remaining potential differ. So called **energy management systems** (EMS) are not widely used yet, however. Only about 20% of all companies have such a system in place. About 20% of the users reported that the energy efficiency of their company had "significantly improved" due to the EMS, and about a third of the companies said the efficiency had "somewhat improved".

Case studies

The case studies in this report provide practical examples of e-business activity in companies, the enabling role of ICT and the strategic implications of this activity for companies. They document the diversity of activities and requirements in the sectors covered by the study, including global companies with highly automated production processes and small niche-players in labour intensive sectors.

Case 1: **Schott AG**, a multinational manufacturer of glass and glass products, implemented in 2003 an e-sourcing solution based on electronic Request-For-Quotations (**e-RFQs**). This tool supports the worldwide sourcing of strategic goods and materials. The case study shows how e-sourcing in a multinational company supports collaboration between procurement, business and technical departments.

Case 2: **BA Vidro SA**, a Portuguese manufacturer of glass flasks and bottles, uses since 1999 an enterprise resource planning (ERP) system to support the business both at the operational level and in decision making, and since 2002 a shop floor control (SFC) system to effectively manage the production floor. The

case shows how the ERP system has been continuously adapted in line with business changes and new needs.

Case 3: **Gmundner Keramik,** a mid-sized manufacturer of handmade ceramics table and ornamental ware in Austria, used ICT to move from on-stock to order-based production, with a huge positive impact on process efficiency and reduced demand for storage capacity. The case study shows how a technologically simple, self-programmed production planning system (based on a widely used, standard database software) enabled this move.

Case 4: **Holcim Slovensko**, a leading supplier of building materials and services in Slovakia, conducts since 2005 e-auctions (including reverse auctions) in order to improve the transparency in purchasing negotiations, and to achieve cost savings in the procurement of supply goods and services. As of 2009, the company procures about 15% of its total purchasing volume through online auctions and is very satisfied with the outcomes.

Case 5: **Lafarge Cement** S.A., a global company in the cement industry, has been present in Poland since 1995. The case study shows how Lafarge modernised previously state owned plants with support of e-business solutions. Lafarge implemented full ERP and CRM suites to support of virtually all business processes. It achieved positive impacts on the control and purchasing of raw materials, and increased profitability through a more accurate and efficient pricing model.

B. Macro-economic analysis: the impact of ICT and e-business

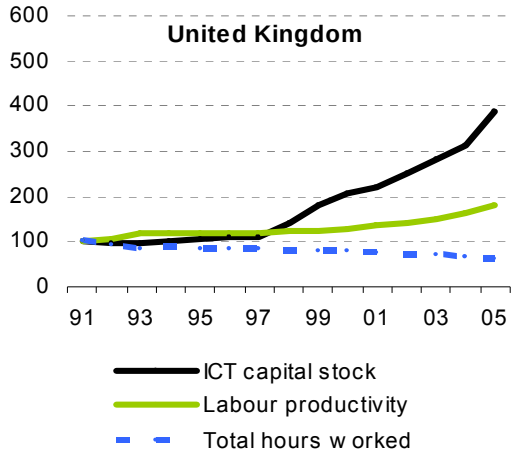
A standard growth accounting framework and correlation analysis (see Section 5.1) was used to analyse the economic implications of ICT adoption for industry growth and labour productivity. A comparison was made between the sector at stake and the whole manufacturing industry. The main findings are:

ICT capital contributes positively to **value added growth** in the GCC sector as well as in the total manufacturing industry, but the contribution is relatively low for both industry aggregates, typically accounting for 0.1-0.5% of annual growth. There are pronounced differences between countries and the periods analysed (see Section 5.2.2).

Total factor productivity (TFP), the residual that cannot be statistically explained (or accounted for) by the other input factors, accounts for a relatively high share of growth in the GCC sector in most of the countries analysed. This finding is quite specific for capital intensive manufacturing industries such as the GCC or the chemical industry, in particular in comparison to service sectors. It indicates the importance of non-tangible "assets" such as organisational innovation (see Section 5.2.2).

Real fixed **ICT capital stock** has surged in the GCC industries since 1995 in nearly all countries analysed. The average annual growth rate (CAGR) from 1995-2005 was 12.8% across the seven EU countries (see Section 5.3.1).

Development of real fixed ICT capital stock, labour productivity and total hours worked in the GCC industries (UK, 1991-2005, Index: 1991=100)



ICT capital stock is strongly positively correlated with **labour productivity growth** in the manufacturing industry and even more so in the GCC sector. The correlation with the number of hours worked is negative (at a less significant level). This does not imply a simplistic, direct causality, though (see Section 5.3.2).

In contrast to (accumulated) ICT capital stock, annual **ICT investments** are not correlated with labour productivity growth and hours worked. This could imply a time lag between the point of investment in ICT and the actual return on investment in terms of productivity growth (see Section 5.3.2).

C. Conclusions and strategic responses

Although the study does not find a massive economic impact of ICT capital on productivity and growth in the sector at the aggregate level, the survey and case studies demonstrate that the **smart use of ICT** and e-business is, for many companies, a relevant **factor for their competitiveness**. Thus, there is mixed empirical evidence, and no simplified conclusions should be drawn with regard to strategic responses for industry and policy.

On the one hand, companies in this sector are 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, the results indicate specific aspects of ICT use that are worth being considered. It can be argued that evolutionary ICT-enabled innovation processes could (or should) be accelerated by appropriate measures, in order to sustain and enhance the –still existing– competitive advantage of the European GCC industries in many segments. In particular, deficits among SMEs from the sector in this respect should be addressed, as they their approach to ICT tends to be too defensive and passive.

The study proposes **four areas for strategic responses** to enhance and exploit the ICT-enabled potential in the GCC industries (see Section 6.2):

(1) Improving the e-skills of SMEs

The "digital divide" in this sector (between large and small companies) is even more pronounced than in most other manufacturing sectors. Many small companies do not use any ICT systems other than e-mail.

The challenge for many small firms is to take an **informed decision** on adoption or non-adoption, as they are not at all familiar with ICT concepts and related business opportunities. Therefore, sector-specific actions to improve the e-business skills of SMEs could / should be considered.

(2) Promoting agreements on standards for e-business within sectoral value chains

e-Business with suppliers and customers has significant scope for expansion in the GCC industries. In contrast to other manufacturing sectors such as the chemical and paper industries, the industry itself has not taken any coordinated initiatives to facilitate electronic data exchanges, for instance by agreeing on the use of e-business standards. The industry could consider initiatives to either promote the use of existing e-business standards among its companies, or copy approaches which other sectors have taken in that respect.

(3) Improving the framework conditions for electronic data exchange

A specific business process which is well suited to be digitised is **invoicing**. The migration to structured electronic invoicing has been on the agenda of European institutions and a number of Member States for some years, as it promises substantial cost savings.

However, there are still complex issues to be solved in order to exploit the full potential. The Expert Group on e-Invoicing implemented by the EC made comprehensive recommendations (November 2009) how the framework conditions for e-invoicing could be improved. This study confirms the relevance of the Expert Group's work. It is recommended that policy should continue its efforts in this area, based on the recommendations of the Expert Group.

(4) Use ICT to facilitate compliance with regulatory requirements

Compliance with environmental legislation is a challenge for many companies in the GCC industries. While these issues are not directly ICT-related, ICT systems can facilitate compliance, as they help companies monitoring and reporting their energy consumption and greenhouse gas emission levels. Policy and industry should jointly aim at maximising the potential of ICT in this respect, in particular for SMEs, and foster the adoption of related systems (such as EMS – energy management systems).

1 Introduction

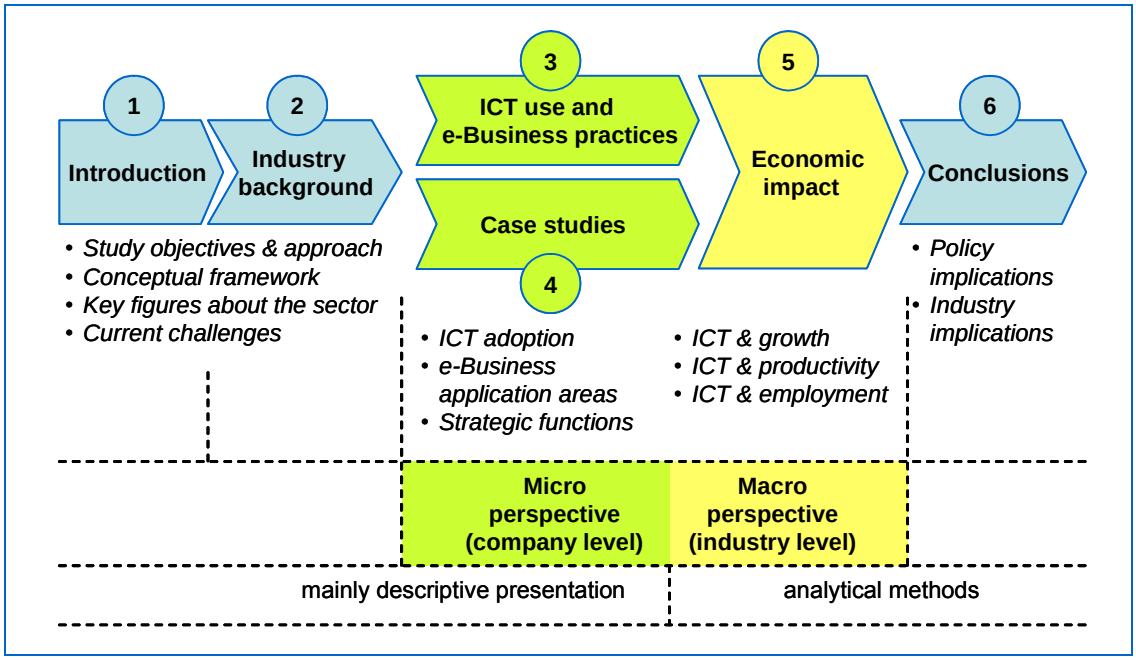
1.1 About this report

This report presents the results of a study on ICT use and e-business activity in the glass, ceramics and cement industry (GCC industries). The study has been conducted as part of the Sectoral e-Business Watch project (see Section 1.2). It aims to describe how companies in this sector make use of ICT for conducting business and to assess implications thereof for firms and for the industry as a whole. The study uses micro data (an international survey of IT decision makers in 676 enterprises from the sector, company case studies) as well as macro data (from official statistics and a special data basis compiled for productivity analyses).

The study addresses, in particular, two **target groups**: first, policy makers in the fields of innovation, ICT-related and industrial policy; second, representatives of the industry at stake, for example associations and federations of the glass, ceramics and cement industry. It aims to provide policy makers with solid, unbiased empirical evidence about e-business developments and impacts in this industry, in order to help them taking informed decisions when formulating policy strategies and programmes. As for the industry, the goal is to provide practitioners with an evidence-based "view from outside" about the role and implications of e-business in their sector, in order to support them in making the right choices with regard to promoting or implementing e-business strategies in their industry or company.

The study is structured into **six chapters** (see Exhibit 1-1). Chapter 1 explains the background and context *why* this study has been conducted. It introduces the Sectoral e-Business Watch (SeBW) project and a conceptual framework with operational definitions of key terms used in this study.

Exhibit 1-1: Structure of the report *



Chapter 2 introduces the glass, ceramics and cement industry in terms of its products, markets, structure and size, and identifies the main trends and challenges the industry is confronted with. Chapters 3 and 4 look at how companies in this sector use ICT and e-business for different purposes, mainly on the basis of a representative survey and e-business case studies. The case studies are presented in detail in Chapter 4. Chapter 5 then moves from the micro to the industry level and analyses the economic impact of ICT on growth, productivity and employment in this sector, using econometric analysis. The effects found in the glass, ceramics and cement Industry are compared to those found for the manufacturing industry as a whole, in order to identify specificities. Chapter 6 finally draws conclusions from the evidence found at the micro and macro levels, notably in terms of possible policy implications.

The **study approach** is to combine descriptive and analytical methods, based on both micro data (company level) and macro data (industry level).[3] The combination of different types of sources and analytical methods is necessary to explore, on the one hand, current e-business practices at the enterprise level (mostly in a descriptive way, see Chapter 3) and, on the other hand, to assess the aggregated economic impact of these individual practices at the industry level (applying econometric models, see Chapter 5). The study aims to integrate these different perspectives by cross-referencing the results of the different parts, pointing out where micro- and macro-level evidence support each other or appear to be in conflict, with suggestions of possible explanations.

1.2 About the Sectoral e-Business Watch

Mission and objectives

The Sectoral e-Business Watch (SeBW) studies the adoption and impact of ICT and 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 Contracts between DG Enterprise and Industry and empirica GmbH.

Within the European Commission, DG Enterprise and Industry has the mission to help improve Europe's economic standing by ensuring that businesses are competitive and that they can compete openly and fairly. In ICT-related fields, DG Enterprise and Industry targets six policy fields: competitiveness of the ICT producing sector, ICT uptake in ICT using sectors, legal issues related to ICT uptake, ICT standardisation, e-skills and disruptive ICT.[4]

The services of the SeBW are expected to contribute to policies in these fields. The SeBW's 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;

[3] See Annex I for more information about data sources

[4] See http://ec.europa.eu/enterprise/ict/index_en.htm#policy for more details.

- 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 provide a **forum for debate,** giving researchers, industry and policy representatives the opportunity to discuss the issues at stake.

By delivering evidence on ICT uptake and impact, the SeBW is to support informed policy decision-making in policy domains also beyond ICT, including innovation, competition and industrial 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*".[5] The **i2010 policy**[6], a follow-up to eEurope launched in 2005, 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).

In 2005, in consideration of globalisation and intense international competition, the European Commission launched a **new industrial policy** (European Commission, 2005) 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. In a **mid-term review** of the new industrial policy in 2007 (European Commission, 2007), the EC identified three particular challenges: intensified globalisation and technical change as well as climate change. In 2009, the EC plans to issue a Communication related to the role of high technology and industrial policy in the **economic crisis**.

By providing empirical evidence about the role and potential of ICT for business, the Sectoral e-Business Watch supports policy formulation by DG Enterprise and Industry in these fields. It has close links with the following other policy action lines and initiatives:

- the e-Business Support Network (**eBSN**), a European network of e-business policy makers and business support organisations,
- **e-Skills** related policies of DG Enterprise and Industry (see European Commission, 2007b)
- activities in the area of **ICT standardisation**, as part of the general standardisation activities of the Commission.

In parallel to the work of the SeBW, the "**Sectoral Innovation Watch**" (see http://www.europe-innova.org) analyses sectoral innovation performance and challenges across the EU from an economic perspective.

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

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

The work programme

Since 2001, the SeBW has published e-business studies on about **30 sectors** 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 cross-industry ICT issues. All publications can be downloaded from the programme's website at http://www.ebusiness-watch.org. In 2009, the main studies of the SeBW focus on the following topics:

No.	Study	Sectors in focus
1	ICT and e-business impacts in the energy supply industry	Electricity, gas, steam and air conditioning supply (NACE Rev.2 Division 35)
2	ICT and e-business impacts in the glass, cement and ceramic industry	Manufacture of other non-metallic mineral products (NACE Rev. 2 23.1-6)
3	ICT impacts on greenhouse gas emissions in energy-intensive industries	Energy-intensive sectors (mainly chemical, steel, paper, glass, cement)
4	An economic assessment of ICT-related industrial policy	(cross-sectoral analysis)

In addition, SeBW conducts a number of further, smaller studies on specific aspects of ICT and e-business, for example a case study report on e-skills developments and challenges in manufacturing companies.

1.3 ICT and e-business – key terms and concepts

A definition of ICT

Information and communication technology (ICT) is an umbrella term that encompasses a wide array of hardware, software and services used for data processing (the information part of ICT) as well as telecommunications (the communication part). The European Information Technology Observatory (2009) structures the ICT market into three broad segments with an estimated total market value of about € 718 billion in 2009 (Exhibit 1-1). Compared to 2008, the European ICT market has experienced a decrease of minus 2.2%. For 2010, EITO expects the ICT market to stabilise and to decrease by only 0.5% to 714 billion €.

Exhibit 1-2: European ICT market (sales volume) in 2009

Market segment	Products / services included	EU market value estimates (2009)	Development to 2008
Information Technology (IT)	IT hardware, software, services	€ 299 billion	-2.6%
Telecommunications (TC)	TC end-user equipment, carrier services, network equipment	€ 361 billion	-0.7%
Consumer electronics	Examples: flat-screen TVs, digital cameras and navigation systems	€ 58.5	-8%
Total ICT market		*€ 718 billion*	*-2.2%*

Source: EITO 2009

ICT is a technology with special and far-reaching properties. As a so-called **general purpose technology** (GPT), it has three basic characteristics:[7] First, it is pervasive, i.e. it

[7] Cf. Bresnahan/Traijtenberg (1996) and Jovanovic/Rousseau (2005).

spreads to all sectors. Second, it improves over time and hence keeps lowering the costs for users. Third, it spawns innovation, i.e. it facilitates research, development and market introduction of new products, services or processes. One may argue that only electricity has been of similar importance as a GPT in modern economic development.

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 framework for the discussion of ICT that has been applied in most studies of the Sectoral e-Business Watch.

A definition of e-business

In a maturing process in the past 15 years, electronic business has progressed from a specific to a broad topic. A central element is in any case the use of ICT to accomplish **business transactions**. This means exchanges of goods – or, in economic terms: property rights – between a company and its suppliers or customers.

Transactions can be broken down into **three phases** and related business processes (see Exhibit 1-3. First, the pre-sale (or pre-purchase) phase includes the presentation of (or request for) information on the offer, and price negotiations. Second, the sale or purchase phase covers ordering, invoicing, payment and delivery processes. Finally, the after sale or 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 and updates. 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. Therefore one needs to decide which components actually have to be conducted online in order to call a transaction (as a whole) "electronic".

Exhibit 1-3: Process components of transactions

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

Source: Sectoral e-Business Watch

Electronic transactions, i.e. electronic procurement or sales, constitute **e-commerce**. The suppliers or customers can be other companies ("B2B" – business-to-business), consumers ("B2C" – business-to-consumers), or governments and their public administration ("B2G" – business-to-government).

The OECD proposed a narrow and a broad definition of e-commerce which both remain useful today. 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 to specify which of the processes along the transaction phases constitute e-commerce. The OECD definition excludes the pre-sale or pre-purchase phase and focuses instead on the ordering process. The SeBW follows the OECD position

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

The OECD Working Party on Indicators for the Information Society proposes a definition of **e-business** as "*automated business processes (both intra-and inter-firm) over computer mediated networks*", with the imperative conditions that "*the process integrates tasks (i.e. a value chain) and extends beyond a stand alone / individual application*" and that "*the processes should describe functionality provided by a technology not a specific technology per se*" (OECD, 2003, p. 6). Using this definition, e-commerce is a key component of e-business but not the only one. This wider focus oriented on business processes has been widely recognised: e-business also covers the digitisation of **internal and external business processes** that are not necessarily transaction-focused. Internal business processes include for example functions such as research and development, finance, controlling, logistics and human resources management. An example of external cooperative or collaborative processes between companies is industrial engineers collaborating on a design in an online environment.

In addition, the OECD proposed that e-business processes should integrate tasks and **extend beyond a stand-alone application**. Thus, simply using a computer in a company does not constitute e-business. The most rudimentary form of e-business may thus be to connect two computers in a local area network.

The term “automation” in the OECD definition refers 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**). Advanced automatic machine-to-machine exchanges are just unfolding their technical and economic potential and may lead to new applications and services with profound impact on business and society. Such developments are related to what is called the “Future Internet”, comprising the “Internet of Things” and the “Internet of Services”.[8]

Electronic exchanges require interoperability, i.e. the agreement between the participants on electronic **standards** and processes for data exchange. In a wide sense, standards are defined here as “technical specifications”. Standards and standardisation remain a key issue in further sophistication of e-business.

Definition of key terms for this study

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) 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 or purchase phase.*

e-Business*: automated business processes (both intra-and inter-firm) over computer mediated networks. (OECD). e-Business 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.*

[8] See European Commission: Internet of Things – An action plan for Europe. COM(2009) 278 final. Brussels, 18.6.2009; and European Commission: Communication on future networks and the internet. COM(2008) 594 final, Brussels, 29.09.2008.

e-Business and a company's value chains

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 remains valuable to understand the opportunities of e-business.[9] A **value chain** represents the main functional areas ("value activities") of a company and differentiates between primary and support activities. These are "*not a collection of independent activities but a system of interdependent activities*" which are "*related by linkages within the value chain*".[10] These linkages can lead to increased process efficiency and competitive advantage through optimisation and co-ordination. This is where ICT can have a major impact.

The term **value system** expands this concept beyond the single company. The firm's value chain is linked to the value chains of (upstream) suppliers and (downstream) buyers. The resulting set of processes is referred to as the value system. All e-business processes occur within this value system. Key dimensions of the value system approach are reflected in the **Supply Chain Management** (SCM) concept.[11] It focuses on optimising the procurement-production-delivery processes, not only between a company and its direct suppliers and customers, but also in terms of a full vertical integration of the entire supply chain. Analysing the digital integration of supply chains in various industries has been an important theme in most sector studies by the SeBW.

The importance of e-skills and company organisation

It is widely acknowledged that the optimisation of value systems with ICT requires employees endowed with particular skills. ICT skills or "e-skills" comprise ICT practitioner skills, ICT user skills and e-business management skills. Furthermore, there are indications that the successful use of ICT is not only a matter of implementing technology but also of adapting the companies' organisation to the specific needs of electronic value chains. Organisational changes may for example relate to a rearrangement of strategies, functions, and departments. Studies of the impact of ICT on firm-level productivity have shown that only if ICT investment is combined with complementary investment in working practices, human capital and firm restructuring it will have an impact on performance (Brynjolfsson/Hitt, 2000). Since these complementary investments and organisational changes are highly firm-specific, returns to ICT investments vary strongly across companies (Pilat, 2005). Hence, e-skills and organisational issues play an important role in SeBW analyses.

e-Business in times of economic crisis

While e-business had regained momentum as a topic for enterprise strategy in recent years, the situation and outlook of ICT investment has turned much less favourable with the economic crisis since mid-2008. In its Information Technology Outlook, the OECD states that in 2009 "*ICT growth is likely to be below zero for the OECD with considerable turbulence as the financial services sector restructures and the real economy experiences a deep economic downturn.*" (OECD, 2008, p. 15)

However, the economic crisis does not affect all ICT in the same way. The OECD expects that "*IT services and software will generally grow, along with new Internet and communications-related products and infrastructure as they are an essential part of spending*

[9] See Porter, Michael E. (2004); original published in 1985.

[10] See Porter (2004), p. 48.

[11] See SCOR Supply-Chain Council: Supply-Chain Operations Reference-model.

and partly recession-proof" (OECD, 2008, p. 15). The OECD also expects that growth of the ICT industry is unlikely to collapse as it did in 2001 when the bubble of the "new economy" burst (p. 23). Furthermore, the development of ICT investment differs by industry. Industries exposed to deep demand cuts such as automotive may have to reduce their ICT investment, while industries with rather stable demand such as energy supply may sustain their ICT investment. In any case, the evolutionary development of e-business has certainly not come to an end with the economic crisis. It is widely recognised that "e"-elements have become an essential component of modern business and the implications of trends such as "cloud computing" and "Web 2.0" are widely discussed.

Increasing competitive pressure on companies, many of which operate in a global economy, has been a strong driver for ICT adoption. Companies use e-business mainly for three purposes: to **reduce costs**, to **increase revenues** and to **improve customer service**. In essence, all e-business projects in companies explicitly or implicitly address one or several of these objectives. Recently, the use of ICT to **save energy** and reduce greenhouse gas emissions emerged as a specific issue of cost reduction, one with wide impacts for the economy and society as a whole.

While cutting costs continues to be a key motivation for e-business activity particularly in the economic crisis, anticipatory firms exploit the **innovation** potential of ICT for key business objectives. They have integrated ICT in their production processes, quality management, marketing, logistics and customer services. These functions are considered key to improve competitiveness of European economies. Competing in mature markets requires not only optimised cost as well as products or services of excellent quality but also the effective communication and cooperation with business partners. Companies that exploit the innovative potential of ICT even in times of economic crisis could leave the crisis stronger and more competitive.

1.4 Study objectives and approach

Research objectives

The glass, ceramics and cement industries constitute a mature, capital- and energy-intensive sector with normally predictable demand and relatively high barriers for market entry. There are many enterprises with a long-standing tradition and the sector is known to be rather conservative in terms of how business is done. Therefore, a basic assumption for this study is that ICT usage and e-business activity will be less deployed than in other manufacturing industries and will normally not have a fundamental impact on industry structure as a whole; definitely not as much as in service sectors such as tourism, banking and ICT services, where new developments in ICT tend to have much more direct and significant impacts on business.

A big question is how the economic crisis (in particular the collapse of demand in important customer sectors such as construction and building) and increasing pressure on European companies to comply with environmental regulation (see Section 2.2.1) will affect e-business developments in this industry in the next few years. On the one hand, these constraints could be a driver for companies to turn their attention to ICT, as they urgently seek opportunities to increase their process efficiency in order to cut costs. In this scenario, the crisis drives companies to exploit a possibly untapped potential to become more competitive. On the other hand, the economic difficulties may shift ICT and e-business further down on

the industry's agenda. The budget for any investments will be extremely constrained. If the business case for investments in ICT leaves doubts about a fast return-on-investment, companies will be strongly inclined to postpone or even cancel ICT projects, turning their attention to their day-to-day business and "more urgent" needs.

Against these background considerations, this study aims to assess the role and potential of ICT and e-business for companies in various segments of the glass, ceramics and cement industry, both from a micro-perspective (strategic implications for individual enterprises) and from a macro-perspective (economic impacts on the sector as a whole). The main research questions are:

- **Current patterns of ICT usage**: What is the level of ICT adoption and e-business activity in this sector compared to other industries, and how do various segments and types of companies differ in this respect? How does ICT support business objectives in different types of companies? See Chapters 3 and 4 for the results.
- **Aggregate economic impacts**: How is ICT adoption linked with industry growth? Is there evidence that ICT capital accumulation is linked with productivity growth and employment dynamics in this sector? How does the sector differ from other manufacturing industries in this respect? See Chapter 5 for the results.
- **Policy implications**: Are there any implications stemming from ICT usage for European economic policy, for example in the fields of competition or R&D and innovation related policy? See Chapter 6 for the policy recommendations.

Data collection

The study is based on a mix of micro and macro data, primary and secondary data sources (see Exhibit 1-4) The way how data has been collected from the main sources is introduced and explained in more detail in the respective section of the report.

Exhibit 1-4: Main sources used for this study

<table>
<tr><th></th><th>Micro data (company level) and background information</th><th>Macro data (industry level)</th></tr>
<tr><td>Primary data collection</td><td>• Representative telephone survey among 680 companies from the sector (see Section 3 and Annex II)
• Company case studies (see Section 4)
• Interviews with industry representatives (see below)</td><td>---</td></tr>
<tr><td rowspan="2">Use of secondary sources</td><td>• Newsclips and articles in ICT and e-business magazines
• Web-based resources
• Reports and position papers by Industry federations / associations
• Reference cases by ICT vendors</td><td>• EU KLEMS Growth and Productivity Accounts (see Section 5 and Annex I)
• Sector statistics provided by industry federations / associations (see references)
• Eurostat Structural Business Statistics</td></tr>
<tr><td colspan="2">• EC competitiveness studies on the glass and ceramics industries, conducted by ECORYS SCS Group, 2008 (see references and Annex I)</td></tr>
</table>

Company case studies: case studies (Chapter 4) describe e-business strategies of companies from the sector in more detail. Cases 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.

Information from industry federations: Statistics, annual reports and position papers of industry federations were used, notably from the following federations:

Industry	Federation	Full name / further information
Glass	**CPIV**	the Standing Committee of the European Glass Industries, http://www.cpivglass.be
Ceramics	**CERAME-UNIE**	the representation of the European ceramics industries, an umbrella organisation of eight ceramics sectors founded in 1962, http://www.cerameunie.eu
Cement	**CEMBUREAU**	the representative organisation of the cement industry in Europe, with 28 members, http://www.cembureau.be

Further federations and associations from which information was used include national industry associations from these sectors, federations representing specific branches of the glass industry (such as FEVE, the European Container Glass Federation), the cement, concrete and plaster industry (such as ERMCO, the European Ready Mixed Concrete Association, or EFCA, the European Federation of Concrete Admixtures Associations), and the members of Cerame-Unie which represent specific sub-sectors within the ceramics industry.

Data analysis

The statistical methods used for the economic analysis of ICT impacts (growth accounting, correlation analysis) are introduced in Section 5.1.

Validation of results – the Advisory Board

The study was conducted in consultation with an Advisory Board, consisting of the following industry representatives and economists (in alphabetical order):

- **Mr Renaud Batier**, Managing Director, Cérame-Unie
- **Mr Jean-François Mottint**, Head of Intelligence Unit, ICT Project Development, CEMBUREAU
- **Ms Brigitte Preissl**, Editor in chief, Intereconomics Wirtschaftsdienst, Deutsche Zentralbibliothek für Wirtschaftswissenschaften (ZBW)
- **Mr Frédéric Van Houte**, Secretary General, CPIV

In addition to informal exchanges and interviews with Advisory Board members, an advisory board meeting was held in June 2009 in Brussels to discuss the interim report. Some of the study results were also presented and discussed at the e-Business Watch Conference 2009 on 29 October 2009 in Brussels.

2 The glass, ceramics and cement industry

Business activities covered

The term "glass, ceramics and cement (GCC) industries" as used in this study refers to business activities specified in NACE Rev. 2 Division 23 as the "manufacture of other non-metallic mineral products". This study focuses on Groups 23.1 to 23.6, which corresponds largely to the former NACE Rev. 1.1 26.1 to 26.6 (see matching of NACE classifications in Exhibit 2-1).

Exhibit 2-1: Scope of the study – definition of the sector covered

NACE Rev. 2	NACE Rev. 1.1*	Business activity
23	**26**	**Manufacture of other non-metallic mineral products**
23.1	26.1	Manufacture of glass and glass products
23.2	26.26	Manufacture of refractory products
23.3	26.30+40	Manufacture of clay building materials
23.4	26.21-25	Manufacture of other porcelain and ceramic products
23.5	26.5	Manufacture of cement, lime and plaster
23.6	26.6	Manufacture of articles of concrete, cement and plaster

There are two further Groups of business activities in NACE Division 23 which are not dealt with in this study: the cutting, shaping and finishing of stone (23.7); and the manufacture of other non-metallic mineral products (23.9).[12] Cutting and shaping stones was felt to be too different from the processes applied in the GCC industries, where different raw materials need to be blended in an energy intensive process.

According to Eurostat, the total sector[13] employed about 1.3 million in the EU in 2005, comprised about 65,700 enterprises and generated a value added of about 62 billion euros across the EU-27.[14] The production value represented about 1.5% of the total value of the manufacturing industry in the EU. Employment figures differ, however, for most sub-sectors from member statistics provided by the European industry federations of the glass, ceramics and cement industry, which tend to report lower figures than Eurostat (see following sections).

2.1 Industry background

The glass, ceramics and cement industries are a long-established sector in the European Union which is an important supplier to other industries: the sector produces raw materials and components for the building and construction industry, packaging solutions (container glass) for the consumer goods industry, and specific materials or components used –for example– in the aerospace, automobile, electronics and medical industries (e.g. technical ceramics). The sector also produces household goods such as glass and ceramics tableware and cookware.

[12] There is no group 23.8. Group 23.9 covers the production of abrasive products (23.91) and the manufacture of other non-metallic mineral products n.e.c. (23.99), i.e. "not elsewhere covered" in Division 23.

[13] figures still based on the NACE Rev. 1.1 classification, Division 26

[14] Eurostat (2008b) “Industry, Trade and Services”. European Business Statistics

The three industries of the GCC sector have in common that non-metallic raw material inputs are blended before a heating process takes place to create those materials which give the industries their name (glass, ceramics, cement). This process of transforming is energy intensive as it requires a heating procedure at high temperatures. The process inevitably leads to carbon dioxide (CO_2) emissions. Coping with environmental objectives, in particular with the new greenhouse gas emissions regulation, is a critical issue for the sector (see Section 2.1.1). In the glass and ceramics industries, the basic materials are then further processed into a range of heterogeneous products. In the cement industry, the output is more homogeneous.

This section introduces the three GCC industries in terms of their size, structural characteristics, outputs and their main customer segments, and discusses the major challenges which European companies in these industries are confronted with. Data presented in this section are mostly based on publications of the main European industry federations in the GCC sector and on collections from Eurostat, notably from the Structural Business Statistics (SBS).

2.1.1 The EU glass industry

The manufacture of glass and glass products is represented as Group 23.1 in the NACE Rev. 2 classification. Glass is made of silica (quartz sand) and other minerals which are fused at very high temperatures of about 1700° C. The resulting substance is then cooled and processed to become different types of glass and glass products for a wide range of uses.

There are four main types of glass in terms of its chemical composition: soda lime glass, lead crystal and crystal glass, borosilicate glass and special glasses.

Market segmentation by products

The glass industry can be broken down into **five main sub-sectors**, depending on the type of products which are manufactured. Container glass (mainly bottles and jars used for packaging food and other goods) is by far the largest segment of the EU glass industry, accounting for close to 60% of total output.

Exhibit 2-2: Segmentation of the glass industry

Sub-sector / type of product	% of total output *	Characteristics
Container glass	~ 63%	 • by far the largest sub-sector • covers in itself distinct segments with different markets, such as packaging glass for beverages, specific packaging products for various industries (e.g. pharmaceuticals / laboratory chemicals), and tableware • products are sold mainly to customer industries in the EU
Flat glass	~ 29%	• a mature and cyclical business covering the production of float glass and rolled glass • world-wide business that is dominated by five major groups: Asahi (Japan), NSG/Pilkington (UK), Saint-Gobain (France), PPG Industries (USA) and Guardian Industries (USA) • 5 manufacturers of float glass and 5 rolled glass manufacturers operate in the EU with production sites in 11 member states
Domestic glass	~ 4%	• covers the production of glass tableware, cookware and decorative items (e.g. drinking glasses, cups, bowls, plates, vases and ornaments) • mainly specialised SMEs
Glass fibre	~ 2%	• consists of two distinct segments: o the manufacture of continuous glass filaments (which are converted into other products such as roving, mat, chopped strand, textile yarn, tissue, and milled fibre); o the manufacture of glass fibre insulation. • the main end use (about 75%) is the reinforcement of composite materials such as thermosetting resins and thermoplastics, mostly for use in the building industry, the automotive and transport sectors
Special glass	~ 2%	• products have a relatively high value and cover a wide range of products, such as cathode ray tube (CRT) glass for monitors, lighting glass (tubes and bulbs), optical glass, laboratory and technical glassware, borosilicate and ceramic glasses, and glass for LCD panels • CRT glass and tubes & bulbs account for over 80% of capacity

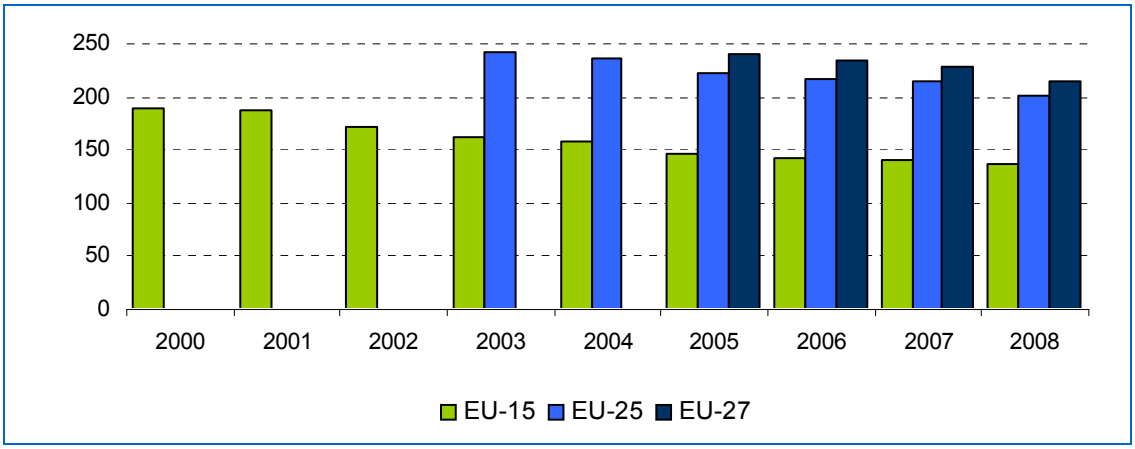
* % of total glass production in tonnes in 2008 (computed from CPIV figures for EU-27 glass production by product segment)

Source: CPIV

Industry size and structure

According to CPIV, **employment** in the EU-27 glass industry (as represented by CPIV members) was about 214,000 in 2008. The four by far largest industries by employment were those in Germany (49,700), Poland (33,000), Czech Republic (22,000) and France (21,000).[15] Employment has steadily decreased in recent years. In CPIV member companies, employment in the EU-15 (of 2000) has decreased from 2000-2008 by 28%, from 189,000 to 136,000.

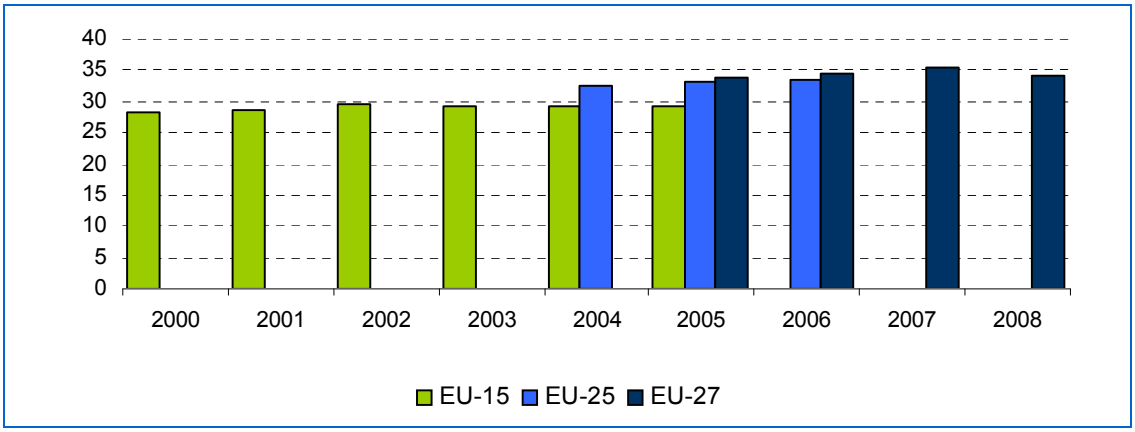
Exhibit 2-3: Employment development of the EU glass industry 2000-2008 *(persons employed in thousands)*



Source: developed from CPIV

Total **glass production** of CPIV members was about 34.3 million tonnes in the EU in 2008, which is about 160 tonnes per employee. Production has been mostly stable in the past 10 years (see Exhibit 2-4). The largest producers were Germany (about 7 million tonnes), France and Italy (both about 5 million tonnes), thus together accounting for about 50% of the total EU-27 production.

Exhibit 2-4: EU glass production 1995-2008 *(in million tonnes)*



Source: developed from CPIV statistics

[15] Note that the figures for employment provided by CPIV (the federation representing the sector at European level) deviate from those in official statistics. According to Eurostat Structural Business Statistics, about 385,000 people were employed in the EU glass industry (in 2005), and Germany, France and Italy were the largest industries (by employment, 2004), closely followed by Poland and Czech Republic.

SMEs play an important role in the glass industry, in comparison to other manufacturing sectors such as the chemical or paper industry. According to official statistics, they probably account for more than 50% of employment and value added.[16] However, their role and importance varies across sub-sectors. Flat glass manufacture, for example, is a world-wide business that is dominated by a few large groups. The manufacture of domestic glass, by contrast, is widely distributed across the EU with about 140 companies which are mainly SMEs and which often specialise in higher value added products such as lead crystal.[17] In the container and special glass sectors, the situation is mixed: there are some large groups as well as many smaller independent companies.

International trade and competition

In the glass industry, **extra-EU trade** represents only about 5-10% of production or consumption (Ecorys 2008a). The EU has still a trade surplus in financial terms. According to Eurostat (2007), the value of EU-27 exports of glass and glass products was about 5.8 billion euros in 2006, with container glass accounting for about two thirds of exports. Imports, which have significantly increased by nearly 30% from 2003 to 2006, reached 3.4 billion euros in 2006. Especially imports of flat and container glass have surged, and here mainly from China. In terms of output (in tonnes), the total volume of extra-EU exports increased by 5.4% between 2004 and 2007, while the volume of extra-EU imports increased by 66% over the same period (Ecorys 2008a). As a result, the EU glass industry recorded its first trade deficit by volume in 2007. CPIV estimates that the export/import ratio for 2008 for the EU-27 was 1.04, i.e. exports still exceeded imports by 4%. The import penetration (i.e. the share of imports as percent of the total market) is high in the segments of tableware (34%), reinforcement fibres (60%) and special glass products (63%). It is low in the container and flat glass market (2-8%).

2.1.2 The EU ceramics industry

Ceramics are non-metallic inorganic materials which are processed into an extremely diverse group of products, including tiles, bricks, electrical insulators, bathroom fixtures and consumer durables such as tableware. As with glass, the production of ceramics products is energy intensive, often requiring kiln temperatures of more than 1000° C.

Market segmentation by products

The manufacture of ceramics covers Groups 23.2-4 in the NACE Rev. 2 classification. For some of the sub-sectors, such as the roofing tiles & brick production, the industry provides most of the raw materials needed itself. In other sub-sectors, such as the production of refractories, materials are also supplied by other industries.

[16] This can be concluded from Eurostat structural statistics (SBS) for the whole GCC industries (i.e. the manufacture of other non-metallic mineral products). Structural data specifically for the glass industry are not available.

[17] CPIV (www.cpivglass.be), March 2009

Exhibit 2-5: Segmentation of the ceramics industry

NACE Rev. 2	Sub-sector / type of product (Federation)	% of total sales / empl.*	Characteristics
23.2	**Refractory products** (PRE)	12% / 8%	• vital for any high-temperature production process, such as steelmaking (60% of sales) • EU has positive trade balance
23.31	**Wall & floortiles** (CET)	39% / 31%	• EU highly competitive internationally: about a quarter of the EU production is exported • Italy and Spain are Europe's major producers; sizeable activities also in Portugal, Germany and France • demand is highly dependant on demand for construction
23.32	**Bricks & roofing tiles** (TBE)	26% / 23%	• mainly SMEs in Southern Europe • concentration process in North-Western and Central Europe • highly automated and energy intensive industry • International trade is of limited importance
23.41	**Table & ornamental ware** (FEPF) 	8% / 22%	• labour-intensive industry • output in the EU has fallen by 50% since 1990 and employment has fallen even more (Encorys, 2008b, p. 22) • important concentrations of tableware producers in regions in Germany, the UK and France • traded over long distance –over 25% output is exported outside the EU • 70% of the EU market are imports
23.42	**Ceramic sanitary fixtures** (FECS)	7% / 11%	• follows closely developments in the building and in particular the renovation market • increasing competition from Asia
23.43+44	**Technical ceramics** (EuTeCer)	8% / 4%	• applied in a wide variety of industries, including the aerospace and automobile industries, electronics, biomedical products and environment protection • competition mainly from Japan and the USA
23.49	**Clay pipes** (FEUGRES)	1% / 1%	• mainly used for sewerage purposes • demand concentrated with local government

* estimates for 2003. more recent figures not available.

Not listed: KPC, the European Clay & Kaolin Producers' Federation

Source: Cerame-Unie (matching with NACE Groups by empirica)

Exhibit 2.5 introduces the main sub-sectors of the ceramics industry, each of which has its own European federation.[18] The largest sub-sectors are the production of wall and floortiles, bricks and rooftiles, and table / ornamental ware. Together, these sub-sectors account for about 70% of total employment and sales.

Industry size and structure

Cerame-Unie estimates that companies from the European ceramics industry (as represented by their members) employed 222,000 people back in 2003 (most recent figure available). However, not all the sector's associations provide systematically data for their members; the actual figures are therefore higher.[19] According to Eurostat Structural Business Statistics, about 380,000 people were employed in the sector in 2005.

Similarly as the glass industry, **SMEs** play an important part in the EU ceramics industry and account for a significant share of employment and value added in the sector.[20] However, a large proportion of the production is geographically concentrated in **regional clusters**. Such clusters exist in Bavaria (DE), Staffordshire (UK), Limousin (FR), Sassuolo (IT) and Valencia (ES). A large part of the production derives from companies and consortia in these regions.

In some sub-sectors, concentration is higher and large companies with production sites in many countries dominate, such as the world's largest brick manufacturer Wienerberger with production sites in 24 European countries, India and the USA.[21] The sanitaryware sector is also quite concentrated, and the clay pipes sector is controlled by only three companies (Keramo Steinzeug, Hepworth, and Società del Gres).

The ceramics industry is capital intensive. As kilns represent a major, long lasting investment, it is difficult for companies to respond to short-tern fluctuations in demand and to comply with new legislation affecting energy or emissions.

Supply chain characteristics

Larger companies in the bricks and roofing tiles sub-sectors tend to be vertically integrated, i.e. producers normally have their own quarries from which they mine their clays. Smaller companies, notably producers of tableware and wall & floor tiles, normally procure their raw materials from dedicated clay producers.

On the sales side, most ceramic manufacturers sell their products to either to wholesale traders or directly to retailers. Some companies have their own sales and marketing outlets, for example sanitaryware Villeroy & Boch. Specialised companies in the table & ornamental ware sub-sector, including many SMEs, increasingly use the internet to market and sell their products directly to consumers.

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[18] Cérame-Unie, founded in 1962, is the liaison office and umbrella organisation of these industry federations: six federations are full members of Cerame-Unie and share a common secretariat in Brussels, two are associate members.

[19] Cérame-Unie recommends to refer to Eurostat data if information about the total sector's employment is required (interview with Mr R. Batier, Managing Director). The federation has statistics from its members, but these are not 100% representative of all branches of the ceramics sector, in particular for SMEs.

[20] According to Eurostat structural statistics (SBS) for the whole GCC industries (i.e. the manufacture of other non-metallic mineral products), SMEs account for more than 50% of employment and valued added in this sector.

[21] DG Enterprise and Industry: "Sector profiles" (Draft)

International trade and competition

The EU is a net exporter of ceramic products. Roughly a quarter of EU output is sold on world markets (Ecorys, 2008b). The share of exports differs considerably between sub-sectors. Export quota of heavy ceramic products with high transport costs in relation to the product costs (which includes ceramics with lower value added such as bricks and roofing tiles) are much lower. The majority of EU ceramic exports are wall and floor tiles, which originate primarily from Spain and Italy, as well as tableware.

Internationalisation also concerns the procurement of raw materials. In many cases, raw materials for use in the cement industry are no longer extracted in the direct surroundings of the user industry. The European industry is increasingly dependent on imports from third countries. Access to raw materials is therefore an important issue for the sector's competitiveness.

2.1.3 The EU cement, lime and plaster industry

This sector covers the manufacture of cement, lime and plaster (NACE Group 23.5) and the manufacture of articles made of concrete, cement and plaster (23.6). Before cement was invented in the 19th century, lime and plaster were the main materials used instead of cement. Reflecting the importance of cement nowadays (as compared to lime and plaster), the focus of this study is on the cement industry.

In contrast to glass and ceramics, **cement** can be considered a quite homogeneous product, even if the raw materials vary slightly from plant to plan. There are only five main classes of cement (the most common type of cement is “Ordinary Portland Cement”) and within these classes, products from different producers can generally be interchanged. Therefore, price is normally the most critical sales parameter besides customer service. Quality premiums are rather limited.[22] Cement is produced in a two-step process. First, "clinker" is produced from raw materials (mainly limestone and clay) that are heated within a kiln at an intense heat before being cooled. Second, gypsum and further additions are added to the clinker and ground to fine cement powder in a cement grinding mill. The cement is then stored in silos before being dispatched either in bulk or bagged.[23]

Concrete is a building material made of cement, water, sand, aggregates, and often some admixtures. Articles manufactured from cement and concrete include a wide range of **construction products** (e.g. prefabricated structural components, flagstones, cement pipes and bricks, artificial stones made of concrete), mortars and fibre cements.[24]

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[22] CEMBUEREAU: "Main characteristics of the cement industry". See http://www.cembureau.be/ (accessed in March 2009).

[23] Eurostat 2007, p. 132

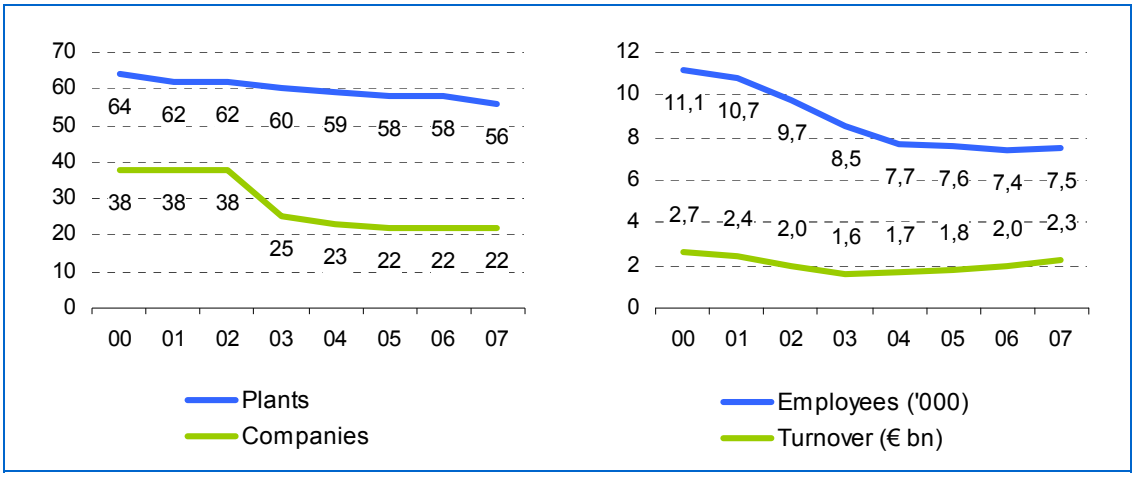
[24] ibid., and CEMBUEREAU: "Main characteristics of the cement industry". See http://www.cembureau.be/ (accessed in March 2009).

Industry size and structure

In total, according to Eurostat, the sector employed about 530,000 persons in the EU in 2005.[25] Only about 86,000 out of those were directly employed in the manufacture of cement, lime and plaster (NACE 23.5),[26] while nearly 440,000 people work in companies producing articles which are made of concrete, cement and plaster (NACE 23.6). The comparatively low number of people working in NACE 23.5 reflects that the cement industry is a process industry characterised by low labour intensity. A modern plant is usually manned by fewer than 150 people.

A general trend towards consolidation in this sector can be demonstrated by the example of the German cement industry. The number of plants has declined from 64 to 56 from 2000 to 2007 (see Exhibit 2.6). The number of employees went down from 11,100 to 7,500 in the period 2000-2004 and has been stable since, while turnover increased significantly from 2003 to 2007.

Exhibit 2-6: Development of the German cement industry (2000-2007)



Source: figures by bdz - Bundesverband der Deutschen Zementindustrie (http://www.bdzement.de) – charts developed by SeBW

The cement, lime and plaster industry is a cyclical business which depends, in particular, on the economic situation of the construction and building industry. Thus, the sector is directly affected by the economic crisis, notably by the decline in building activities in the residential sector in many countries. In the EU 27, cement production fell by about 7% year-on-year to currently 254 million tonnes (CEMBUREAU, 2008).

Cost structure

Due to the low labour intensity of this industry (NACE 23.5 and 23.6), personnel costs only account for about 18-20% of total expenditures. Purchases of supply goods and services (including, in particular, raw materials and energy), account for about 75%, and investment in intangible goods for the remainder (Eurostat 2007). All segments of this sector are highly

[25] Eurostat structural statistics (SBS)

[26] CEMBUREAU reports for the cement industry (as represented by its members) a figure of 52,800 direct jobs in the EU (2007).

energy-intensive. In the cement industry, energy costs account for more than 30% of total production costs.[27] Each tonne of cement produced requires about 105 KWh of electricity.[28]

A significant cost factor with implications for trade are transportation costs, in particular for land transportation, because of the weight of the products. A rule of thumb used to be that cement could not be economically hauled beyond 300 km, because the price of road transportation could easily become higher than the product price. Bulk shipping has changed that to some extent.[29] Still, as a result, plants are mainly producing for the local market.

International trade and competition

Historically, the cement industry was globally fragmented, with most markets served by local producers. Beginning in Europe in the 1970s, the cement industry experienced significant worldwide consolidation. Today, there are a handful of multinational cement companies, including Lafarge Group, Holcim (Switzerland), Cemex (Mexico), HeidelbergCement (Germany) and Italcementi (Italy). These companies compete against each other and have established local producers in various markets around the world. New entrants to the industry face a significant **barrier to entry** in the form of high initial capital costs. Constructing a new cement line with a capacity of 1 million tonnes annually costs between 50 and 160 million euros, depending on the country in which it is located. Cement is also a product which is costly to transport over land. Consequently, the area within which a typical cement plant is competitive extends to about 300 km (for the most common types of cement). However, the cement industry is highly competitive with some countries or regions more exposed during certain periods than others, due to factors such as the level of demand, access to the market or reserves of raw materials, energy prices or policy developments (for example policy on CO2 emission).

Thus, the cement, lime and plaster industry is witnessing an accelerated **internationalisation**, but not necessarily a "globalisation": companies still operate predominantly in regional markets. In other words, big cement companies are expanding their positions in new and emerging markets, but in all markets where they operate, competition remains mainly local. The largest cement producers in the world with interests in the EU are generally regarded to be CEMEX (Mexico), HeidelbergCement (Germany), Holcim (Switzerland), Italcementi (Italy) and Lafarge (France). These groups have expanded their product portfolio into several building materials and sub-sectors such as aggregates, concrete products and plasterboards.[30] According to CEMBUREAU, the EU member states account for about 9% of world production (2008). Asia is by far the largest producer, accounting for about 71% of total production.

In the international trade of cement and clinker (which is the exception, as explained above), European companies always had a trade-surplus until 2006. In 2007, for the first time, imports into the CEMBUREAU member countries exceeded exports by a few million tonnes (see Exhibit 2.7). The amount of imports (in tonnes) surged in the period from 1987 to 1992 and has risen steeply again since 1999. Exports, on the other hand, have been mostly stagnating (with some fluctuations from year to year) since the mid 1990s. In 2008, however,

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[27] bdz: "Themes: Energy intensity and energy efficiency", http://www.bdzement.de/75.html?&lang (March 2009)

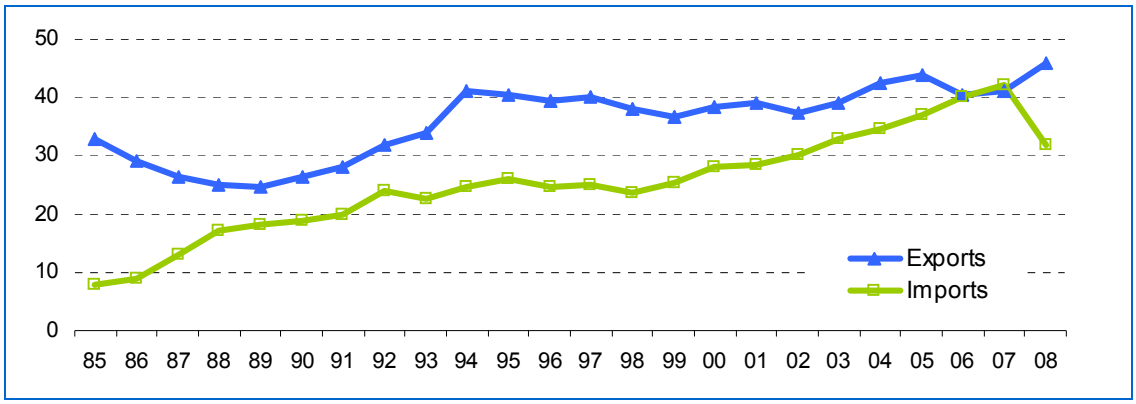
[28] CEMBUREAU: "Main characteristics of the cement industry." www.cembureau.be (March 2009)

[29] CEMBUREAU Key Facts: "A heavy product" www.cembureau.be (April 2009)

[30] CEMBUREAU: "The European industry: an international presence." www.cembureau.be (March 2008)

exports increased by nearly 12% up to about 46 million tonnes, while there was a 23% decline in imports to approximately 32 million tonnes.

Exhibit 2-7: Development of EU exports and imports of cement and clinker since 1985 *(in million tonnes)*



Source (figures): CEMBUREAU Activity Report 2008 (http://www.cembureau.be)

The main destination for EU cement and clinker exports is traditionally the USA. EU companies own almost 60% of US production capacity, as cement producers have generally invested in manufacturing sites there. Imports (which supplied 7% of EU consumption), three-quarters of which are clinker, come mainly from far eastern Asian countries, like China, Thailand, and the Philippines.[31]

2.2 Challenges

This section looks at recent developments in the market and regulatory environment which create challenges for companies in the GCC sector. Major challenges are energy costs and increasing pressure to cope with environmental regulation (Section 2.2.1), a sharp decline in global demand due to the overall economic crisis (Section 2.2.2), and the increasing intensity of competition (including aspects of unfair competition such as the counterfeiting of trademarks – see Section 2.2.3).

2.2.1 Coping with environmental regulation and energy costs

Industrial activities account for more than half of global greenhouse gases emissions. Energy-intensive sectors such as the GCC industries, inevitably, cause a disproportional share of emissions. There is strong evidence that greenhouse gases have an impact on climate change, commonly referred to as global warming. Today, the great majority of experts takes these links for granted, while only few still oppose the view that global warming is (at least partly) caused by industrial civilization. In the past five years, international efforts to reduce greenhouse gas emissions (GHG) have significantly gained support and momentum. Europe is committed to take a lead in this field.

[31] see sector profile "cement" provided by the European Commission, DG Enterprise and Industry (http://ec.europa.eu/enterprise/sectors/metals-minerals/non-metallic-mineral-products/cement/index_en.htm, November 2009)

EU policy towards reducing greenhouse gas emissions

Until 2005, GHG emissions resulting from commercial activities were not restricted in most of the EU member states.[32] In 2005, the **EU Emissions Trading System** (**EU ETS**) became effective,[33] the first GHG emissions trading system in the world. It covers the nine most intensive GHG-emitting industrial sectors with currently more than 10,000 installations, including the GCC sector. Most of the EU ceramics and cement installations are covered by the Directive. Under the EU ETS, each country determines a binding cap for its national GHG emissions and allocates tradable emission allowances in the same amount to all affected installations (NAPS – National Allocation Plans). In this way, operators of installations can choose to either use the allowances to back up own emissions or to sell the allowances on an EU-wide market and to reduce their own emissions by the same amount. In this way, the costs of reducing EU-wide GHG emissions are minimised at given national emission caps.

Industry concerns

The GCC industries has expressed major concerns about the effects of the ETS on the competitiveness of the European industry. A study by the Boston Consulting Group, requested by CEMBUREAU,[34] concludes that clinker and cement production in the EU will be seriously affected by carbon leakage, leading to an acceleration of the **relocation** of clinker production to countries with no carbon constraints from 2013 onwards.[35] The study estimates that at current CO_2 prices of 25 € per tonne, approximately 80% of clinker production could be offshored, if no free allowances are allocated. The industry therefore stresses the importance of taking appropriate measures to prevent unfair competition from products (e.g. cement and clinker) imported into the EU from regions with no carbon constraints and, therefore, no CO_2 costs.

A counter-argument to this view is that cement and clinker are mostly traded regionally within a distance of 300 km radius, because of the high **transportation costs**. This has also been stated in the document accompanying the package of implementation measures for the EU's objectives on climate change and renewable energy for 2020. CEMBUREAU argues that this applies to land transport only, but not to shipments over long distances by sea (from countries with no carbon constraints such as China).[36]

The industry also argues that greenhouse gas emissions should be accounted for in a **product life-cycle perspective** and not just by looking at the production process. For example, the production of construction materials made of clay and ceramics may cause more greenhouse gas emissions than other materials such as wood, but are then used for many years. Similarly, glass bottles are more energy-intensive in their production, but the carbon footprint could be shown to be positive if recycling of glass was accounted for. British

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[32] Notable exemptions are Sweden, Denmark and Finland, where carbon taxes were introduced in the early 1990s, and the UK, where such a tax was introduced in 2001.

[33] In 2003, the European Commission had published Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, stipulating that the ETS was to start in January 2005.

[34] "Assessment of the impact of the 2013-2020 ETS Proposal on the European cement industry". Study by BCG (2008).

[35] Quoted from: "Carbon leakage: European cement industry at risk", press release by CEMBUREAU, 7 October 2008

[36] "Emission Trading Scheme 3rd Phase: CEMBUREAU invites Commission to rethink conclusion of study on cement as an energy intensive industry", press release by CEMBUREAU, 23 January 2008.

Glass estimates that glass recycling in 2006 in the UK saved 365,000 tonnes of CO_2 emissions, equivalent to removing over 100,000 cars from the road.[37]

The industry also considers increasing the use of **eco-labels** on its products to mark environment-friendly products, similarly as it is practised with household appliances such as refrigerators (with regard to energy efficiency). The hope is that European GCC products, which tend to be among the most advanced in terms of their environmental "footprint", should benefit from such a labelling system.

A prisoner's dilemma

It is not the topic and objective of this study to enter into the details of these legal frameworks and their challenges, as there are no direct links with ICT, except that specialised ICT solutions can help companies in their compliance with the ETS.[38] In conclusion, policy is confronted with a typical "prisoner's dilemma"[39] 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. The GCC industries is a perfect example – European industry associations from these sectors have already warned against the migration of production from Europe to Asia or other regions where environmental regulation is less strict.

Seen from a global perspective, the additional **costs** to reduce GHG emissions are most certainly not only a necessary, but also an economically reasonable investment. Stern (2006) argues that ignoring the impact of GHG emissions would be far more expensive, as the resulting climate change will damage future economic growth. According to the well-known Stern Review, a lack of reduction efforts will result in costs and risks that will be equivalent to 5% of global gross domestic product (GDP) each year. In contrast, the costs of taking actions to reduce GHG emissions and to avoid the worst impacts of climate change could be limited to 1% of global GDP each year.

Energy costs

Emissions are closely linked with energy consumption. Besides the environmental effects of energy consumption, rising energy costs are also a business concern of the GCC sector, as it is a highly relevant **cost factor** with an **impact on competitiveness**. In the cement industry, energy costs typically amount to about 30% of production costs, in the glass industry they account for about 20%. Of energy costs are significantly lower in one region or country than in another, companies producing in this region/country therefore have a competitive advantage.

To counteract rising energy costs, the industry has made enormous efforts to become **more energy efficient** in production. The glass industry, for example, has significantly decreased its energy consumption levels since the 1970s. The German industry association has calculated that energy efficiency has increased by 77% since 1970, mostly due to continuous

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[37] "Glass: Society and the Environment", brochure by British Glass

[38] Whether and to what extent ICT can help reducing GHG is the focus of another Sectoral e-Business Watch study conducted in parallel to this study: "ICT Impact on Greenhouse Gas Emissions in Energy-Intensive Industries" (2009). The issue is therefore not analysed in more detail in this report.

[39] 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.

innovation in production technologies.[40] British Glass, the manufacturers' confederation, reports that the amount of energy required to melt a tonne of glass has fallen from 3.18MWh per tonne to 1.47MWh between 1979 and 2003, i.e. by more than 50%.[41] The technological progress in production procedures has also led to reduced CO_2 emissions (in relation to the output). The efforts to reduce CO_2 emissions are documented in regular monitoring and inspections by independent institutes. Production processes in the cement and ceramics industry have also become much more energy efficient.

Although the various industries of the sector continue to seek new ways of further reducing their emissions and energy consumption, it is questionable whether there is much **further potential** in the foreseeable future. Representatives of the ceramics industry believe that the remaining potential to further bring down energy costs in production is only about 5%.[42] In the cement industry, the co-processing of alternative fuels (e.g. used tyres) might be one way of recovering energy and material from waste.[43]

ICT-based tools can possibly contribute to increase the energy efficiency in production, but mainly in indirect ways, by optimising business processes in general. Examples how this is accomplished are given in Section 3 and in case studies in Section 4.

Other areas of environmental concern

While greenhouse gas emissions, energy consumption and the ETS are probably the most important environmental challenges for the GCC sector, there are other relevant topics as well. These include the REACH regulation for chemical substances,[44] the Directive on Integrated Pollution Prevention and Control (IPPC) and its implementation, and the Directive on Packaging and Packaging Waste (affecting the glass industry). In principle, the challenge is similar as in the case of ETS: how to improve environmental standards without risking that imbalances in the international regulation leads to undesirable outcomes, which, in the worst case, might be contrary to the intended effects.

A specific case where the internet could play an important role is the revision of the Construction Products Directive (CPD),[45] presented by the Commission in 2007. There are some conflicts between the authorities involved and the industry associations representing the sector concerned about the implementation details. Basically, associations see a solution

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[40] Information by BV Glas (the association of the German glass industry), http://www.bvglas.de/umwelt-energie/energie-klimaschutz/ (accessed in May 2009)

[41] "Glass: Society and the Environment", brochure by British Glass

[42] Interview with Renaud Batier, Managing Director, Cérame-Unie, April 2009.

[43] See "Sustainable cement production: Co-processing of alternative fuels and raw materials in the European cement industry", brochure by CEMBUREAU. In 2006, the European cement industry used an energy equivalent of about 26 million tonnes of coal, a non renewable fossil fuel, for the production of 266 million tonnes of cement. Alternative fuels constituted 18% of this across Europe, saving about 5 million tonnes of coal.

[44] All manufacturers and importers of chemicals must identify and manage risks linked to the substances they manufacture and market. For substances manufactured or imported in quantities of one tonne or more per year per company, manufacturers and importers need to demonstrate that they have appropriately done so by means of a registration dossier, which must be submitted to the European Chemicals Agency (ECHA).

See http://ec.europa.eu/enterprise/reach/reach/index_en.htm (May 2009).

[45] Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products (89/106/EEC), amended by Council Directive 93/68/EEC of 22 July 1993 and Regulation (EC) No 1882/2003 of the European Parliament and of the Council of 29 September 2003.

to some of the practical challenges if compliance with the CPD could be achieved by putting the requested information on the internet.

2.2.2 Impact of the economic crisis

While climate change and resulting environmental pressure is a longer-term challenge for the GCC industries, the main short-term challenges is certainly the unprecedented global economic crisis that has unfolded since 2008. In particular, the complexity of the situation and the **uncertainty** how long it will take for the economy to recover make strategic and operational planning extremely difficult. The GCC industries suffers, in particular, from the slack period in the **construction industry**, one of its main customers. During the global economic boom from 2004 to 2007, many companies have expanded their capacity; now they are witnessing a rapid decline in business.

A specific challenge resulting from the crisis is the widely-debated "**credit crunch**". In particular SMEs often have difficulties financing their growth and innovations, as banks have tightened their conditions for providing credit. BDI, the association of the German glass industry, has warned against the difficult access to finance for its members. The association expresses major concerns that financing conditions for its members will become even more constrained in 2010. It has issued a position paper ("Securing business financing, avoiding the credit crunch") with recommendations to banks and policy.[46] BDI argues that the securitisation market (a financing process where risks are distributed by aggregating debt in a pool and issuing new securities backed by this pool) should be stimulated, and to adapt capital and liquidity requirements to banks depending on risks. However, there are different views on the credit crunch, both with regard to the actual dimension, and in terms of the assessment.

The issue is relevant for this study in so far as financing difficulties can be a **barrier for ICT investments**. If companies face difficulties in financing their ongoing business, they are likely to postpone or cancel any investment in future business. Thus, the credit crunch may be a barrier to innovation, as ICT is an important means in innovation processes (see Sections 3.3.1 and 3.3.2).

2.2.3 Increasing intensity of international competition – creating a 'level playing field'

It is not only lower production costs 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. The European Commission is aware of this challenge, pointing out that EU exporters face a number of obstacles. To improve the situation, a number of directions are being explored, and cooperation with WTO is sought.

[46] "BDI warnt vor sich verschärfender Situation bei der Unternehmensfinanzierung", 01. December 2009, http://www.presseportal.de/pm/6570/1522489/bdi_bundesverband_der_dt_industrie

Industry proposes that actions to establish a level playing-field should focus on the following action lines:[47]

- promote ILO social conventions
- induce competing countries to adopt ETS
- extend REACH substances classification to third countries (not only imports to EU)
- promote pollution standards (IPPC)
- promote construction products standards
- check tableware health & safety standards at EU borders

Protection of IPR and measures against counterfeiting

Specific challenges closely linked with globalisation are the protection of intellectual property rights and the fight against counterfeiting. European industry federations cooperate closely with customs in this area and provide support for EU helpdesks in China, one of the main origins of counterfeited products.

Concerned are mainly well-known brands in the ceramics table and ornamental ware market. The internet also causes some problems in this respect. The web has arguably facilitated the distribution of counterfeited products, notably if they have a well-known brand and are intended for the consumer market (e.g. glass, table ware), 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.

Access to raw materials

Ensuring access to raw materials is a critical issue in this context. In the refractory products segment, for example, magnesite, bauxite and aluminium are important raw materials. These need to be imported, e.g. from China, Australia and Brazil, since the deposits in Europe are not sufficient. The percentage of raw materials imported varies considerably between the different segments of the GCC sector, but also between companies within a segment. There is a clear trend towards importing materials, however, In a survey conducted for the EC study on the Competitiveness of the Glass Sector (2008), all respondents said that since 2000 the share of raw materials imported had either increased or not changed (ECORYS SCS Group, 2008a).

In the glass industry, further a shift towards the use of recycled glass as a raw material might contribute to decreasing the demand for raw material inputs such as soda ash and silica and thus the dependency on suppliers.

[47] Presentation by Mr. Ian Dudson, President of the European federation of porcelain and earthenware manufacturers FEPF, CEO of Dudson Ltd., at the high-level conference "From 2007 on: the principal challenges facing the European glass and ceramics industries" (Brussels, 16 May 2007)

3 Micro-perspective (I): e-Business activity in the GCC industries

ICT – a key enabling technology for manufacturing companies

As part of their efforts to cope with the challenging business environment described in the previous section, companies need to decide about their **e-business strategy**. This implies decisions on investments in ICT, in related skills and services, and goes normally hand in hand with organisational changes.[48] This chapter explores the current patterns of ICT use and e-business activity in the GCC industries. It presents recent data on the diffusion of ICT systems and how companies use them to support their business processes, internally and in the data exchange with business partners.

A TNO literature study on "Manufacturing Futures for Europe" (van der Zee / Brandes, 2007) found that foresight studies point towards four "**key enabling technologies**" for the manufacturing industry: (i) ICT, (ii) micro-systems, (iii) advanced materials, and (iv) bio- and nano-technologies. Amongst those, ICT were considered to be the most advanced technology. In literature, according to the study, ICT are broadly regarded to have **high potential** in manufacturing for productivity growth and for improvements in product quality. However, it is also much emphasis on the investment risks and the difficulty to quantify benefits:[49] "*New process technologies will improve production processes increasing productivity, efficiency and the quality of products. Most futures studies expect ICTs to play a decisive role in short-term manufacturing operations (…) ICTs allow for productivity increases through automation as well as through reorganizing business processes. In combination with technologies such as RFID, this will cause supply chains and value networks to dramatically transform. It will also enable the emergence of new business models. Although this will no doubt lead to productivity increases, high uncertainty precludes any firm quantitative predictions*. (…) *Furthermore, ICTs are important for the customization of products as they enable producers and customers to communicate in different and new ways, itself being a new and important ingredient for the creation of new business models.*" (van der Zee / Brandes, 2007: Section 3.3, p. 21f)

This summary of a literature review reflects very well the assessment of the Sectoral e-Business Watch for various manufacturing sectors, as presented in sector studies in previous years, e.g. for the chemical, rubber and plastics industry (2008c) or for the pulp and paper industry (2006). However, the sector studies also found that e-business practices and their strategic implications differ between industries (depending on factors such as their structure and value chain configurations), and even more so between individual companies.

This Section explores to what extent the general assessment presented above (as derived from a broad literature review) can be specifically applied to companies in the glass, ceramics and cement industries. A specific objective in this regard is to analyse how e-business activity is linked with different set-ups of companies and their specific market environments. For example, companies whose products are mainly bought and used by the

[48] The case studies in Section 4 illustrate this.

[49] The TNO study is based on a broad literature review, including the following "key European manufacturing foresight projects" of recent years: FutMan (2003) - “The future of manufacturing in Europe 2015-2020: the challenge for sustainability”; the ManVis Reports (Manufacturing Visions), which developed future visions of EU manufacturing 2020; and the ‘ManuFuture’ Strategic Research Agenda, a European Technology Platform which mission is to develop a strategy based on research and innovation. See study, Box 1: Overview of Key Futures Studies (p. 5)

construction industry can be expected to have a different focus in their ICT usage than companies producing consumer goods and selling either directly to end users or through retailers. In addition, the analysis takes into account (to the extent possible) the different requirements of small and large companies. The Chapter has been structured into three main sections:

- Section 3.1 looks at the companies' access to ICT networks and their endowment with basic infrastructure, i.e. the general "e-readiness" for e-business activity.
- Section 3.2 focuses on the actual status of electronic data exchanges between companies and their business partners. It is explored how advanced different types of businesses are in this respect.
- Section 3.3 discusses the "enabling role" of ICT beyond e-business, focusing on the role of ICT in innovation in companies.

In all sections, the study aims to make comparisons between different types of enterprises, in particular in terms of their size and the markets in which they operate. Where possible (i.e. if the respective variables were covered in earlier surveys as well), references will also be made to findings for other sectors.

Data sources

Most of the data on ICT adoption and e-business activity presented in this section are the results of a **representative survey** among ICT decision makers from 676 GCC companies in six EU countries (Germany, France, Italy, Poland, Spain, UK). The interviews were conducted as computer assisted telephone interviews (CATI method) in March 2009. In tables and charts, the survey is named "e-Business Survey in the GCC industries (2009)". More information about the survey methodology, including information about the participation rate and the statistical accuracy that can be expected for the results is available in Annex 2 ("Methodology report").[50]

For making **comparisons with other sectors**, the results of earlier e-business surveys by the Sectoral e-Business Watch are used, in particular those of the survey of 2007 among manufacturing sectors, which covered the chemical, steel and furniture industries. Some of the survey questions were the same in both surveys. The definition of the survey population (enterprises with at least 10 employees from 6-7 EU countries) was similar, [51] and the methodological approach for sampling was the same in both surveys. Results are therefore comparable. Structural differences of the sectors should be taken into account, however; the chemical and steel industries have a much higher percentage of employment in the large enterprises, while the furniture industry is SME dominated.

[50] A detailed Table Report with further survey results is available via the project website (www.ebusiness-watch.org). Researchers who want to use the raw (case level) data for their own statistical analysis can send a request to receive the data via an online form on the website (the conditions for use are also specified there).

[51] The sample of countries was similar in both surveys; the only differences is that Sweden was included in the survey 2007 but not in 2009.

3.1 "e-Readiness": ICT infrastructure, e-skills and ICT budgets

The objective of this section is to assess the sector's overall "e-readiness" in 2009, that is the level of preparedness for doing e-business. There are three main dimensions of "e-readiness" which are discussed in this section: the (technical) **infrastructure** dimension, i.e. to what extent companies are equipped with ICT network infrastructure and software systems supporting the electronic data exchange (Section 3.1.1); a **skills** dimension, i.e. the different types of ICT skills (including ICT practitioners and user skills) available in the company (Section 3.1.2), and the **financial** dimension, i.e. the capacity and willingness to make investments in ICT (Section 3.1.3).

3.1.1 Basic ICT infrastructure

Internet access and the use of internal ICT networks

In advanced economies, doing business without having **internet access** is practically no longer possible in most business sectors. In the survey of GCC companies, all but four of the 676 companies interviewed said they were connected to the internet in 2009 (see Exhibit 3-1). This was already found for the chemical and furniture industries back in 2007 and does not come as a surprise.

Exhibit 3-1: Companies with internet access and internal networks used (2009)

e-Business W@tch	Internet access		Broadband access (2 Mbit/s +)		LAN		W-LAN	
Weighting: % of …	empl.	firms	empl.	firms	empl.	firms	empl.	firms
GCC total	100	100	89	85	91	83	50	38
By sector								
NACE 23.1 (Glass)	100	100	92	89	92	83	52	42
NACE 23.2-4 (Ceramics)	100	100	90	83	93	82	56	38
NACE 23.5-6 (Cement)	100	100	88	83	90	83	47	37
GCC by company size								
Small (10-49)		100		83		78		34
Medium (50-249)		100		91		96		49
Large (250+)		100		90		95		51
Other sectors (2007)								
Chemical, rubber, plastics	100	99	*	*	95	82	58	38
Furniture	100	99	*	*	84	71	47	30
Base (100%)	All		All		All		All	
N (Base, total)	676		676		676		676	
Questionnaire reference	A1_a		A2		A1_b		A1_c	

* figures not directly comparable due to differences in the underlying question

Source: e-Business Survey in the GCC industries (March 2009)

What has been a concern of ICT-related policy in the past five years is rather the quality of companies' internet access. Advanced forms of e-business and online collaboration with business partners require sufficient bandwidth. The Sectoral e-Business Watch study on the chemical industry (2008) found that **broadband access** had significantly improved since the

last point of measurement in 2003, notably among SMEs. This finding is confirmed by the new survey results. The diffusion of broadband access –defined as connections with an available bandwidth of at least 2 Megabit per second– could actually be much higher than expected. Even among small companies (with 10-49 employees), more than 80% said that they were connected with broadband; among medium-sized and large firms, broadband adoption has apparently reached levels of more than 90% (see Exhibit 3-1).

This comes a bit as a surprise because figures for the chemical and furniture industry (survey of 2007) were much lower: only about 40% of the small companies and 50% of the medium-sized and large enterprises said they were connected with a bandwidth of 2 Mbit/s or more. While it is likely that broadband deployment has considerably increased in the two years since, a part of the difference may also be due to a change of the underlying survey question.[52] At least for large companies, "90%" with broadband access (figure of 2009) appears to be more realistic than the "50%" found in 2007. In any case, already the study of 2007 concluded that older types of low-bandwidth access such as analogue dial-up "has mostly disappeared from the market" and that "… broadband internet access should be considered as basic infrastructure and become the norm for the majority of companies" (p. 43). The new results suggest that this is no longer a vision but has become a reality.

The use of internal ICT networks

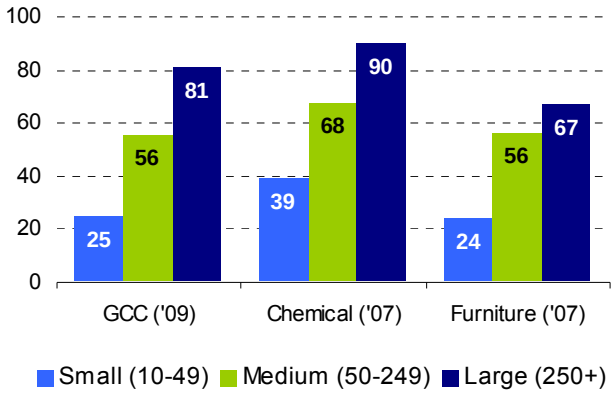
Similarly to internet access, the use of ICT to connect computers internally to a company network (Local Area Networks – **LAN**) has become a commonplace, even for small firms (see Exhibit 3-1). Diffusion has increased to more than 80% of companies in the GCC industries in 2009. More than 95% of medium-sized and large firms use a Local Area Network. The diffusion of **Wireless LAN** (W-LAN) technology has surged in the past five years. In the GCC industries, about half of all employees work in companies that operate a W-LAN (2009). It was already close to 60% in the chemical industry two years ago, where adoption rates among the large enterprises are higher than in the GCC industries. W-LAN is a means to facilitate network access within a site or building, for example in meeting rooms. Its relevance and usefulness increases with the respective number of employees that use computers in their daily work and thus with firm-size.

Another infrastructure 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 large companies, and to a slightly lesser extent in medium-sized companies, this has become a commonplace. In most sectors, more than 80% of the large firms make use of this relatively easy to establish opportunity (see Exhibit 3-2).

[52] In 2009, interviewees were simply asked whether their internet connection was "a broadband connection". If the respondent was unsure to say yes or no, the interviewer specified: "With broadband, we mean a data transfer rate of 2 megabits per second or more." In 2007, by contrast, interviewees were asked to chose one of three options: "What is the maximum bandwidth of your internet connection available for download? Is it less than 144 kilobit per second, between 144 kilobit and 2 megabit per second, or more than 2 megabit per second?"

In the GCC industries, about 60% of all employees work in companies which enable employees to remotely access files on the company's computer network. However, these represent only about a third of all firms. In small companies, logging in from a remote place is not yet a commonplace. Only about a quarter of all small GCC firms say that they have implemented remote access technology. Smaller companies from the chemical industry were slightly more advanced in this regard already two years ago.

Exhibit 3-2: % of companies offering remote access to their computer network



Source: e-Business Surveys 2007 / 2009

3.1.2 Adoption of advanced e-business software systems

The automation of data exchanges as discussed in the Section 3.2, in 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), SCM (supply chain management) and CRM (customer relationship management). This section focuses on the deployment of these systems in the GCC sectors as a basis for more advanced e-business practices.

Enterprise Resource Planning (ERP)

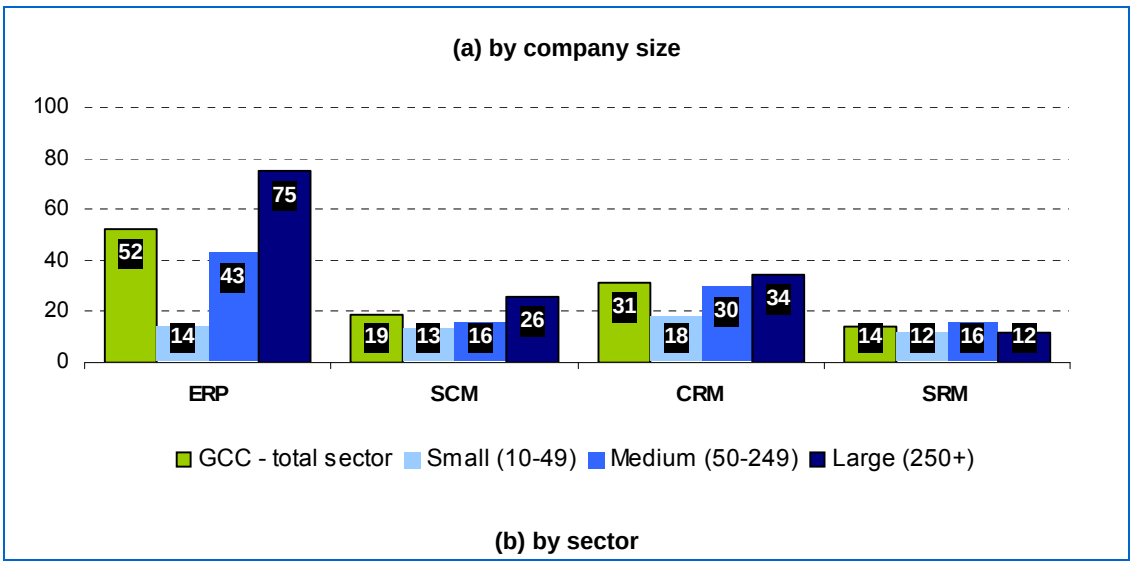
For manufacturing companies, Enterprise Resource Planning (ERP) systems are an important "hub" for much of their e-business activities with other companies. This applies at least to the larger enterprises in the glass, ceramics and cement industries, where B2B data exchanges as well as planning and controlling processes are largely based on functionalities provided by ERP systems. 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 play an important role in supporting connectivity between enterprises. Historically, 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 majority of large companies in the GCC industries (75%) has an ERP system in place. Among medium-sized companies, still more than 40% are ERP users. In total, companies representing 52% of employment in the three sectors said they had an ERP system (see Exhibit 3-3a). A high adoption rate of ERP systems supports the deployment of more

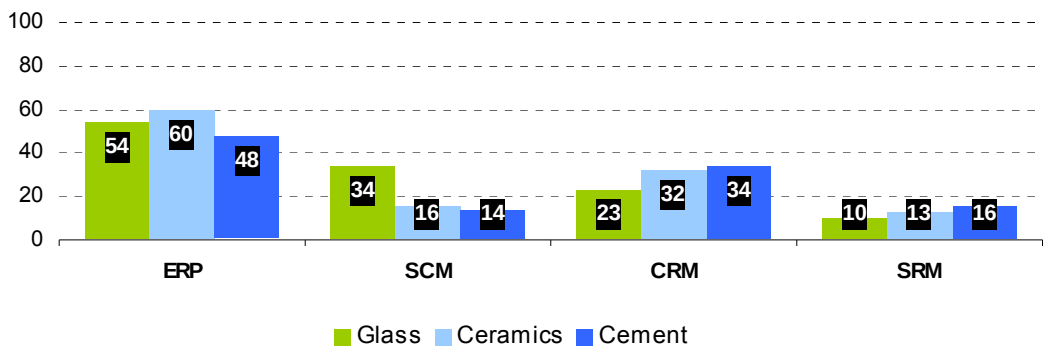
advanced forms of data exchange. Exhibit 3-3b compares ERP adoption rates in different manufacturing sectors, compiling the results of different representative enterprise surveys conducted by the Sectoral e-Business Watch since 2005. The results show that adoption rates among large companies are quite similar across the sectors (65%-80%). Among medium-sized companies, differences are more pronounced. In fact, the deployment of ERP systems among SMEs is probably a good indicator to conclude about the e-business activity levels in a sector, at least in manufacturing. In the chemical industry and in ICT manufacturing, where e-business was found to be more advanced than in other sectors, ERP adoption among medium-sized enterprises has reached 60%.[53] In the GCC industries and other sectors (food, paper, furniture, steel), ERP adoption among SMEs is less common (typically 40-45%).

Case studies about ERP use in these sectors show that most of the large companies have implemented their ERP system in the late 1990s or in the early years of this decade. All case companies reported that the introduction of the ERP system has been a major milestone (and sometimes turning point) in many respects, as it has a fundamental impact on the company's internal organisation and work-flows. The new ERP-focused case studies presented in this report, the glassmaker **BA Vidro** (Portugal) and **Lafarge Cement** in Poland (Sections 4.2 and 4.5), confirm this assessment and illustrate the central role that ERP systems have for the effective and efficient management of business processes. BA Vidro, a glass manufacturer with about 1500 employees, reports that its ERP system (initially introduced in 1997 and continuously adapted to emerging business needs since) has developed into an essential platform for company-wide information management. It enables the tracking of materials, tools, machines and time used in production. This results in a more effective management of orders and better consumption forecasts. At Lafarge Cement in Poland (about 600 employees), benefits include cost savings in plant management due to better control through a specific plant maintenance module of the ERP system, and improved control and purchasing of raw materials.

Exhibit 3-3: % of companies using advanced e-business software systems



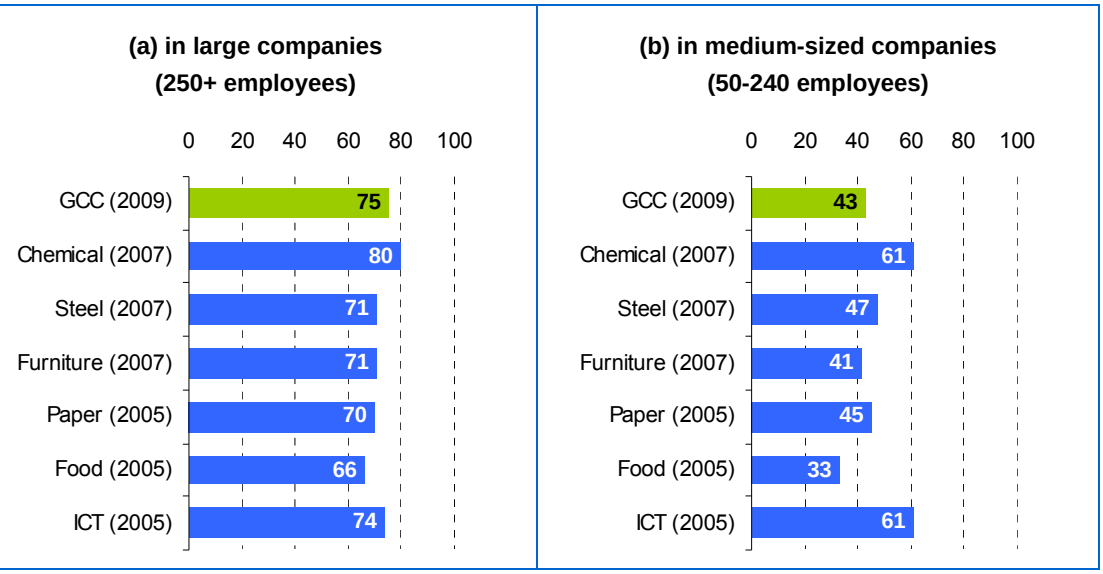
[53] In ICT manufacturing, which was surveyed back in 2005, deployment has probably further increased since.



Base (100%): all companies. N = 676. Data for the sector totals are weighted by employment (companies representing x% of employment), data for size-bands are in % of enterprises. Reading example: "Companies representing 52% of employment in the GCC industries have an ERP system."

Source: e-Business Survey 2009

Exhibit 3-4: Adoption of ERP systems in different manufacturing sectors (2005-2009, in %)



Source: e-Business Surveys 2005 / 2007 / 2009

Supply chain management (SCM)

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 adding more SCM functionality to

their products, while SCM vendors are also expanding their functionality in areas traditionally handled by the ERP vendors.[54]

In the GCC industries, companies representing about 20% of employment said that they had an SCM system (see Exhibit 3-3a). The adoption rate is somewhat lower than in other manufacturing sectors such as the chemical industry (about 40%) and the steel industry (27%) which were surveyed in 2007. Within the GCC sectors, the larger companies in the **glass industry** are important users of SCM systems. The SCM adoption rate in this sector is more than twice as high as in the cement and ceramics industries (see Exhibit 3-3b). Managing the supply chain in the glass industry is particularly complex. The nature of glass is a supply chain challenge in itself: it is bulky, fragile, and difficult to deliver intact, on top of meeting stringent requirements for high quality and safety. SCM systems promise helping companies in coping with these challenges (see SAP business example)

Business example

SCM for the glassmaking industry

SAP, a large software company, offers a supply chain management solution ("mySAP™ SCM") as part of its "SAP for Mill Products" portfolio. The SCM system supports glass-specific business processes across the entire enterprise, including forecasting and inventory management. The system is integrated with SAP's ERP solution, so that companies can tie their supply chain with the manufacturing process.

SAP says that the solution It addresses "all the core business software requirements of midsize and large glassmakers for the complete range of glass products like tempered glass, insulated glass, glass wool, bottles and jars, windows, and optical fibers." The system is expected to provide companies with better control over their inventories and production capacity, which should lead to more efficient processes, facilitated decision making and ultimately reduced costs.

Source: SAP Solution Brief: SAP for Mill Products (http://www.sap.com/industries/millproducts/pdf/BWP_SB_Supply_Chain_Management_for_Glassmaking.pdf, accessed in November 2009)

Customer / supplier relationship management (CRM / SRM)

Customer relationship management (CRM) systems promise a company the ability to systematically increase knowledge about its customers and their profitability, as well as to build and adapt marketing strategies on the basis of this intelligence. Within this broad objective, CRM covers a broad range of methodologies and software applications. Normally, the system will be based on a database with systematic information about customers and the business record the company has with them. In literature, three levels of application of CRM are commonly distinguished:[55]

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

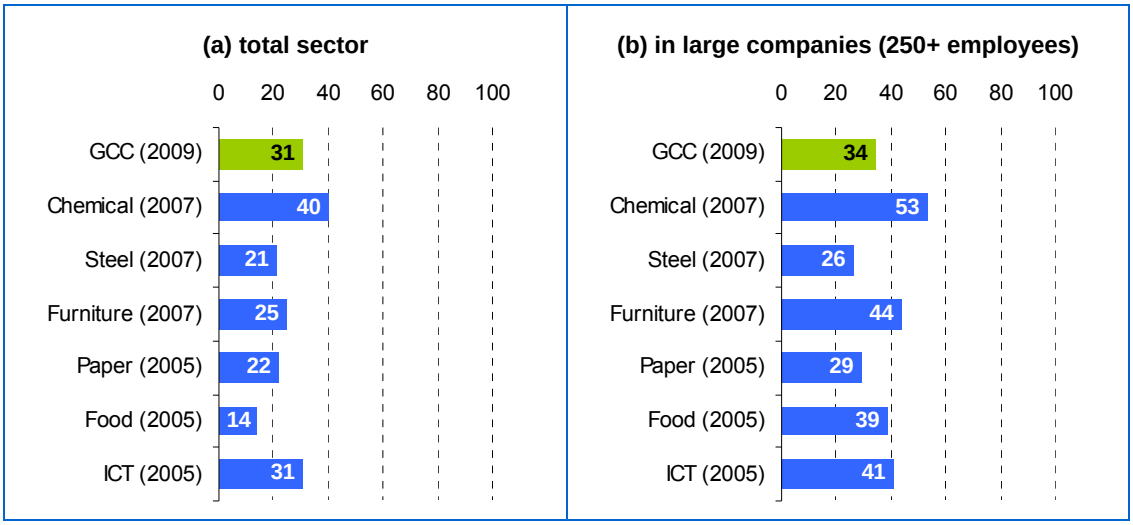
[55] see for example Kollmann (2007), p. 327

- **Operational CRM**: supporting front-office work by storing basic data on customers (e.g. addresses, track record of contacts); front-office enters new data as part of their work;
- **Analytical CRM**: analysis of data gathered through operational CRM in order to segment customers;
- **Collaborative CRM**: facilitates interactions with customers through all channels (personal, letter, web, e-mail) and supports co-ordination of employee teams.

The cost for CRM software suites differs considerably depending on the requirements of the company and the resulting complexity of the system. Costs for a simple CRM system with licences for some users, catering to the typical needs of smaller companies, will start from about € 5,000. A more complex system will be much more expensive and require a lot of organisational preparatory work to be effectively introduced in a company. CRM is a key application for many of the larger companies in service sectors catering to many customers such as telecommunications and travel organisers. It is also used in manufacturing industries, but to a lesser extent.

In the GCC industries, companies representing about 30% of the sector's employment said they had a CRM software system in place (see Exhibit 3-3). Adoption rates increase by firm-size, but not to the same extent as those for ERP systems. This indicates that the barriers for CRM adoption are considerably lower. First, the CRM market is much more diversified than the ERP market, with a wide array of low-cost solutions for SMEs. Second, the organisational implications of implementing and using a CRM system are typically much less "disruptive" than the act of implementing an ERP system, at least at the levels of operational and analytical CRM. In contrast to SCM systems, which are most widely used in the glass industry, the adoption rates for CRM systems are higher for the ceramics and cement industry (see Exhibit 3-3b). When comparing the CRM adoption rates in different manufacturing sectors, use is comparatively widespread in the GCC industries. Among the sectors surveyed in recent years, only the chemical and the ICT manufacturing sector had a higher adoption rate (see Exhibit 3-5). As a rule of thumb, the added value of a CRM system for managing and analysing customer data tends to increase with the number of customers that are serviced. If a company makes business predominantly with a few main customers, it will not need a specific software to analyse its sales.

Exhibit 3-5: Adoption of CRM systems in different manufacturing sectors (2005-2009, in %)



Source: e-Business Surveys 2005 / 2007 / 2009

Supplier relationship management (SRM) is the supply-side equivalent to CRM. An SRM system supports specifically the strategic planning and central management of a company's relationship to its suppliers. SRM can also be seen as an element of SCM (see above) and an extension of the sourcing and e-procurement processes. The SRM system is a database that provides a complete view of the company's suppliers and their offer, such as information about their spot goods, the purchases made in the past, and information about the conditions, quality and possible risks. The system has typically online connection at least with the main suppliers so that the information can be automatically updated. The added value results from the integration of all this information in a single database.

SRM systems are not yet widely used in the GCC industry, not even among large companies. In total, about 15% of the companies interviewed said they had an SRM system in place (see Exhibit 3-3a). The statistical evidence is supported by the case studies, not only those presented in this report but also those conducted in the previous years. While many of the case companies were users of ERP and/or CRM systems, the use of a specific SRM software was never mentioned in interviews. However, supplier relationship management is an activity which has not the same direct connotation with ICT systems as ERP or CRM. The concept is closely related to e-procurement, and therefore ICT-based e-procurement systems may contain SRM-related functionalities.

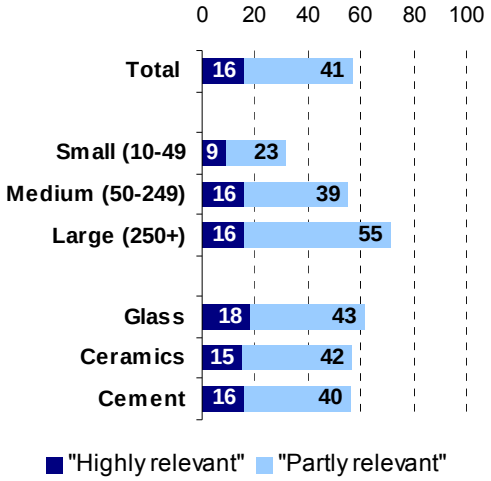
The case studies on the use of e-procurement systems in **Schott AG** and **Holcim Slovensko** (see Sections 4.1 and 4.4) may serve as examples. Sourcing and procurement at Schott has a strong impact on the company's overall success. Schott AG, a large glass manufacturer, uses an explicit SRM tool. This is tightly integrated with the overall sourcing and procurement systems of the company: various e-sourcing features originally developed for the needs of Schott have been integrated as a standard in the Onventis TradeCore SRM software suite. The company points out that sourcing does not mean to search the *cheapest* offer, but rather to find *reliable* suppliers that meet the needs of the company at an optimal price and in adequate quality.

Other software systems supporting e-business

Besides ERP, SCM, CRM and SRM, there are several **further software systems** that support companies in replacing paper-based processes. For example, document management systems (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) means systematically planning and controlling the entire lifecycle of a product, from its initial concept and design, through manufacturing and service to the disposal. 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 as it builds on functions of those basic systems.

Another example of advanced systems to automate processes are **mobile applications** which enable workers to access the company's business systems from different locations by use of mobile computing devices. According to the survey, close to 60% of the companies (in particular medium-sized and large firms) consider mobile applications as relevant for their business. For instance, sales people use mobile devices to connect with the company's system from abroad. An important trend in this domain is "mobile ERP", which enables employees to remotely access data stored in the ERP system. This can be useful, for example, for warehouse employees as they can access or send data from the warehouse to the system in real time. There are solutions for SMEs.

Exhibit 3-6: % of GCC companies that consider mobile services as "highly" or "partly" relevant for their business (2009)



Base (100%): companies with at least 10 employees and using computers (N = 676).

Source: e-Business Survey 2009

3.1.3 ICT skills – demand and supply[56]

The Sectoral e-Business Watch studies of 2007/08 show consistently that the successful implementation and use of ICT goes hand in hand with having the right e-skills. This is valid for the workforce that uses software in its daily operations, for specialists that implement, run and maintain ICT systems in companies, as well as for managers that have to take decisions on strategy (including e-business strategy), ICT investments and business organisation.

The **e-skills policy framework** of DG Enterprise and Industry distinguishes between "ICT practitioner skills", "ICT user skills" and "e-business skills":[57]

- **ICT practitioners** are staff with the specialised skills and tasks of planning, implementing and maintaining ICT infrastructure.
- **ICT user skills** are defined as the capabilities required for the effective application of ICT systems and devices by the individual in his daily work routine. At the general level, they cover what is frequently referred to as "digital literacy".

[56] A more detailed and in-depth analysis of the demand for ICT skills is available in another Sectoral e-Business Watch study of 2009. This study analysed trends in e-skills demands in an explorative way by interviewing CIOs and Human Resources managers of specific companies (case study approach), both from ICT using and ICT producing industries. The study is available at the company website (http://www.ebusiness-watch.org).

[57] European e-Skills Forum (2004). E-skills in Europe: Towards 2010 and beyond. Synthesis report of September 2004 of the European e-Skills Forum, established by the European Commission, DG Enterprise and Industry.

- **e-Business skills** are defined as the capabilities needed to exploit opportunities provided by ICT, notably the internet, to ensure more efficient and effective performance of different types of organisations. e-Business skills have strong links with the managerial understanding of ICT-based business opportunities and strategy development. The management needs to conceptually understand what ICT can do for the company, in order to take the right decisions and to support investments (if needed) and related innovation processes. This applies to SMEs and to large companies. While "e-business skills" are a vital part of e-skills in business, these skills are the most difficult ones to quantify and measure. They are to a large extent intangible skills.

In this section, the focus is on the first two types of e-skills. Companies in the GCC industries were asked about their actual demand for ICT practitioners and to what extent they experience challenges due to a lack of ICT user skills among their employees. Finally, some data on the outsourcing of ICT services are presented.

Demand for ICT practitioners

In the assessment of the demand for ICT practitioners (in non-ICT companies), a clear distinction must be made between larger companies that typically employ practitioners and other (mainly smaller) companies that cannot afford employing specialised ICT staff. The challenges differ accordingly. Larger companies may directly suffer from a shortage of ICT professionals (e.g. software programmers, ICT consultants). Those companies that do not employ practitioners themselves are only indirectly concerned by skills shortages, for example in the way that procuring or outsourcing ICT services can become more difficult or expensive.

In the GCC industries, about 20% of all companies with at least 10 employees said that they **employed ICT practitioners** in 2009. Among SMEs, only about a quarter of all companies had their own IT staff, but 60% of the large firms do (see Exhibit 3-7). These figures are quite similar to findings for other process manufacturing sectors such as the chemical, steel and paper industry in earlier e-Business Watch studies. 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? It can be speculated whether the term "ICT practitioner" in itself can be misleading in time-constrained telephone interviews; possibly, some companies do not count their PC and network administrator(s) in, although they are mainly charged with ICT tasks.

A large firm with several hundred employees will typically have an IT department in the range of 4-10 people.[58] Depending on the turnover, they will normally not have job openings every year. If they need additional IT expertise for specific projects and for a limited time period, they will rather contract an external service provider. Only very large companies with 1000 employees or more have such a large ICT departments that recruiting new IT staff is a routine. They are the ones (in the ICT using industries) who are primarily affected in case of a skills shortage.

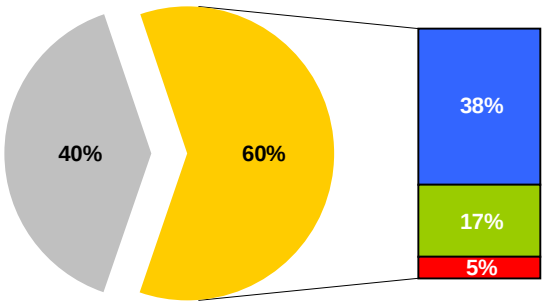
[58] These are typical numbers given by human resources managers of companies of that size interviewed for Sectoral e-Business Watch studies (for case studies, or at events). In the survey, the average number of practitioners was 4 (for large companies; interviewees were asked how many ICT practitioners their company employs).

To assess whether there is a shortage in the supply of ICT specialists, companies that actually employed practitioners were asked whether they had had job vacancies for IT staff in the past 12 months. If so, they were asked whether they had experienced difficulties in finding qualified people for any of these positions. All in all, about 5% of the large companies in this sector reported **difficulties in finding qualified people** (see red segment in Exhibit a). This is about a quarter of all companies with job openings. About two thirds of the large companies with ICT practitioners said they had no job openings for such positions in 2009 (see blue segment in Exhibit a). Among SMEs (see Exhibit b for medium-sized firms), the figures are insignificant. Only about 2% of all companies had looked for new ICT staff and experienced difficulties in finding the right people. Only 3% of the SMEs said they had posted job openings in 2008/09.

In summary, these figures indicate that the vast majority of companies in the GCC industries is at least not directly affected by a possible shortage of ICT practitioners. A shortage in ICT skills is probably mostly a problem for the ICT industries themselves (e.g. for the large providers of e-business software), and possibly in some service sectors.

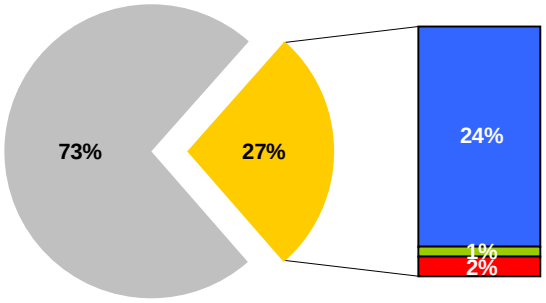
Exhibit 3-7: Employment and recruiting of ICT practitioners by GCC companies (2009)

(a) Large companies (250+ empl.)



Do not employ ICT practitioners
Practitioners, but no job openings (past 12 m.)
Had job openings & no difficulties in recruiting
Had difficulties in finding qualified practitioners

(b) Medium-sized companies (50-249 empl.)



Do not employ ICT practitioners
Practitioners, but no job openings (past 12 m.)
Had job openings & no difficulties in recruiting
Had difficulties in finding qualified practitioners

Source: e-Business Survey 2009

However, anecdotal evidence confirms that a lack of qualified ICT and e-business practitioners can be a relevant concern at least for very large companies with their advanced and sophisticated e-business practices.

ICT user skills

While there are comparatively few ICT specialists in most companies, many jobs require **computer and software user skills**. A manager from a large manufacturing company with about 8,000 employees interviewed for the e-Business Watch study on e-skills said that about 2,500 of them were mainly PC workers. Most of them use mainly basic office applications such as text editing and spreadsheet calculation, communication tools (e-mail) and the web. Depending on the department they work in, they may also be users of specific applications such as the ERP or CRM system or the procurement system. There is no special education or training needed to use these systems if the employee is "digitally literate", i.e. has learned how to use a computer in principle. A few people work with more advanced software tools, for example CAD/CAM programmes, which require more experience and special expertise. However, learning how to use these tools has typically been an integral part of their professional education and should therefore not constitute a challenge for them.

The share of PC workers in the GCC industries will also depend on the degree of automation in production. In highly automated sub-sectors such as the production of machine-made glass products more people will use a computer to do their job than in labour-intensive sub-sectors (such as the production of handmade table and ornamental glass and ceramics products).

As a general perception, more than 50% of the survey respondents felt that the **demands** on employees regarding their computer and software skills "**have noticeably increased**" in the past few years. Interestingly, this view is more widespread the larger the company is (see Exhibit 3.8). At the same time, however, a majority of the same interviewees also say that either no or only a **few employees have problems** in their job because of insufficient computer and software skills (see Exhibit 3.9). Even among the large companies interviewed, where more employees might be concerned, only few respondents (9%) said that "many" of their employees had problems because of insufficient computer skills. Close to 30% observed that some employees were challenged, the rest felt that this was not a problem or only for few employees.

Exhibit 3-8: % of companies feeling that the demands on employees regarding computer and software skills have increased

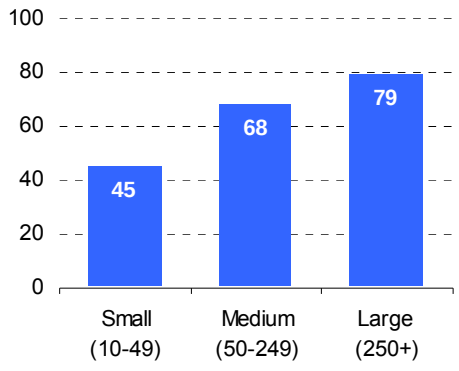
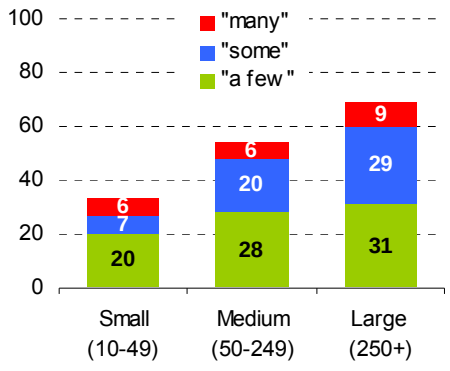


Exhibit 3-9: % of companies observing that many / some / a few employees have problems because of insufficient computer skills



Source: e-Business Survey 2009

These results suggest that the vast majority of the workforce in the GCC sector (and probably in other manufacturing sectors as well) is digitally literate and has no major difficulties in using the software applications which they need in their daily work routines. There are certainly cases where individual workers have difficulties in adapting to new systems and working routines; but these are the exceptions and do not present a pressing business need that needs to be taken care of. Companies can handle such situations themselves.

With regard to positions requiring more specific, **advanced ICT user skills**, for example operating design programmes, only 6% of the companies interviewed had job openings for such positions in the 12 months prior to the interview. Among large firms, close to 30% said that they looked for new staff with such skills. In total, about 30% of those firms that wanted to hire staff reported difficulties in finding people with the required user qualifications. Thus, the figures are quite similar to those for ICT practitioners. All in all, there is no evidence of a major, systemic problem in this area.

Outsourcing of ICT services

A company's demand for ICT skills is also related to its outsourcing strategy. An e-Business Watch study on the chemical industry (2008) found evidence that manufacturing companies increasingly outsourced ICT and e-business functions, either partially of fully, to specialised service providers. 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; a model which is used by about 20% of the companies (see Exhibit 3.11). It can also mean that whole business processes are outsourced to specialised service providers, for example B2B invoicing process to an e-invoicing company.[59] The goal of outsourcing is to achieve productivity growth, by enabling companies to focus more on their core business, while the specialised service provider should be more efficient in accomplishing the outsourced processes. The main risks associated with outsourcing are the loss of competences and control and an underestimation of the transaction costs and coordination efforts.

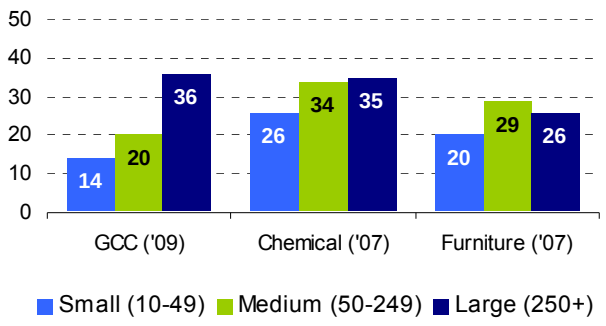
Outsourcing ICT services does not mean that a company does no longer need a proper understanding of ICT and e-business related opportunities. On the contrary, there is evidence that companies with a better ICT infrastructure and a good knowledge of e-business are more likely to draw benefits from outsourcing specific ICT services, paradoxically because they can leverage their own ICT infrastructure to better manage the interfaces with the external service provider.[60]

[59] For an example, see case study on OB10 in the Sectoral e-Business Watch study on the chemical industry (2008).

[60] See economic analysis of links between ICT and outsourcing in the Sectoral e-Business Watch study "An economic assessment of ICT adoption and its impact on innovation and performance" (Sectoral e-Business Watch / European Commission, 2008b).

In the GCC industries, about 16% of the companies interviewed in 2009 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). A difference to other sectors is that the trend towards outsourcing is less pronounced among SMEs (see Exhibit 3-10). In the chemical industry, for instance, about 30% of the companies had outsourced services in 2006/07.

Exhibit 3-10: % of companies having outsourced ICT services in 2008/09

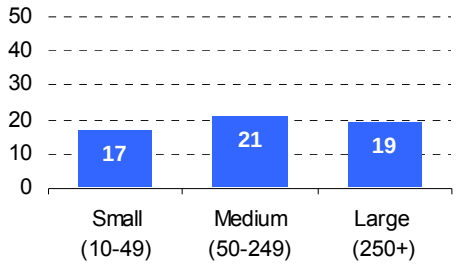


Source: e-Business Surveys 2007 / 2009

This may have to do with the change in the business environment since then, but also with structural factors. e-Business intermediaries such as e-invoicing service providers or connectivity-hubs that facilitate B2B processes have a less prominent role in the GCC industries compared to other sectors.

A specific way of outsourcing is "software as a service" (SaaS), meaning that a software application is not purchased and installed in the company, but made available (by the service provider) and used online based on a licence. About 20% of the companies in this sector said they made use of SaaS, according to the survey. The figure could be expected to be higher. Market analysts from Saugatuck Technology estimated that about 40% of all companies in Europe used at least one software solution online at the end of 2008, and expect this figure to grow to 65% by 2010.[61] It is possible that SaaS is more widely used in other sectors.

Exhibit 3-11: % of GCC companies using software by SaaS* agreements (by company size)



Source: e-Business Surveys 2007 / 2009

[61] Quoted in: "Software as a Service erreicht Europa", ComputerWoche, 31-32/2008.

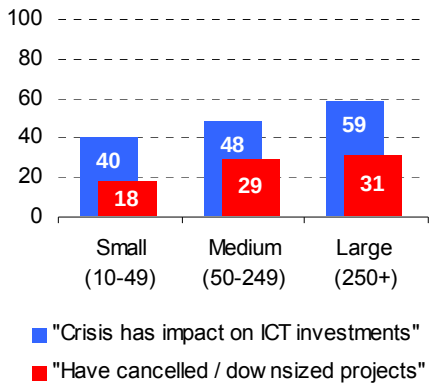
3.1.4 ICT budgets

Impact of the crisis on ICT investments

The general climate for ICT investments has significantly changed due to the economic crisis since late 2007. Many large companies are cutting their ICT budgets or cancelling projects. On the other hand, the pressure to cut costs wherever possible can also have a leveraging effect on ICT use and e-business, if companies see this as a means to achieve savings in a reasonably short period of time. Thus, the impact of the crisis has mixed effects. In fact, ICT managers give completely different answers when asked how and whether their departments have been affected by the crisis.[62]

To get a broad picture, e-Business Watch asked interviewees in the survey whether the economic crisis had an impact on ICT investment plans or ICT projects. If so, interviewees were asked whether their company had already "cancelled or significantly downsized" any ICT or e-business projects. In total, more than 40% of the GCC companies said that the crisis would affect their ICT investments; more than 20% had already downsized or cancelled existing projects. Among large companies, the effects appear to be more pronounced: nearly 60% say the crisis has consequences for their ICT plans.

Exhibit 3-12: Impact of the economic crisis on ICT investments (2009)



Source: e-Business Survey 2009

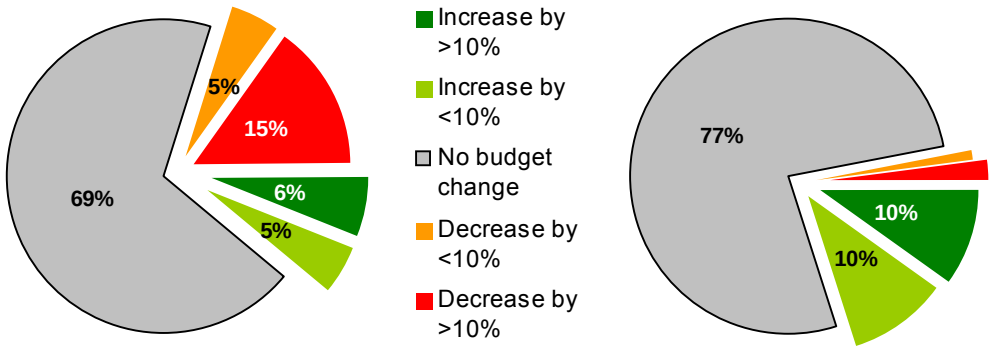
Budgeting trends: more companies decrease their ICT budget

Although, as stated above, the cost pressure can also strengthen the strategic importance of the IT departments, in most cases companies will rather aim to reduce or freeze their expenditures on ICT infrastructure during this critical period. This shows up in the survey results. As in previous surveys, the Sectoral e-Business Watch asked companies whether, in the forthcoming financial year, they would rather increase their ICT budget, decrease it or keep it roughly the same. Exhibit 3-13 indicates the effect of the crisis. Back in 2007, still in a phase of economic boom and prosperity, only a minor percentage of companies (3%) had the intention to decrease their ICT budgets, while 20% of the companies in the chemical industry planned to increase budgets. By contrast, in 2009, 20% of GCC companies say that they planned to **cut down on their budget**, with only 10% planned to increase it. The others, in a majority (70%), say that the budget will remain about the same. This is the highest trend towards decreasing ICT budgets ever recorded by e-Business Watch (in any sector) since this type of survey was first conducted back in 2002. It must be considered that interviewees are normally inclined to be "positive" in their responses, while being hesitant to openly concede that their company experiences difficulties. Thus the real figure of budget cuts is probably somewhat higher than suggested by these figures.

[62] A general impression based on several interviews with IT managers conducted for this and other Sectoral e-Business Watch studies in 2009.

Exhibit 3-13: % of companies planning to increase / decrease their ICT budget in the forthcoming financial year: GCC 2009 vs. chemical industry 2007

(a) Glass, ceramics & cement (2009) **(b) Chemical, rubber & plastics (2007)**



Reading example: "15% of the GCC companies (by their share of employment) said that they planned to decrease their ICT budget by more than 10% in the forthcoming financial year."

Source: e-Business Surveys 2007 / 2009

ICT sector market research broadly confirms the assessment that companies tend to cut down on their ICT budgets. Gartner Group estimated that ICT expenditures in 2009 would decrease by 3.8% compared to 2008, which would be more significant than the decrease of 2.1% in 2001 after the new economy bubble had burst.[63] The major cuts are expected in the hardware area. Investments in software and services might be less affected, according to analysts; for example, IDC forecast a growth of 3.3% for the German IT services industry for 2009 in spite of the crisis.[64]

[63] Gartner Group, quoted from Handelsblatt, 19 May 2009: "Mittelstand kappt IT-Budgets".

[64] "Der Markt für IT-Services in Deutschland im Zeichen der Krise, 2007-2012 – Update". IDC Study, 2009. Press release, 8 January 2009; see http://www.idc.com/germany/press/presse_itservices_krise.jsp (accessed in May 2009)

3.2 "e-Activity": data exchanges with suppliers and customers

Section 3.1 has analysed the adoption of ICT systems by companies in the GCC industries. However, e-business is not primarily about systems and technology itself. It is about optimally managing relationships with customers, suppliers and business partners in a complex and often global competitive environment. This Section focuses on the processes, i.e. the activities, which companies accomplish with the ICT systems they have. Clearly, a more advanced and powerful ICT infrastructure facilitates more advanced forms of data exchange and thus a higher potential to achieve benefits. Some of the case studies about large companies in Section 4 present examples how advanced players use sophisticated ICT systems to this end (Schott AG, Holcim, Lafarge). However, there are also examples how simple ICT-based solutions enable companies, in particular SMEs, to innovate and improve their processes. This Section analyses the state-of-play in e-business in the GCC industries. It presents different approaches and maturity levels, depending on business requirements, and discusses how the economic crisis has affected e-business developments.

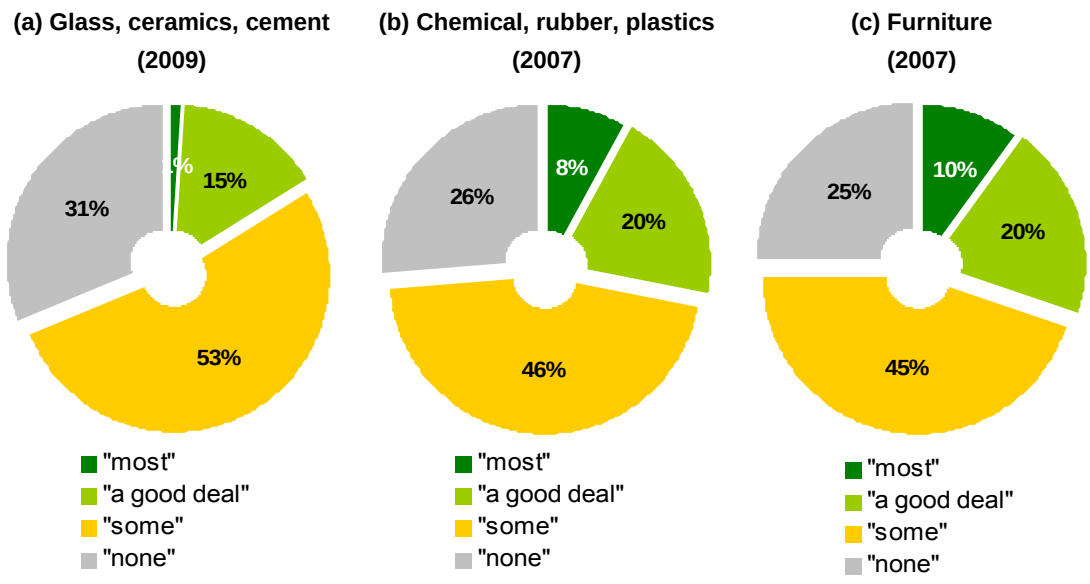
3.2.1 Electronic vs. manual data processing

Which share of business processes is conducted electronically?

A primary objective of ICT use in business is to reduce costs by making business processes more efficient. Almost by definition, e-business means "automating business processes" (see Section 1.3), that is **replacing** formerly **paper-based document exchanges** and their manual processing by **electronic exchanges**, both between and within companies. 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.

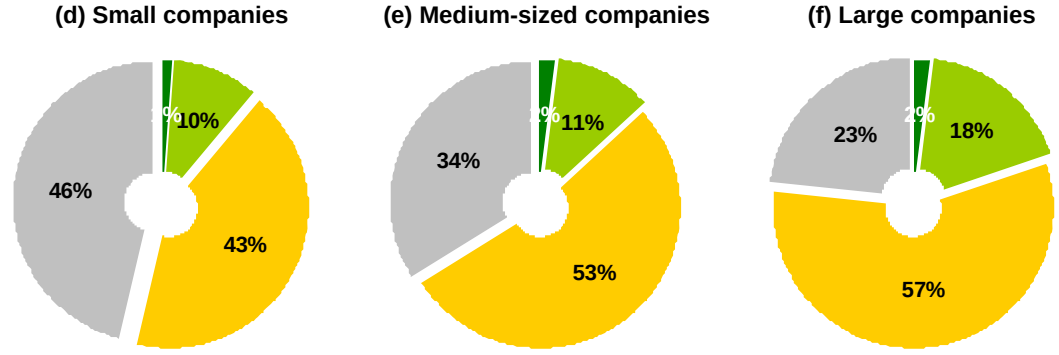
Nevertheless, in order to get an idea where companies position themselves on the road towards e-business, the SeBW asked companies to estimate whether they conducted "most", "a good deal", "some" or "none" of their business processes as e-business. In total, about **70%** of all companies in the GCC industries (by share of employment) said that **at least some of their business processes** were conducted electronically in 2009 (see Exhibit 3-14a). About 15% saw themselves as intensive users, saying that e-business accounted for "most" or "a good deal" of their business activity. The results are comparable to those of other manufacturing sectors obtained in the e-Business Watch Survey of 2007 (see Exhibit 3-14b, c).

Exhibit 3-14: Share of business processes conducted as e-business (self-assessment)



Reading example: "15% of the GCC companies (by their share of employment) said that they conducted a good deal of their business processes as e-business."

Glass, ceramics and cement industry by size classes (2009)



Reading example: "43% of the small companies in the GCC sector said that they conducted some of their business processes as e-business."

Source: e-Business Surveys 2007 / 2009

The difference between large companies and SMEs in this respect is less pronounced than could be expected. The main difference between the size-classes concerns the percentage of companies which say they do not conduct any e-business at all. Nearly half of all small companies from the sector say that they do not have any digital data exchanges (see Exhibit 3-14d). The example of a small glass producer in the Czech Republic (see box below) which does not see any benefit in ICT use (other than e-mail) for its business is probably representative for many companies from the sector that belong to this category. Among large companies, the segment of companies without any e-business still accounts for 23%. However, most of these companies have somewhat more advanced ICT systems in place (not just e-mail), but only use them for internal purposes which they do not regard as "e-business".

Business example

e-Mail only: a small company rejects ICT use

In an interview for this study, the Sectoral e-Business Watch talked to a small glass producer in the Czech Republic. The interviewee, who does not want him or the company to be named, explained that the only ICT tool which his company used was e-mail. The company is in a traditional, labour intensive segment of the glass industry. He believed that ICT (other than e-mail) would not have any business potential for his company, neither for improving the products nor for providing a better service to customers. Moreover, he believed that it would be difficult for his company to implement new technologies as they were not familiar with them. He admitted, however, that the company had not yet seriously considered the issue. Thus, it was more a general feeling than an informed and strategic decision.

Source: Telephone interview, conducted in September 2009

Thus, there is still much scope for further digitisation of business process in the GCC industries. On the other hand, the results demonstrate that e-business is a reality in a majority of companies, even if it typically concerns only "some" of the business processes. The replacement of paper-based, manual data processing has obviously gained momentum, even in this highly traditional and rather conservative industry.

Deployment of e-invoicing

A good example to study the digitisation of formerly paper-based processes is electronic invoicing. 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.

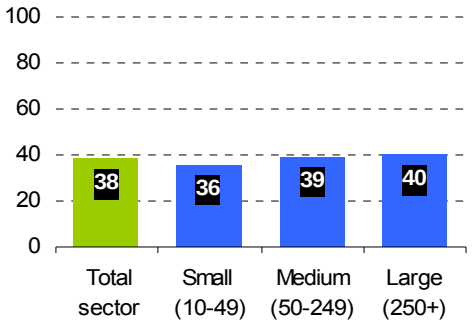
It is widely recognised that e-invoicing promises rather **easy-to-achieve cost savings** for both parties involved (i.e. the invoicing entity and receiving entity), because processing invoices in a standardised, electronic format can be accomplished much faster compared to the often cumbersome handling 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 **policy**, as there are still complex issues to be solved in order to exploit the full potential. The European Commission has actively addressed the challenges in several activities. implemented an Expert Group which has delivered its final report with recommendations for the way forward in November 2007 (see policy implications, Section 6.2.1). Already prior to the work of the Expert Group, cross-border initiatives to pilot and promote e-invoicing adoption had 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.[65]

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

Reflecting the broad interest in this topic, the Sectoral e-Business Watch has paid special attention to the uptake of e-invoicing among companies in its surveys since 2006. In the GCC industries, 35-40% of the companies said that they sent and/or received electronic invoices in 2009 (see Exhibit 3-15). There is not much difference between smaller and large companies at the basic adoption level. Differences were more pronounced with regard to the intensity and the different sophistication levels of e-invoicing (see below).

Exhibit 3-15: % of companies using e-invoicing



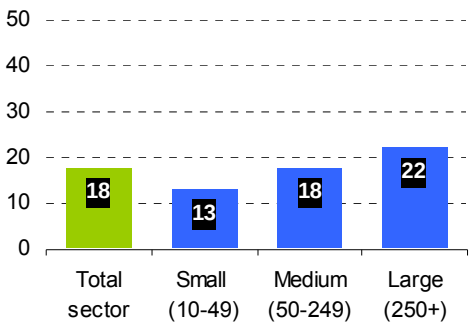
Base (100%): all companies (N = 676)

Source: e-Business Survey 2009

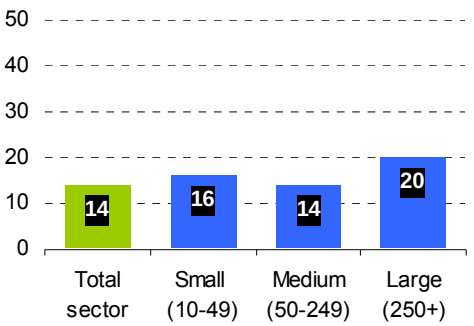
Those companies that used e-invoicing were asked to estimate the percentage of invoices which they sent and received electronically. On average, the companies in the sample estimated that they sent about 18% and received about 14% of their invoices as e-invoices, if all variations such as signed PDF documents and EDI-based invoices are included. The percentage is slightly higher for large companies (see Exhibit 3-16).

Exhibit 3-16: Share of invoices sent/received as e-invoices

(a) % of invoices sent as e-invoices
(on average, by companies using e-invoicing)



(b) % of invoices received as e-invoices
(on average, by companies using e-invoicing)



Reading example: "Companies from the GCC sector that use e-invoicing estimated –on average– that they send 18% of their invoices as e-invoices."
Base: companies using e-invoicing, excl. "don't know" (N = 200).

Source: e-Business Survey 2009

Due to the mentioned challenges and barriers that still exist, e-invoicing is typically used between companies that do business with each other on a regular basis, with a high frequency of orders and invoices – i.e. typically between large players. The main barrier for large companies to deploy e-invoicing schemes faster and more comprehensively is that the small companies they do business with are often not capable of handling e-invoices. The large companies can typically exert power on their suppliers to switch to e-invoicing, but they

have no leverage to force their customers into e-invoicing. Therefore, industry structure is a critical factor that can determine the deployment of e-invoicing.

The term "e-invoicing" is not as straightforward as it might seem, unfortunately. There are different technical ways of delivering an invoice electronically, and different views on the minimum requirements that a certain procedure actually constitutes an "e-invoice". The definition of the European Commission's Expert Group on e-Invoicing stresses that data need to be "**structured**" so that they are machine-readable and do not have to be keyed in manually by the receiver into his system.

> *"Electronic Invoicing has been defined as the sending or making available of an invoice and its subsequent processing and storage, wholly by electronic means. The e-invoicing process needs to employ fully structured data, which is capable of being automatically processed by senders, receivers and other involved parties. The transmission of an electronic image of an invoice document, whilst common, is not strictly electronic invoicing."*
>
> *Source: Final Report of the Expert Group on e-Invoicing. DG Enterprise and Industry, November 2009.*

The reason is that the transmission of unstructured data, for example invoices which are simply sent as a PDF document attached to an e-mail (typically a scan from a paper invoice), only saves costs for the sender (the postal fee), but not for the receiver; by contrast, the receiver may have additional efforts because he may have to print out the document.

e-Invoices can also be presented online in a web-based environment. At an advanced level, the 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 relatively broad installed base of ERP systems in the GCC industries (see following section) could provide a solid basis for wide adoption of e-invoicing, at least among medium-sized and large firms.

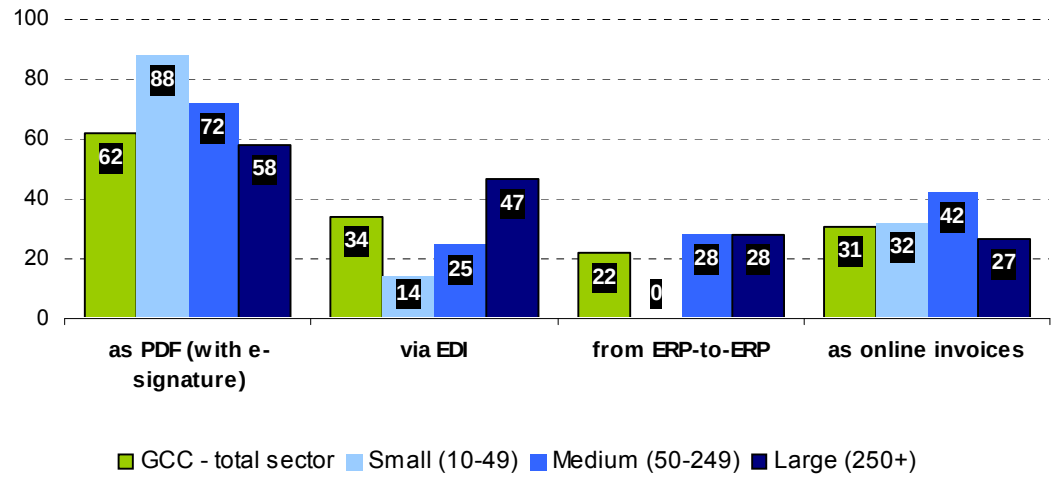
To assess the adoption of different ways of sending and receiving e-invoices, the Sectoral e-Business Watch asked companies whether they send/receive invoices (a) as PDF documents (signed with an e-signature), (b) via EDI, (c) directly from their ERP system to that of a customer, and whether (d) invoices are presented as online invoices that can be accessed and downloaded from a website. These categories are not mutually exclusive, but can be combined. Exhibit 3-17 shows the adoption rates for each of these methods for different size-bands.

The results confirm that sending / receiving **PDF documents** is the preferred method of the small companies. Nearly 90% of those small companies that send or receive e-invoices said that they would use this method. If companies use **EDI** (mainly large companies, see also following section), invoicing is normally one of the processes which is covered by their EDI connections with suppliers or customers. Nearly half of the large firms that send or receive e-invoices said that EDI was one of the instruments they used to this end. Nearly 30% of the medium-sized and large enterprises with e-invoicing said that they exchanged invoices with business partners directly between directly between the **ERP systems** of the involved companies.

Finally, the **online presentation** of invoices is apparently also gaining momentum in B2B exchanges (about 30% of the e-invoicing companies in the GCC sector said they used it). This method is already widely used in service sectors where companies typically have a

large number of customers (such as telecommunications and utilities). Service providers are eager to migrate their customers from paper-based to online invoicing. Savings are substantial (both due to saved postal fees and due to automated processing).

Exhibit 3-17: Methods used for e-invoicing in the GCC sector



Base (100%): companies using e-invoicing. N = 218. Data for the sector total are weighted by employment (companies representing x% of employment), data for size-bands are in % of enterprises.

Reading example: "88% of the small companies that use e-invoicing send and/or receive electronic invoices as PDF documents with e-signature."

Source: e-Business Survey 2009

3.2.2 Use of production-oriented ICT systems

A common development in most manufacturing sectors has been the automation and growing complexity of production processes in the past 10-15 years. Technological innovation, including ICT-related developments, growing pressure to reduce energy costs, and increased competition due to globalisation have been major drivers of this change. The GCC industries are a prime example of this development. In fact, a central assumption of this study, based on literature review, is that the focus of ICT use in the GCC industries is not so much on the data exchange with business partners, but on improving production processes.

The EU competitiveness study on the ceramics industry, for examples, finds that the use of automation technology is widespread in ceramics manufacturing (ECORYS SCS Group, 2008b, p. 52). The study quotes an assessment of EuroCERAM that the majority of companies in the sector, including SMEs, "*have invested heavily in new technologies including new automated casting and decoration equipment*". The objective of this investment into automation is not only to reduce long term costs by reducing labour, but also to increase the flexibility of the production processes in an increasingly consumer-orientated sector. The case studies of **BA Vidro** and **Gmundner Keramik** (see Sections 4.2 and 4.3) are good examples to demonstrate the important role of ICT to support flexible production schemes. At Gmundner Keramik, simple ICT-based solutions helped the company to move from on-stock to order-based production. BA Vidro designed, developed and implemented a Shop Floor Control (SFC) system in 2002 which helps the company tracking materials, tools,

machines and the time utilised in production. As a result, production planning has been greatly facilitated.

However, the implementation of ICT solutions by itself is not a guarantee for success. In all ICT projects, it is particularly important to be clear about the business objectives and to consider and specify organisational requirements in advance. Companies often underestimate the organisational implications of ICT projects and only find out when the solution is already operational. The following example of a glass producing company in the Czech Republic, which is currently (as of autumn 2009) implementing an ICT system to support production and sales processes, illustrates this challenge.

Business example

Implementing new ICT systems: the importance of specifying requirements in advance

The Sectoral e-Business Watch talked to a representative of a medium-sized[66] manufacturer of glass products (including decorated glass and special glass appliances) in the Czech Republic. After having used predominantly basic ICT systems such as e-mail and the internet, the company has recently contracted an ICT service provider to build and implement a software application for managing the whole production and sales process.

However, the company is not yet really convinced about the new application as it is being designed. "I have the feeling that we are currently adding new functionalities to this system all the time in an 'ad-hoc' way rather than in a planned, systematic manner", said the interviewee. They still hope that the new software will make production and sales processes more efficient, although, at the moment, they are worried because the whole process seems to be a bit chaotic. When the software will finally be operational, and provided that it works well, he anticipates that the company will not need any major additional ICT system for the foreseeable future.

Source: Telephone interview, conducted in September 2009

CAD / CAM systems

Production processes in the sector differ between the manufacturers of raw materials (e.g. flat glass, cement, plaster) and the "converting" subsectors which produce articles of those raw materials (e.g. articles made of cement and concrete, glass products) industries. While the processes are complex in all segments, the design of products is particularly important in the manufacture of products.

Special software for **Computer-Aided Design** (CAD) is a commonly used tool to support the design e.g. of glass 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. There are software companies offering CAD solutions for specific sectors, for instance adapted to the design of products made of concrete, glass, wood or stone.[67]

[66] According to EU definition, i.e. with 50-249 employees

[67] Examples: CAD systems of bocad are optimised for the construction of products made of steel, concrete, wood and glass (http://www.bocad.com); the "SCAD" system offered by Softsolution (http://www.softsolution.at); the systems of Albat & Wirsam (http://www.a-w.de) – see box.

Business example:

CAD for automotive glass

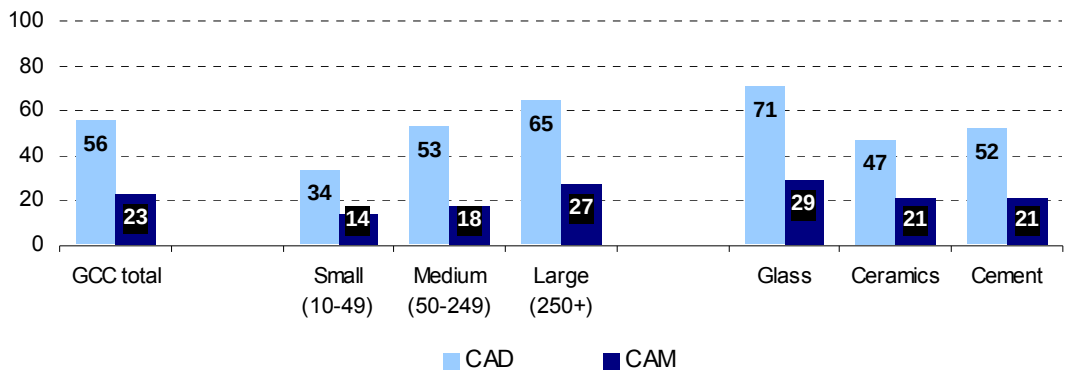
Albat & Wirsam is a software company providing solutions specifically to manufacturers of glass products, windows and doors. Its CAD system "Shaping & Nesting" specifically supports automotive glass production. The system offers highly specialised tools that facilitate the smoothing of contours and interactive correction of shapes. Several production lines can be controlled by just one Shaping & Nesting file.

Source: Website of Albat & Wirsam (http://www.a-w.de), accessed in November 2009

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 six EU countries surveyed, companies representing 56% of employees in the GCC industries said in 2009 that they used CAD and 23% CAM. Among manufacturers of glass and glass products, more than 70% used a CAD system (see Exhibit 3-18). The adoption rate of CAD and CAM systems increases by firm size. The figures are comparable to those obtained for the chemical, rubber and plastics industry in 2007.

Exhibit 3-18: Adoption of CAD / CAM systems* in the GCC industries (% of firms, 2009)



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

Base (100%) = companies with at least 10 employees that use computers. N = 676.

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

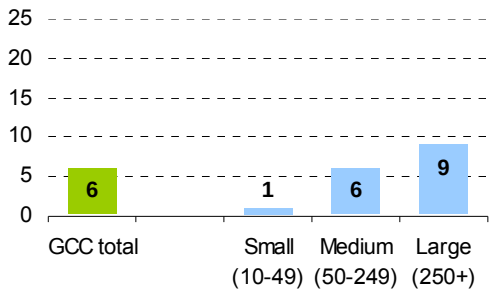
Source: e-Business Survey 2009

Use of RFID in the GCC industries

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 to improve work-flows is **RFID** (Radio Frequency Identification).

Although the maturity of RFID-based applications has matured in the past few years, it can still be considered an emerging technology. Currently, it is mainly used by large companies with at least 1000 employees.[68] In the GCC industries, the adoption rates are lower than in other manufacturing industries. Even among large firms, less than 10% said they used RFID in 2009. For comparison, in the chemical, rubber and plastics industry about 20% of the large firms used RFID already in 2007. However, even if adoption is not yet widespread in the GCC industries, there are many examples of how this technology can be used to facilitate production and supply-chain processes.

Exhibit 3-19: % of companies* in the GCC industries using or piloting RFID



Base (100%) = companies with at least 10 employees that use computers. N = 676.

Source: e-Business Survey 2009

The following business examples demonstrate how this technology can be embedded in production routines in many ways and for many purposes, such as to support quality assurance and safety.

Business example

"Smart bottles" – RFID use in glass manufacturing

The Irish glass container maker Ardagh Glass, one of the largest glass manufacturers worldwide, uses Agent QC, an RFID-based system provided by Sensor Wireless, to identify areas of the bottle factory in which glass is at risk of breakage, to improve line performance and quality control as it manufactures the bottles. Ardagh hopes to reduce the cost of losing products, as well as the strain on landfills resulting from broken glass.

The system includes "smart bottles": facsimiles containing built-in RFID tags with sensors. By placing a smart bottle on the assembly line, the company can identify the exact point in the process at which real glass containers would likely be damaged. The smart bottle, which contains a 3-inch-long RFID tag and sensors, is then placed with real bottles moving though the Ardagh Glass facility. The sensors are designed to measure pressure, impacts and temperature. They are wired to a battery-powered RFID tag that constantly transmits data, either by a 900 MHz signal using a proprietary air-interface protocol, a 2.4 GHz signal complying with the ZigBee standard, or both.

Source: "Smart Bottles Reduce Glass Breakage", published in: RFID Journal, 29 December 2008 (http://www.rfidjournal.com/article/articleview/4526/1/1/).

[68] 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. The study found that about 30% of all manufacturing companies with 1000+ employees either used RFID or were in the process of piloting or implementing this technology.

Business example

RFID use to boost worker safety and productivity

AGC Flat Glass Europe, a division of Asahi Glass Co. that employs 10,600 workers, is using an EPC tags and readers in its plant in Moustier (Belgium) to help automate the packaging of large sheets of glass, and to ensure forklift drivers are beyond the reach of robot-operated cranes.

The system provides the company with real-time information regarding the locations of four large forklifts as workers drive them into and out of the packaging area. During the dangerous part of the packaging process, the system helps managers ensure no one is in an area where the crane is carrying out its work. Because the interrogators automatically identify the tags of the particular stillage a forklift is carrying, the system knows when a worker is in a specific row in the packaging room, and keeps the crane from operating there during that time.

Source: " At Glass Factory, RFID Boosts Worker Safety and Productivity", published in: RFID Journal, 01 December 2008, available at http://www.rfidjournal.com/article/articleview/4476/1/1/.

3.2.3 Supply-side e-business

Improving the efficiency of production and supply chain processes is an important objective for all manufacturing businesses. The procurement of supplies is a central element in managing the supply chain. Efficient management of procurement processes 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. Although the various segments of the GCC sector are heterogeneous in terms of the markets in which they operate and the industry structure, they have as a common feature that companies typically procure raw materials such as minerals which they then process into the specific products they sell. This section explores to what extent companies in this sector use ICT to support their data exchanges with suppliers, and possible impacts on industry structure. The assessment and conclusions are based on desk research, case studies (see Chapter 4), interviews with industry representatives and data from the e-Business Survey 2009.

Direct supply goods which companies in the sector procure from suppliers include, in particular, raw materials such as minerals. In the glass industry, the main raw materials used are sand/silica, Sodium Oxide and Calcium Oxide. The percentage of raw materials imported varies widely – in a survey, companies provided figures between 10-80% (ECORYS SCS Group, 2008a, p. 49). The ceramics industry procures clays, synthetic materials and minerals such as Feldspar, Calcium Carbonate, Kaolin, Silica, Talc, and Borates. The suppliers of these industrial minerals operate more than 800 sites throughout Europe. Some companies in the ceramics industry, such as producers of bricks and refractories, may excavate their own raw materials rather than buy them from suppliers. In total, the procurement of raw materials accounts for about a fifth of total ceramics manufacturing cost (ECORYS SCS Group, 2008b). An increase in input prices can thus have a significant impact on production costs and the competitiveness. In the cement industries, the type of supplies differ between the raw materials producers (manufacturers of cement, lime and

plaster) and the "converting industry" who produces articles of concrete, cement and plaster. Cement itself is a raw material for producing concrete, besides water, sand, aggregates and specific admixtures.

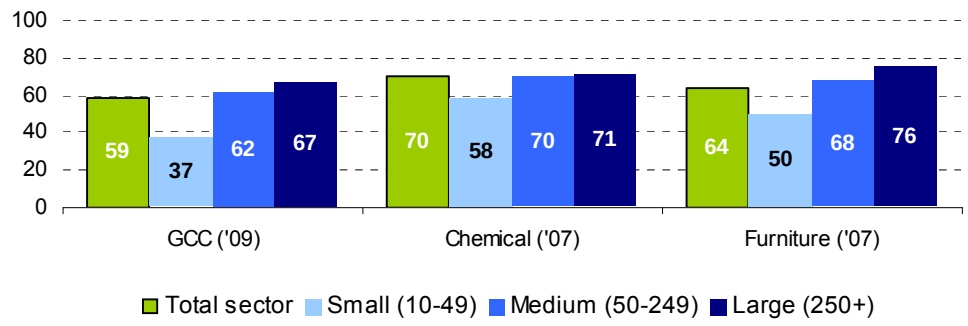
In addition to direct supply goods (raw materials and intermediary products), online procurement is often used for "**MRO goods**" (maintenance, repair, and operating supplies). This category typically includes office supplies and diverse other items which are not materials or components directly used for the products or services which a company produces. ICT equipment falls into this category.

Ordering supplies online

The cost efficient procurement of direct supplies is an important goal for nearly all companies in the GCC sector. The internet as well as specific ICT-based tools support the procurement of supplies. Companies can buy supplies on the web (directly from their supplier or on marketplaces), or use advanced ICT tools to connect with their suppliers. The case study on **Lafarge** in Poland provides an example of an advanced e-procurement scheme, including the using reverse auctions (see Section 4.5). The case demonstrates the potential of specific ICT tools not only to reduce the direct procurement costs (i.e. the costs of the purchased goods), but also to improve the internal process efficiency in procurement.

A global company such as Lafarge has the necessary means and know-how to leverage this potential. The survey results indicate, however, that it is apparently much more difficult for small companies in this industry to benefit from online procurement. In the six EU countries surveyed, companies representing about 60% of employment in the GCC industries said that they placed at least some orders to suppliers online (see Exhibit 3-20). While there is not much difference between medium-sized and large companies in this regard, only few small companies in the sector make use of online ordering (37%). This is different to other manufacturing sectors which the Sectoral e-Business Watch surveyed in 2007 (e.g. the chemical industry), where the adoption of online ordering is more common also among small firms (58% in 2007).

Exhibit 3-20: % of companies placing orders for supplies online



Base (100%): all companies (N = 676). Data for the sector totals are weighted by employment (companies representing x% of employment), data for size-bands are in % of enterprises.

Source: e-Business Surveys 2007 / 2009

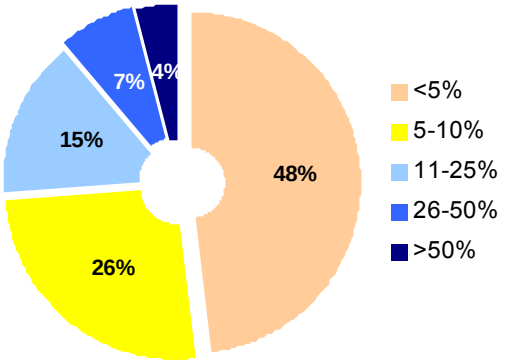
While the adoption rate of online ordering is comparatively low in the GCC sector, the actual adopters make active use of it. In the previous series of sector studies (2008), the Sectoral e-Business Watch reported that the intensity of e-procurement activity had increased and was no longer a marginal activity. This assessment was based on survey results in the

chemical, rubber and plastics industry of 2003 and 2007. In both surveys, companies that placed orders online to suppliers were asked to estimate the percentage of their orders they actually made online. The average percentage had significantly increased in this period. The results for the GCC sector (in 2009) are very similar to those found for the chemical industry in 2007. There are still many companies for where e-procurement accounts for only a small share of the orders (less than 55); however, about quarter of the companies said that online orders accounted for 5-10%, and another quarter said it was more than 10%.

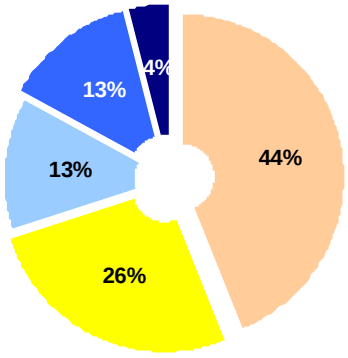
Large companies procure, on average, a higher share of their supplies online than smaller ones (see Exhibit 3-21c-e). Many large companies use advanced ICT systems for the data exchange with their major suppliers, in particular if these are also large companies. Orders from these suppliers typically account for a significant share of the total procurement in terms of the volume, but not necessarily in terms of the number of orders. Thus, 5% or 10% of all orders (in Exhibit 3-21) can account for a large proportion of the total order volume in companies.

Exhibit 3-21: Share of orders for supplies made online

(a) Glass, ceramics, cement (2009)



(b) Chemical, rubber, plastics (2007)

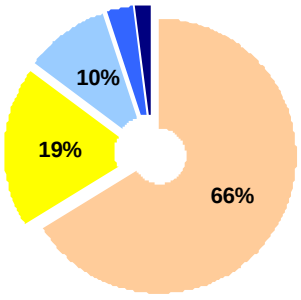


Base (100%): companies placing orders online (N = 351).
Weighted by employment (companies representing x% of employment).

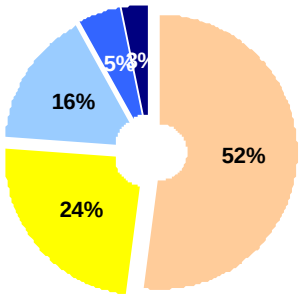
Reading example: "48% of those GCC companies which place orders online (by share of employment) said that online orders account for less than 5% of their total orders."

Glass, ceramics and cement industry by size classes (2009)

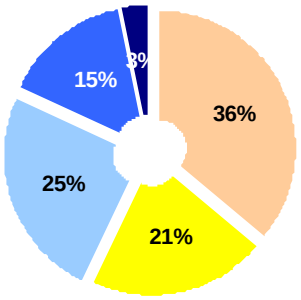
(c) Small companies



(d) Medium-sized companies



(e) Large companies



Reading example: "25% of those large companies that place orders online said that online orders account for 11-25% of their total orders."

Source: e-Business Surveys 2007 / 2009

Electronic data exchange with suppliers

There are **different channels** and technical solutions which companies can use for e-procurement. These are the same channels which companies can also use for selling their products online (see following Section), but have to be viewed from the perspective of the buyer. The main channels that can be used for e-business with suppliers (and buyers) are briefly shown in Exhibit 3-22.

Exhibit 3-22: Important platforms, channels and technical solutions for e-business (for both supply-side and customer-facing e-business activity)

Type	Key characteristics	Adoption level and typical users in the GCC industries
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 between large firms (but even here only advanced ERP users) ○
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	Ordering from a website with an online shop function, enabling any visitor to place an order for products offered by the company.	Typically used for occasional purchases of specific goods, e.g. MRO goods; only few small companies make use of it. ●●○
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.	Do not play a major role in the GCC industries; some large companies use platforms to procure raw materials. ○○
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.	No industry-specific intermediaries (such as Elemica for the chemical industry); e-invoicing specialists (such as OB10) have clients from the GCC sector. ●
Internal e-procurement systems	ICT systems to coordinate purchasing activities of different units or employees in the company, aiming at internal process efficiency.	Mainly used by large GCC companies. ●○

● = used by at least 10% of enterprises; ●● = at least 20%; ●●● = at least 50%

(○ = larger companies only)

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. Thus, e-procurement can be carried out regardless of a real integration of systems with suppliers. Simple methods such as placing orders via a supplier's website can be the first step towards a more comprehensive and integrated use of ICT in supply-side business processes.

Companies from the GCC industries, depending on the segment and size of operations, have chosen different approaches for connecting with their suppliers, including those within the same sector as well as in other sectors.

Electronic data exchange via **EDI**[69] is in many sectors still among the preferred methods to connect with regular business partners, often involving frequent exchanges and large orders of volumes. 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.

Setting up EDI connections is rather expensive, as these are point-to-point connections with repeated costs for every installation. Therefore, EDI is mainly used by larger companies. In the GCC sector, companies representing a quarter of the sector's employment said they maintained EDI connections with suppliers. Among large companies, close to 40% do so (see Exhibit 3-23a). Thus, this relatively old format of data exchange is still a major channel for e-commerce with suppliers.

Supply chain integration via **connecting ERP systems** (or similar standard software packages) is the most advanced approach which is used by only few companies in the sector (see Exhibit 3-23b), mainly larger companies.

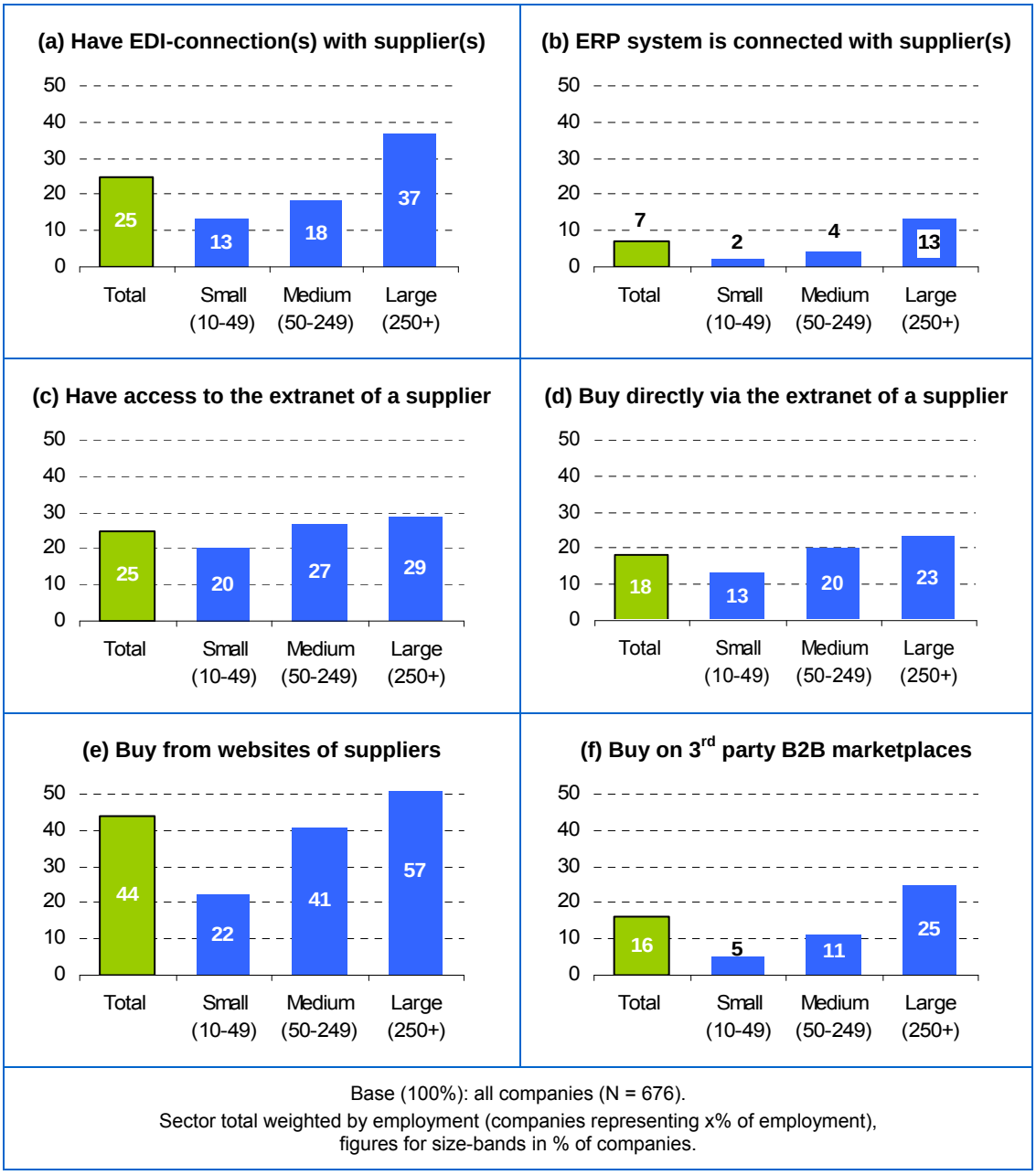
A quarter of all companies interviewed said that they had **access to the extranet** of a supplier or to those of several suppliers (see Exhibit 3-23c). An extranet is a company website (or part of a website) with restricted access (typically password protected) for customers or suppliers. Functions offered by an extranet typically include a well-structured overview of the status of all orders a customer has placed and their supply fulfilment (see also following section on e-marketing). Maintaining an extranet does not necessarily imply that companies can also place orders online directly via this extranet. The function can be restricted to information provision.[70] In a majority of cases, however, online ordering functionalities appear to be integrated in the extranets of companies. About three quarters of

[69] EDI stands for Electronic Data Interchange

[70] See, as an example, the case study on the cartonboard producer Mayr-Melnhof in the Sectoral e-Business Watch study on the pulp and paper industry (2005). The company established the extranet "coMMunity" as a web-based workplace for its SME customers. An extension towards online ordering has been considered.

those companies that have access to a supplier's extranet said that they could place orders directly from the extranet (see Exhibit 3-23d).

Exhibit 3-23: Different channels / platforms used for e-procurement



Base (100%): all companies (N = 676).
Sector total weighted by employment (companies representing x% of employment), figures for size-bands in % of companies.

Source: e-Business Survey 2009

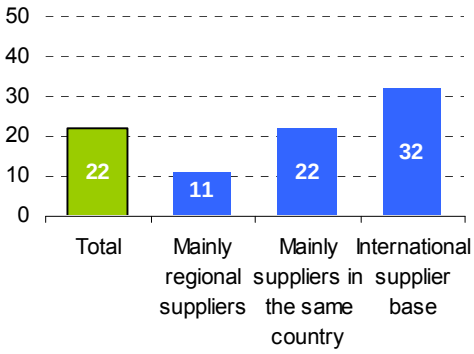
Companies representing 44% of the sector (by their share of employment) buy supplies by directly ordering from **websites of suppliers** (see Exhibit 3-23e). This is the most simple method of online ordering as there are no technical requirements other than having internet access. Basically, it is similar to B2C e-commerce where customers buy goods or services on the web. In spite of the simplicity, relatively few companies make purchases of supplies in this way, in particular small companies (only 22%). This is somewhat counterintuitive at first sight. In interviews, companies state that they use this method in B2B trade mostly for occasional purchases which are not strategically important, for example for ordering office supplies or other MRO goods. A disadvantage of this method is that the gains in process efficiency are limited. Online purchases from supplier websites can normally not be

integrated with the internal ICT systems. Thus, all data (from order to delivery and invoice) need to be keyed into the system manually.

Finally, instead of directly buying from a supplier, companies can also order supplies on web-based **B2B marketplaces** which are operated by a 3rd party acting as a matchmaker between sellers and buyers. A lot of B2B marketplaces were founded during the new economy boom in the late 1990s, but the business model has mostly failed. Many marketplaces went out of business or changed their business model fundamentally. While only few SMEs in the GCC industry said that they procured supplies from marketplaces on the internet, a quarter of the large enterprises said used this channel. eMarket Services[71], an acknowledged directory of e-marketplaces around the world, lists 344 marketplaces for Europe. However, the typical supplier industries of the GCC sector such as raw materials are hardly represented. Neither are the glass, ceramics and cement industries represented themselves. The concept of B2B marketplaces has not become popular in this sector.

Some companies, in particular large ones, use specific ICT systems to coordinate the purchasing activities of different units or employees in the company. In the GCC industry, companies representing more than 20% of the sector have such an internal e-procurement system. In particular, companies with an international supplier base use these systems to streamline and coordinate their global purchasing activities (32%). The case study on Schott AG (see Section 4.1) is an example of an advanced approach to e-procurement based on a combination of different ICT systems.

Exhibit 3-24: % of GCC companies using an internal e-procurement system



Base (100%): all companies (N = 676)
Sector total weighted by employment (companies representing x% of employment),
figures for size-bands in % of companies.

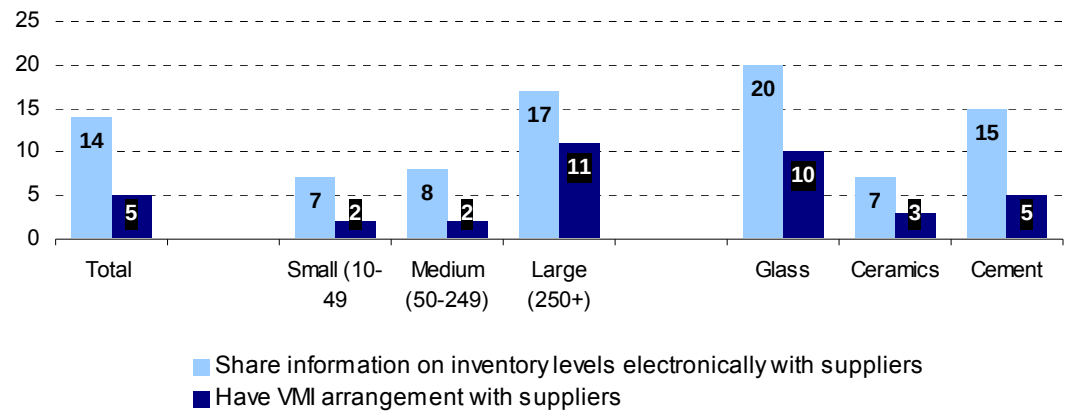
Source: e-Business Survey 2009

One of the most advanced business models of integrating with suppliers is **Vendor Managed Inventory** (VMI). In this model, the buyer of a product informs the supplier of that product constantly about the current inventory levels, normally online by granting the supplier access to specific data in its ICT systems. The supplier, in return, takes full responsibility for maintaining an agreed inventory of this product. Thus, it is a means of optimising the supply chain. The buyer does not have to actively order replenishments from the supplier – the inventory is "automatically" replenished so that the agreed stock of products is always available. Third party logistics providers can be involved for the transportation of the supplies. VMI arrangements are typically made between a manufacturer and a distributor (in retail or wholesale), but they can also be made between manufacturers for specific supply goods.

[71] See http://www.emarketservices.com. eMarket Services is funded by the trade promotion organisations of Canada, Ireland, Norway, Spain and The Netherlands. It is a non profit project aiming to help companies to expand their business.

ICT systems are very important to enable this close cooperation between buyers and suppliers, not only for providing the data about current stock levels, but also for enabling forecasts to anticipate demand. ICT systems used for running VMI include EDI and supply chain management (SCM) systems. The Sectoral e-Business Watch asked companies from the GCC sectors whether they shared information about inventory levels electronically with suppliers, and – if so – if they had VMI arrangements with suppliers. In total, companies representing 14% of the sector (by their share of employment) said that they shared such information with suppliers. 5% said they had VMI arrangements with one or several suppliers, mainly large companies (see Exhibit 3-25). The glass industry is the leading adopter of the VMI business model (in relationships with suppliers) among the three sectors covered.

Exhibit 3-25: Companies sharing information about inventory levels electronically with suppliers (2009)



Base (100%): companies with at least 10 employees and using computers (N = 676).

Sector totals weighted by employment (companies representing x% of employment), figures for size-bands in % of companies.

Source: e-Business Survey 2009

3.2.4 e-Marketing and sales

Changing e-business objectives in times of economic distress

ICT, and in particular the internet, can be used in many ways to support marketing activities, including the communication with customers, offering products for sale, and developing new marketing strategies. Several former e-Business Watch studies on manufacturing industries, notably the studies on the paper (2005) and chemical industries (2003, 2008), concluded that these application areas would gain in importance in comparison to the cost cutting perspective. There was evidence that ICT presented opportunities to companies in different sectors for innovative, better focused marketing approaches to reach new customers, but that the respective opportunities were not yet fully exploited.

This assessment was largely valid for the period of economic from 2003 to 2007/08. However, the business environment for many companies in manufacturing sectors such as the glass, ceramics and cement industries has fundamentally changed due to the financial and economic crisis. Many companies in the GCC industry are under severe pressure to consolidate their activities and use ICT to realise cost savings wherever possible, rather than for enhancing their market presence and customer service. They cannot (or do not want to) afford an expansive e-business strategy which supports longer-term objectives such as market expansion and growth.

This shift of attention was largely confirmed by interviews with ICT and e-business managers in large companies conducted for another Sectoral e-Business Watch study.[72] ICT departments of companies in ICT using sectors such as the GCC industries are thus in an ambivalent situation. On the one hand, their budgets are often decreased and they have to cut costs themselves. On the other hand, there is an increased interest in their services; ICT is seen as a key to achieve cost savings. An IT manager interviewed for the above mentioned study said that it was a "very exciting period" for him and his unit, because the enormous time pressure that dominated their work during the growth period until 2008 has been relieved. He said they could now take the time to develop their own (and better) solutions, while in the years before, "*everything had to be accomplished in a hurry, with little opportunity for developing innovative, creative solutions ourselves.*"

Viewed from a larger perspective, the Sectoral e-Business Watch concluded in its "European e-Business Report 2008"[73] that e-business had developed in three main periods since the mid 1990s.

- In the first period, from 1995 to 2000, internet-based trade emerged as a new phenomenon. Companies connected to the internet and were quickly lured into buying all sorts of immature technology.
- After the shake-out of several failed business models, ICT use in the period from 2001 to 2004/05 focused mainly on cutting costs. This period was characterised by a rather conservative attitude towards ICT.
- Since 2005/06, companies became more "e-friendly" again. The underlying information infrastructures had matured, and the importance of ICT for modern business is widely acknowledged.

[72] Sectoral e-Business Watch study on "e-Skills – Demand Developments and Challenges" (2009), available at the project website (http://www.ebusiness-watch.org).

[73] Available at http://www.ebusiness-watch.org/key_reports/synthesis_reports.htm

However, this third period may have come to a sudden stop (or at least to an interruption) due to the impact of the financial and economic crisis. While there is no evidence for a pessimistic or even negative attitude towards ICT as often observed during the 2nd period (2001-2004/05), the key objective has shifted back to becoming more efficient.

This does not mean that online marketing and sales activities have come to a complete stop, not even in a traditional sector such as the GCC industries. However, as the following data and business examples will show, customer facing applications are not a priority in this sector.

The main customer segments and distribution channels

The customer-facing e-business strategy of a company is part of its distribution strategy and, in a wider sense, an element of its general business model. When companies consider whether and to what extent they want to market and sell their products online, the two principle factors are:

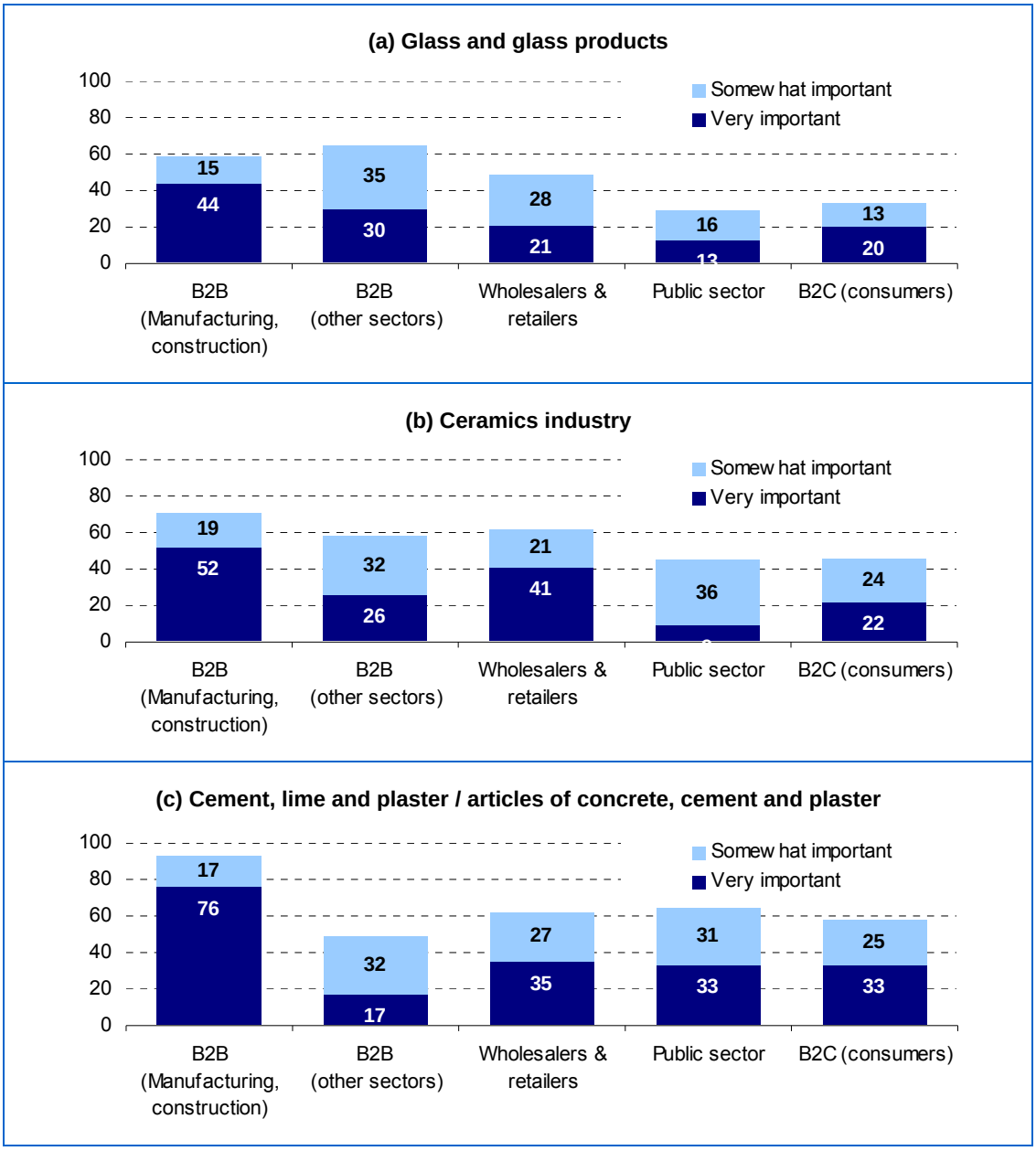
- Who are the customers that will ultimately use the company's products and services?
- How can these products and services reach the customers in the most effective and efficient way?

When analysing the potential of ICT and e-commerce in this context, a principle differentiation must be made between companies whose products are mainly for the consumer market ("B2C" – business-to-consumer) and those whose products are supply goods for other businesses ("B2B" – business-to-business) or for the public sector ("B2G" – business-to-government). Analysing the adoption and potential of e-commerce adoption in the GCC sector is quite complex in this respect, because the sector comprises B2B as well as B2C segments with completely different requirements with regard to marketing. In terms of size and trade volumes, the B2B segments of the sector (providers of construction materials, container glass for the consumer goods industry) are much larger than the B2C segments (such as glass and ceramics tableware and arts).

To get some empirical evidence how the survey sample is structured in this respect, respondents were asked how important different customer segments were for their company as *direct buyers*. As to be expected, in all three sectors, notably in the cement industry, direct sales to **other companies** (B2B) dominates, in particular sales to the construction industry and to companies in other manufacturing sectors (see Exhibit 3-26). In the cement, lime and plaster industry, more than 90% of the interviewed companies said this segment was very important or at least somewhat important as a direct buyer. Distribution via **wholesalers and retailers** is also important in all sectors, but in the ceramics and cement industry more than in the glass industry. In these sectors, 35-40% of the companies said that retail distribution was "very important" for them, another 25% that it was a "somewhat important" channel. The **public sector** (B2G) is an important direct buyer mainly for companies in the cement, lime and plaster industry.

About 20% said that direct sales to **consumers** (B2C) were very important for their company. Unexpectedly, the percentage was even higher in the cement, lime and plaster industry (includes products made thereof): about a third of all companies interviewed said sales to consumers were "very important", and a quarter said "somewhat important". These results demonstrate that the target markets and, subsequently, the adequate distribution strategy, can differ widely between companies in this sector; not only between the three main segments (glass / ceramics / cement), but even more so within segments.

Exhibit 3-26: Importance of different customer segments for companies in the survey sample



Source: e-Business Survey 2009

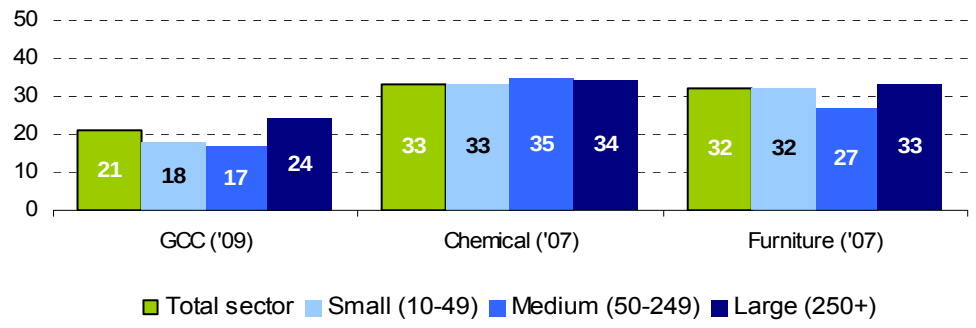
Unfortunately, it is not possible to analyse the e-commerce approach specifically for all the different types of companies in this heterogeneous sector. However, in the following, an effort was made to combine the general assessment (based on survey results) with some specific examples of companies (based on interviews or desk research).

Accepting and processing customer orders online

All in all, about 20% of all companies active in the GCC industries said in 2009 that they enable customers to order their products online. This includes orders placed on their own website, through internet trading platforms, extranet connections with customers and via EDI. There is only a minor difference between companies from various size-bands in this respect (see Exhibit 3-27), an observation which holds true for many sectors.

The share of companies that use e-commerce to sell products online is lower than in other manufacturing sectors, as a comparison with the chemical and furniture industries (both surveyed in 2007) shows. In these sectors, about a third of all companies used e-commerce. This evidence is in line with the principle observation that GCC companies use ICT primarily to improve the efficiency of their internal processes, in particular production and production planning, rather than for the data exchange with their business partners. In other words, with a view to the OECD definition of e-business ("*automated business processes (both intra-and inter-firm) over computer mediated networks*", see Section 1.3), the focus in the GCC sectors is clearly on the *intra*-firm processes.

Exhibit 3-27: % of companies letting customers order goods or services online



Base (100%): all companies (N = 676). Data for the sector totals are weighted by employment (companies representing x% of employment), data for size-bands are in % of enterprises.

Source: e-Business Surveys 2007 / 2009

Sectoral e-Business Watch studies on the chemical, rubber and plastics industry found that not only the share of companies that used e-commerce had increased in that sector (from 10% to 30%), but also the intensity of activity, measured as the average share of orders that companies received online.[74] Back in 2003, most companies that sold online (about 75%) said that their online sales accounted for only less than 5% of their total sales. Thus, it was only a marginal sales channel. In 2007, when the same sector was surveyed again, the situation had changed: 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 3-28b). 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,[75] suggested that the total share of sales that were conducted online in this sector (only considering those companies that actually sell online) had increased form about 5-8% in 2003 to about 25-30% in 2007. With this

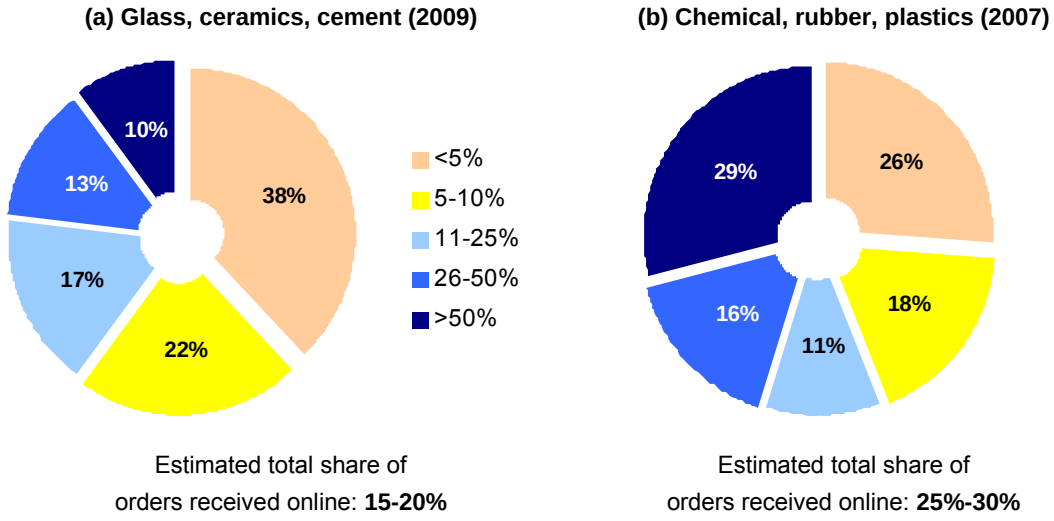
[74] Electronic transactions with customers constitute e-commerce. Transactions can be broken down into three phases and related business processes (see Section 1.3): the pre-sale phase (information, requests for offer), the sale phase (ordering, invoicing, payment and delivery processes), and finally the after-sale phase (customer services, repair and updates). Practically each step in a transaction can either be pursued electronically or non-electronically, and all combinations of electronic and non-electronic implementation are possible. Our definition of an "online sale" is that at least the ordering process is accomplished online. The subsequent processes such as invoicing and payment do not necessarily have to be conducted online.

[75] 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.

percentage, the chemical industry was one of the most intensive users of e-commerce among manufacturing sectors.

Unfortunately, it is not possible to compare the progress over time in the GCC sector in the same way, as the Sectoral e-Business Watch does not have data from an earlier point of measurement for this sector. However, it is possible to compare the average share of orders companies reported to receive online in 2009 with the data reported by chemical companies. The comparison shows that the share of intensive e-commerce users in the GCC sector (companies reporting online sales account for more than 25% of total sales) is lower; however, the difference is not that pronounced. In total, applying the same model as for the chemical industry, the **share of sales conducted online** can be estimated to be **15-20%** (considering only companies that actually receive orders online). With high probability, this percentage has significantly increased in the past few years, similarly as in the chemical industry. There is certainly much scope for further growth of online sales, even if the trend towards e-commerce has lost some momentum due to the economic crisis.

Exhibit 3-28: Share of customer orders received online



Base (100%): companies receiving orders online (N = 120).
Weighted by employment (companies representing x% of employment).

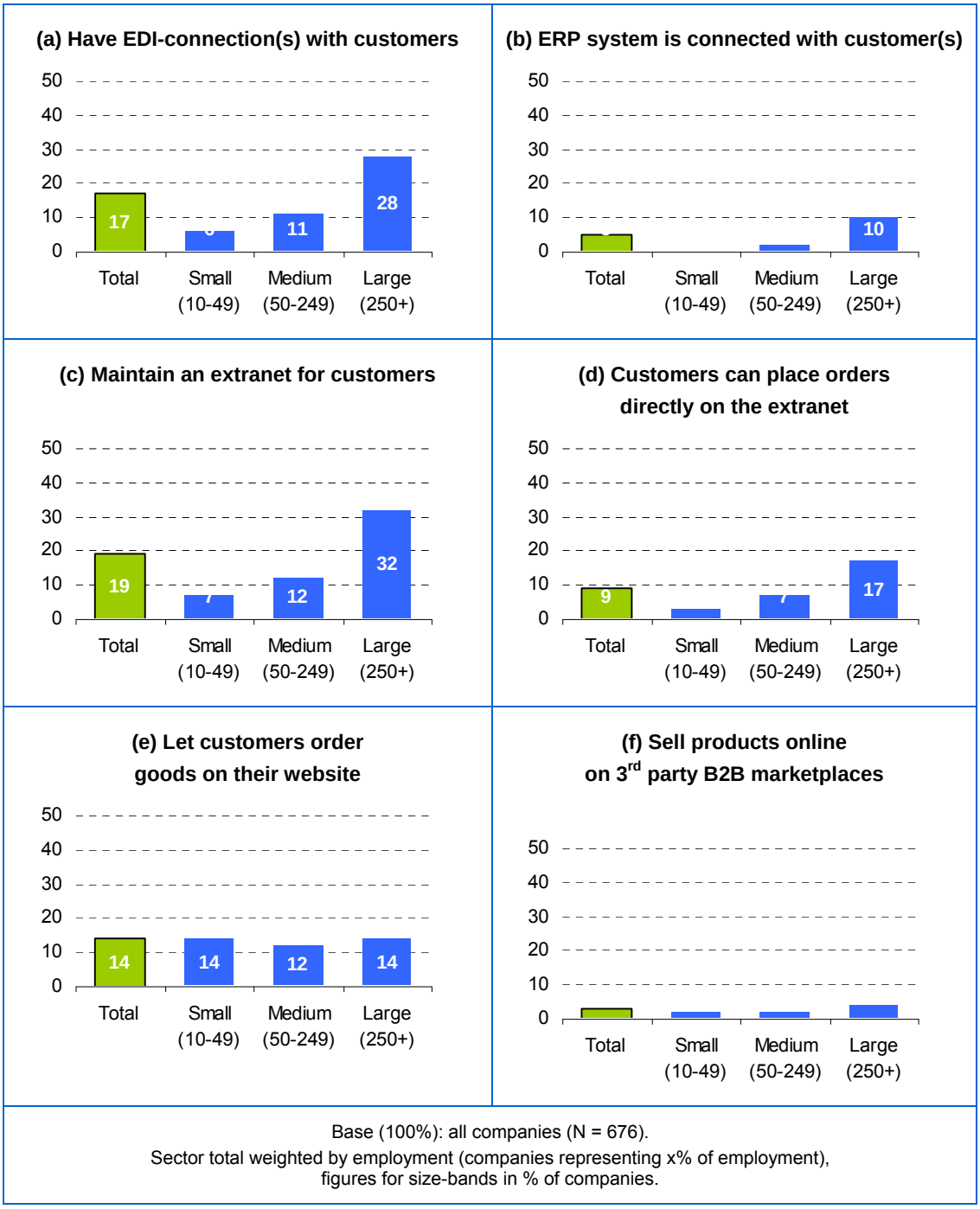
Reading example: "22% of those GCC companies which receive orders online said that online orders account for 5-10% of their total orders received from customers."

Source: e-Business Surveys 2007 / 2009

e-Commerce channels used for servicing customers

Technically, companies can take different routes to e-commerce. These are basically the same whether it is for data exchange with customers or with suppliers, only that the involved parties switch the perspectives and roles. Therefore, the different e-commerce platforms and channels which are presented in Exhibit 3-22 for the supply-side (see Section 3.2.2) apply for online marketing and sales as well.

Exhibit 3-29: Different channels / platforms used for online sales



Source: e-Business Survey 2009

Two technical platforms are particularly relevant for B2B e-commerce exchanges and thus for a large segment of the GCC industries: EDI-enabled data exchanges, and, as a more recent development, extranets as web-portals for customers.

Electronic data exchange via **EDI**[76] is still one of the preferred methods to connect with regular business partners, for example with retailers and wholesalers. EDI has been used for years. Setting up EDI connections is rather expensive, as these are point-to-point

[76] EDI stands for Electronic Data Interchange

connections with repeated costs for every installation. Therefore, EDI connections are normally established only with business partners with whom a company has frequent exchanges, often involving large orders of volumes. In the GCC industry, mainly large enterprises have EDI-based connections with their customers (28%). In total, enterprises representing close to 20% of the sector's employment said they connected with customers through EDI (see Exhibit 3-29a). The adoption is thus lower than in the chemical industries, where 50% of large firms and 40% in total reported that they used EDI (2007). This reflects differences in the industry structure: the chemical industry is better suited for EDI use, as it is dominated by large companies (who often do business with each other), while the GCC industries have a higher share of SMEs.

Data exchanges with customers by linking the **ERP** systems of the two companies –a very advanced mechanism– are not common in the GCC industries. One in ten large enterprises said that their ERP system was connected to that of a customer; among SMEs, hardly any companies had ERP-to-ERP connectivity with customers (see Exhibit 3-29b).

About 20% of the companies interviewed (by share of employment) said that they maintained an **extranet** for their customers (see Exhibit 3-29c). An extranet is a kind of website (or part of it) with restricted access for customers or suppliers. The functionalities typically include a well-structured overview of the status of all orders a customer has placed and their supply fulfilment. In addition, companies can provide additional information to their business partners on the extranet, such as product-specific information or the terms of business. Extranets are often operated by larger companies as a service for their SME customers, recognising that these SMEs do not have their own advanced systems for data exchange and managing orders. Maintaining an extranet for customers does not necessarily imply that these can also place orders online via the extranet. The function can be restricted to information provision. In a majority of cases, however, online ordering functionalities appear to be integrated in the extranets of companies. About half of those companies that maintain an extranet for customers said that customers could also place orders directly from this web platform (see Exhibit 3-29d).

Only about one in seven companies of the GCC industries let customers order products or services online on their **website** (see Exhibit 3-29e). The low adoption rate is somewhat counterintuitive, because setting up an e-shop on a website has become quite simple. It does not require major investments in technology, nor does it necessarily have significant organisational implications (depending on the degree of intended back-end integration of the e-shop).

In the B2C-focused segments of the industry, web-based e-commerce (selling products on the internet) can be a useful and cost-efficient distribution channel for SMEs, for example for companies producing glass and ceramics ornamental and tableware with a high value added. The internet gives them the opportunity not only to present their offer to a wide audience, but also to make direct sales to customers. However, the experience with online marketing and sales are mixed. The business example of Artcristal Bohemia (see box) illustrates the unforeseen difficulties which small companies may encounter in the online environment. The company finally decided to completely stop their online sales activities and continue relying on their traditional sales channels instead. By contrast, the ceramics tableware producer Gmundner Keramik, whose production planning process is presented in the case study in Section 4.3, has decided to introduce e-commerce as an additional distribution channel (see box).

Business example

Artcristal Bohemia stops online sales on the web

Artcristal Bohemia, a small manufacturer close to Prague, produces decorative glass articles. All products are hand-made. In the past, the company used to sell its products online on the web. However, the experience was negative. The offer was not accepted in the way it was hoped. Moreover, a counterfeiter started producing and selling copies of Artcristal's products by using the information about parameters of the products which were published on the company website. Also, the company experienced other breaches of copy-right law: information they had published on the website appeared on other websites without obtaining prior agreement.

As a reaction to these difficulties, the company abandoned online selling and went back to the traditional sales channels. Today, they have about 25 sales representatives who sell the products worldwide – using telephone and e-mail.

Source: Telephone interview with Mr Machalek from Artcristal Bohemia (http://www.artcristal.cz), conducted in October 2009

Business example

Gmundner Keramik launches e-shop

Gmundner Keramik is a medium-sized manufacturer of ceramics table and ornamental ware and tiled stoves in Austria (230 employees). All designs are hand-painted. Products are mainly sold to private households, but increasingly also to business customers.

In distribution, Gmundner cooperates with a large network of trading partners, in particular specialised retail stores selling ceramics table ware, including large furniture store chains in Austria. The trading partners are attended to by 6-8 (employed) sales representatives of Gmundner. Furthermore, products can also be bought directly at the production site company's own factory outlet.

The company has considered introducing e-commerce for years, but launched its web-shop only recently in autumn 2009. It expects that the new distribution channel will complement the existing mix of sales channels without hurting them. The e-shop is seen as an improvement in customer service: for example, owners of Gmundner Keramik can easily order replenishments in case a cup or plate gets broken or expand their existing collection with specific pieces.

Source: case study interview with Mr Josef Feichtinger, April 2009 (see Section 4.3) and company website (http://www.gmundner-shop.de/).

Finally, instead of directly selling online to customers, companies can also sell or present their products on **web-based marketplaces** which are operated by a 3rd party. The marketplace operator acts as a matchmaker between sellers and buyers. Sector-specific marketplaces for the GCC industries are rare, and – vice versa – there are very few companies that actually use internet marketplaces as part of their distribution strategy (see Exhibit 3-28f). Some of the marketplaces focus on B2B exchanges, others are mainly B2C. In some cases, the online platform is entirely for presenting the products and does not provide users with the possibility to order products, as the business example of GLASS.cz (see box) demonstrates.

Business example

GLASS.CZ – an online showroom for SME glass producers

GLASS.CZ is a virtual showroom where glass and jewellery producers from the Czech Republic, in particular SMEs, can exhibit their products online. The marketplace consists of three main elements: a product catalogue, structured into 10 basic product groups; a directory of the participating companies; and search tools is facilitate retrieval of specific products or companies.

For an annual fee of about € 200, companies can exhibit up to 100 products in the showroom and present themselves with a company profile in the directory. Currently, 16 SMEs exhibit their products on the marketplace. Registered users can send inquiries about products to the exhibitors.

The Sectoral e-Business Watch interviewed Mr Jirman, the head of the company, about his perception of the ICT use of SMEs in this industry.

Mr Jirman said that most of the smaller glass producers used basic ICT such as computers and the internet, but typically they would not use advanced software tools, e.g. for product design or communication with customers. He argued that the companies lacked the necessary ICT skills to apply more advanced tools. Due to the economic crisis, many SMEs struggled for survival; in this situation, the owners could not neither afford the money for buying new technology nor the time for learning how to use it.

He believed that many companies could actually benefit from using more advanced ICT solutions, but the challenge was how to take the first step without neglecting the day-to-day business.

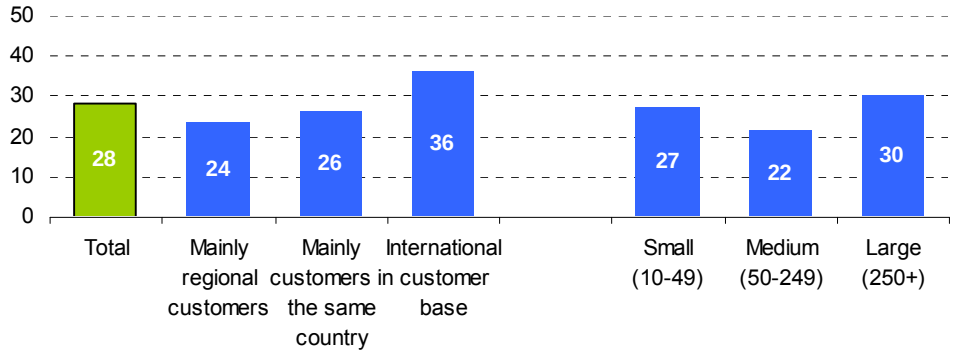
Source: Website of GLASS.CZ (http://www.glass.cz) and interview with Mr Jirman, Managing Director.[77]

Close to 30% of the companies (by their share of employment) said that they had established an **electronic catalogue** which describes their products based on an industry standard for e-catalogues to facilitate data exchanges with business partners (see Exhibit 3-29). Companies with an international customer base are more likely to have their products systematically listed in an e-catalogue than those selling predominantly to customers in the same region or country. This is not only because these are –mostly– larger companies; size is less indicative as a predictor for this indicator, differences are not pronounced.

e-Catalogues can and should ideally be based on widely accepted classification standards, such as GPC or eCl@ss. The initial process of cataloguing ones products presents a considerable effort, but can be a requirement when companies decide to use e-commerce in a more systematic and digitally integrated way. ICT service providers offer a wide range of catalogue management systems that support companies in keeping their catalogues up to date. Specific catalogue exchange standards facilitate the exchange of product data between suppliers and their customers, for instance the updating of product data without having to transmit the full catalogue when only data for specific products have changed.

[77] The interview was conducted by Aneta Herrenschmidt-Möller on behalf of the Sectoral e-Business Watch in September 2009.

Exhibit 3-30: % of companies maintaining an electronic catalogue of their products as a basis for data exchanges with business partners



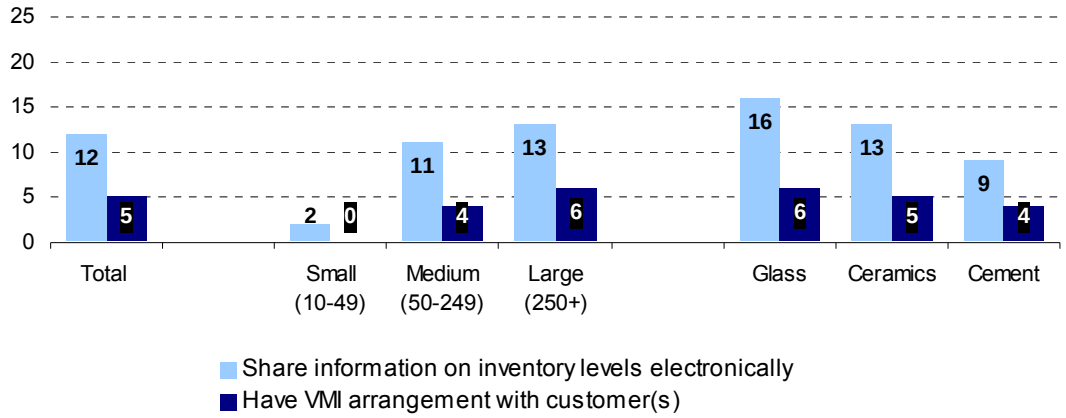
Base (100%): all companies (N = 676). Sector total weighted by employment (companies representing x% of employment), figures for size-bands in % of companies.

Source: e-Business Survey 2009

Vendor Managed Inventory (VMI) as a business model to optimise the supply chain by cooperating closely with preferred suppliers was discussed in Section 3.2.1 above. As many GCC companies are suppliers to other industries, they can also have VMI arrangements with customers. In this case, they would take responsibility for maintaining an agreed inventory of their product(s) at the customer's site. As discussed, ICT systems are crucial for enabling this advanced form of cooperation in the supply chains.

The Sectoral e-Business Watch asked companies from the GCC sectors whether they had customers who shared information about their inventory levels with them electronically, and – if so – if they had VMI arrangements with these customers. The adoption rates are very similar to those for the supply-side. In total, companies representing 12% of the sector (by their share of employment) said that they had customers who allowed them to access electronically information about their inventory levels. 5% said they had VMI arrangements with one or several customers (see Exhibit 3-31). The glass industry is again the sector where most companies have customers who provide them with information about inventory levels. Examples for VMI arrangements with glass producing companies can be found in the automotive industry, where auto glass producers (as suppliers) manage the storage, transport and delivery of automotive replacement glass (such as windshields and rear windows) for car makers. In the cement industry, companies are more likely to integrate with suppliers than with customers.

Exhibit 3-31: Companies having customers who share information about inventory levels electronically with them (2009)



Base (100%): companies with at least 10 employees and using computers (N = 676).

Sector totals weighted by employment (companies representing x% of employment), figures for size-bands in % of companies.

Source: e-Business Survey 2009

Web 2.0 as a means for marketing

An emerging trend in ICT use for marketing and customer service are applications that are based on Web 2.0 models. 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[78] and blogs[79]. 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 to what extent companies in the GCC sectors can exploit this concept for their own marketing purposes is difficult to answer at this point, considering that many companies do not use any e-marketing tools at all currently (see above). Large companies that maintain extranet portals could consider enhancing their extranets with Web 2.0 functionality, for instance 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 may no longer be in full control of the communication.

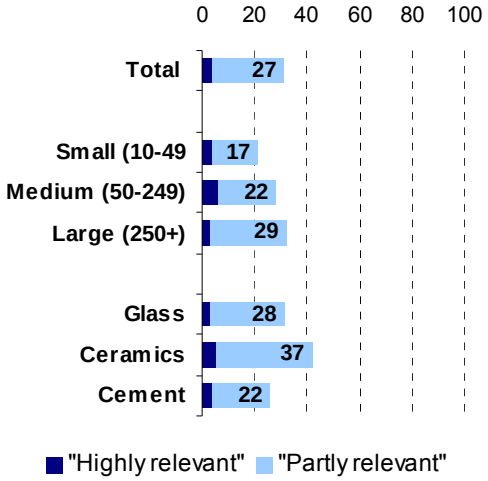
[78] A wiki is a software that enables users not only to read content on the web, but to edit it and make their own contributions. It has some similarities with traditional encyclopedia, the major difference being that the entries are made by the user community themselves.

[79] 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.

The Sectoral e-Business Watch asked companies whether they considered Web 2.0 as relevant for their own business. While only few companies regard Web 2.0 already as "highly relevant", more than 30% (in total) say that it is at least "partly relevant". Among large companies, more than 40% anticipate that Web 2.0 could play a role for them in the future (see Exhibit 3.32).

The results demonstrate that this topic has gained momentum in the past two years. When the same question was asked to companies from the chemical industry in 2007, only about 20% considered Web 2.0 as relevant, although this sector is, on average, quite advanced in its ICT use (more than the GCC sectors).

Exhibit 3-32: % of GCC companies that consider Web 2.0 as "highly" or "partly" relevant for their business (2009)



Base (100%): companies with at least 10 employees and using computers (N = 676).

Source: e-Business Survey 2009

3.3 Enabling functions: ICT and innovation

The growing diffusion of ICT in all areas of business is commonly seen as a major enabler of organisational change and the development of new products or services – in short, of innovation. ICT-enabled innovation activity is central to the understanding of the economic impact of ICT. ICT can have significant effects for **downstream innovation** in manufacturing. For example, ICT can facilitate product innovation in the technical ceramics industry, which in turn enables innovation in the medical equipment industry where the new materials are used. Process innovation, on the other hand, has led to significant improvements in furnace output and efficiency in the glass industry, with a significant impact on the amount of energy required to melt a tonne of glass (ECORYS SCS Group, 2008a, 18); this is beneficial for the construction industry, the main user of flat glass. Process innovation also has close links with e-business. The introduction of more advanced forms of e-business activity, to be successful, typically requires changes in working routines which constitutes, to some extent, process innovation.

The **capability for innovation** is considered very important by European companies in the GCC industries in order to face global competition and to keep their position in higher market segments, which rely on differentiation and quality (see Section 2.1). The EU has been a major innovator in most segments of these industries, certainly in the flat glass industry (cf. ECORYS SCS Group, 2008a). Continuous innovation will remain a critical success factor to sustain Europe's competitive advantage compared to Asian manufacturers, which can draw on cheap labour. 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 GCC industries, as in most process manufacturing sectors, tends to be centred on production processes, such as automated and computer-based manufacturing systems, or on supply chain processes.

This section aims to explore in what ways and to what extent ICT enables innovation activities in the GCC industries. To collect empirical evidence on links between ICT and innovation, the Sectoral e-Business Watch asked companies 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.[80] Innovators were then asked some follow-up questions on whether and how ICT had played a role in their innovation(s). 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 in one way or the other with ICT usage. For product innovation, ICT matter as well, but to a lesser extent.

3.3.1 ICT and product innovation

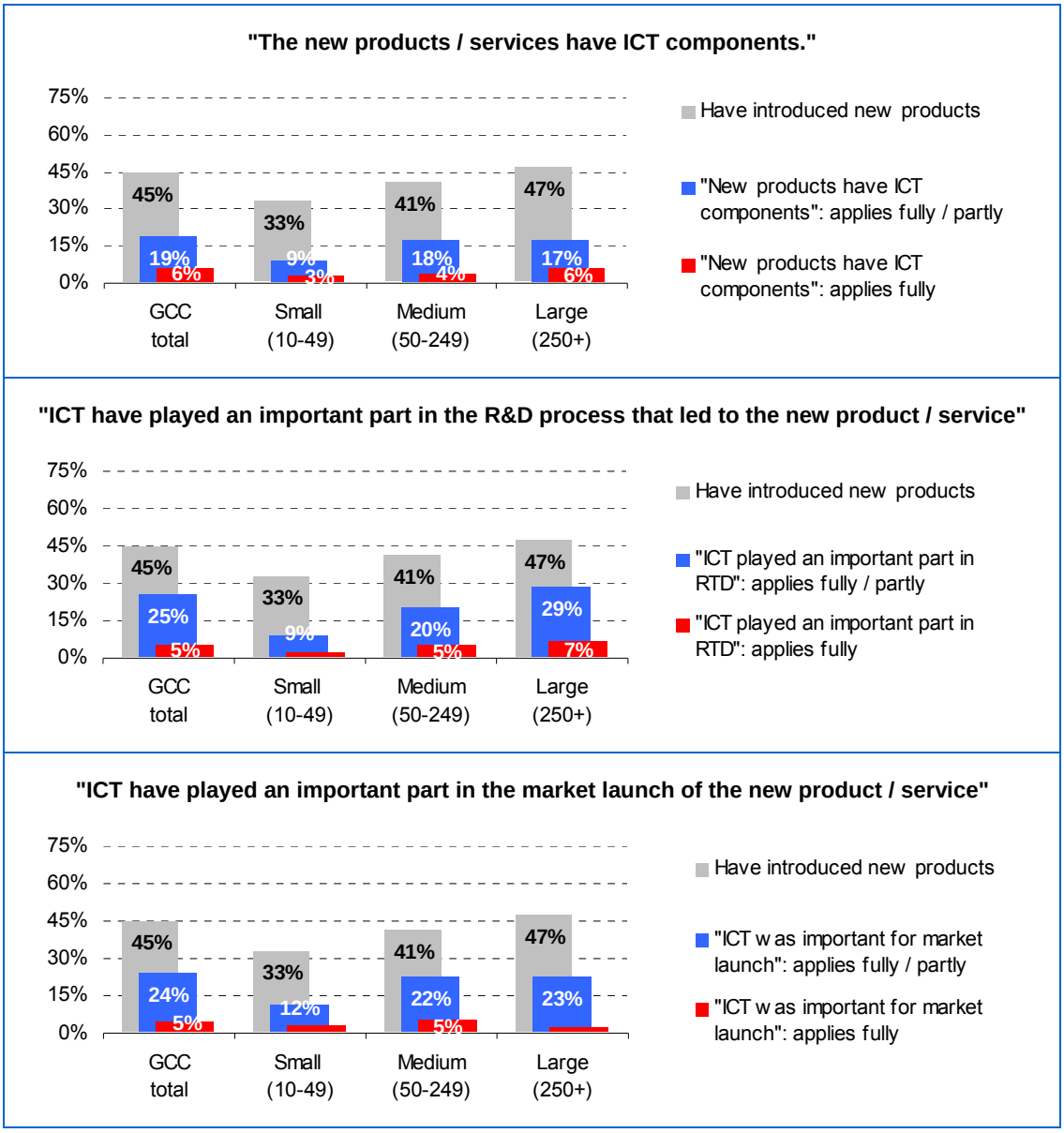
Product innovation In the GCC industries focuses on the goods that are made of glass, ceramics or cement, to a lesser extent on the raw materials themselves. An important driver of product innovation has its roots in the environmental crisis and resulting pressures. For example, glass is used to manufacture environmental technologies, such as reinforcement

[80] In this report, the term "innovation" is used from a company perspective and not from an industry perspective. In this sense, innovation means introducing products or processes that are new to the company, even if they already exist in the industry.

glass fibres in wind turbines and collar control glass. This could be an opportunity for Europe. The increase in demand for environmentally friendly and innovative glass products favours EU glass producers with their superior technical know-how and capabilities for innovation. However, it applies only to the value added segments of the glass and ceramics industries where price competition is less important compared to technological leadership.

In the survey, companies representing about 45% of the sector's employment said that they had introduced new or significantly improved products or services in 2008/09 (i.e. in the past 12 months prior to the interview). Interestingly, differences between small and large companies are not very pronounced in this respect, although large firms could be expected to have a higher innovation output simply because of their typically larger product portfolio. Exhibit 3.33 indicates to what extent this innovation activity was linked with ICT use.

Exhibit 3-33: The role of ICT for product innovation in the GCC industries



Source: e-Business Survey 2009

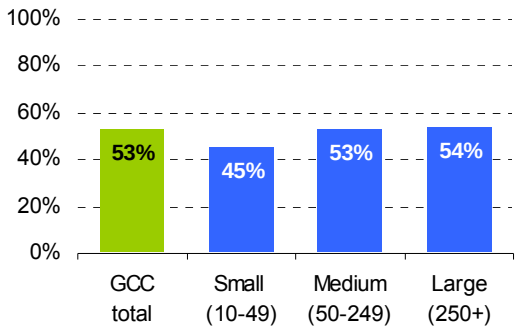
- When asked whether their new products had *ICT components*, about 40% of the innovators (i.e. 20% of all companies in total) said that this would fully or partly apply. This is a surprisingly high percentage; only 13% of the innovators said it would "fully apply", however.
- More than half of the product innovators said that *ICT had played a role in the R&D process* that led to the innovation, at least to some extent. The role of ICT in R&D increases by firm size, which probably simply reflects the fact that R&D activity as a formal business function with its own department is mostly conducted in medium-sized and large firms.
- Finally, about half of the product innovators said that ICT was somewhat important for the *market launch of the new product*; again, this is more often the case in medium-sized and large firms.

In summary, the results indicate that ICT matters for product innovation even in a traditional sector such as the glass, ceramics and cement industry, whose products certainly do not have a natural propensity towards information technology.

Involvement of external business partners

Those companies that hat launched new products or services in the past 12 months were asked whether external business partners had been involved in developing this product or service. About half of the companies said that this was the case. This indicates that innovation is often a collaborative process with contributions from various business partners. It links to the concept of "open innovation" (cf. Chesbrough 2006), which receives much attention from innovation policy. The concept argues that companies can no longer afford to rely entirely on their own research, but should instead cooperate with other companies, for instance by buying or licensing specific components or processes from other companies which they need to create new products.

Exhibit 3-34: % of product innovators saying that external business partners were involved in developing the product



Base (100%): Companies having launched new products / services in past 12 months (N = 247)

Source: e-Business Survey 2009

3.3.2 ICT and process innovation

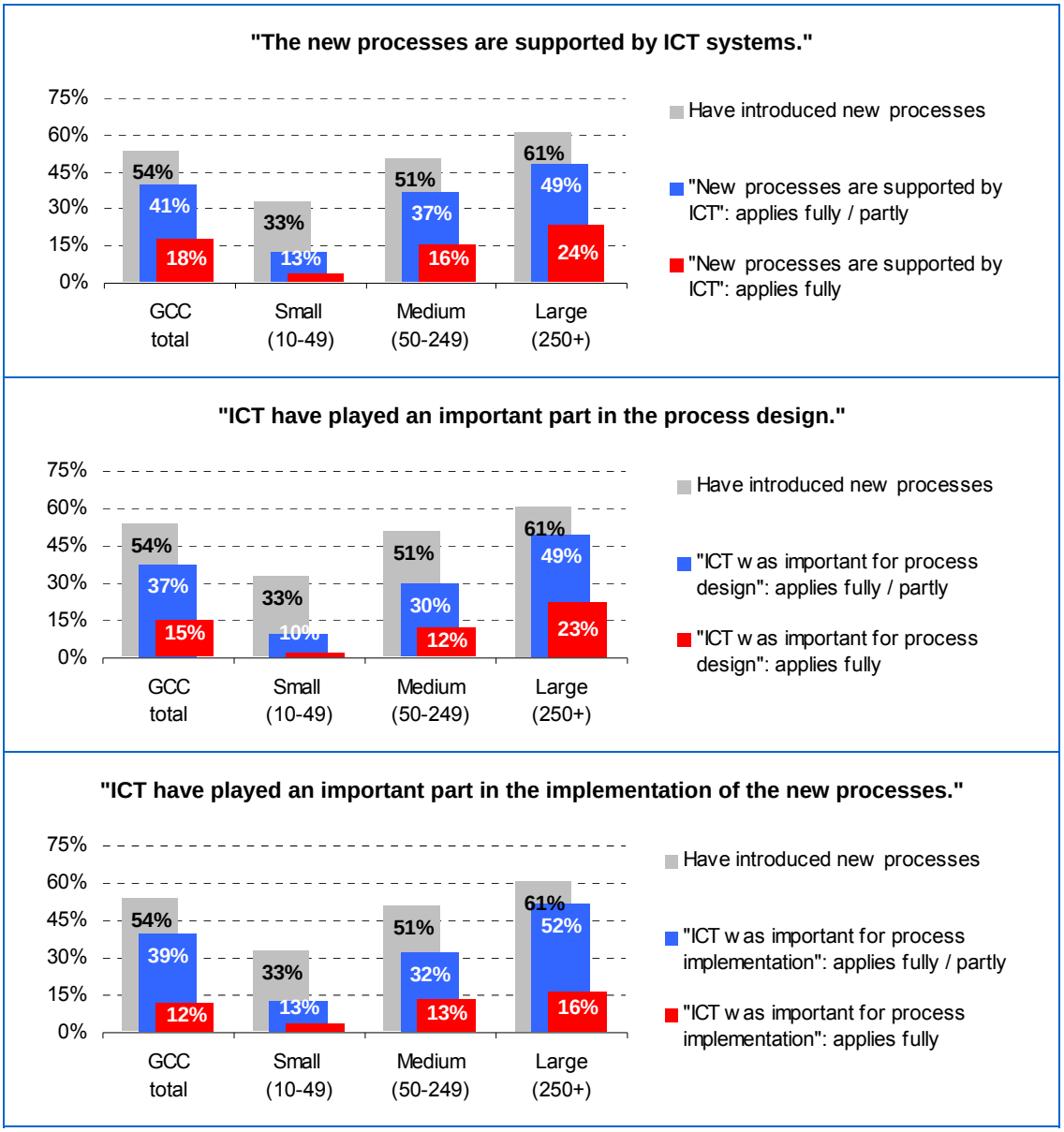
A process innovation, from a micro-economic perspective, can be viewed as an outward shift of an existing supply function, which should lead to lower variable costs in the production of an existing product or service and therefore to a productivity increase.

In the survey, companies representing more than half of the sector's employment said that they had introduced new or significantly improved internal processes in 2008/09 (i.e. in the past 12 months prior to the interview). It was a consistent finding in e-Business Watch sector

studies that ICT plays a crucial role to support process innovation, in manufacturing as well as in service industries. This can be confirmed for the GCC industries. Exhibit 3.35 indicates to what extent this innovation activity was linked with ICT use.

- Among medium-sized and large process innovators, a majority of about 75% said that the new process(es) they had introduced were at least partly *supported by ICT*. About a third of them said this would fully apply. In small companies, new business processes are to a lesser extent directly enabled by ICT.
- Similarly, about 70% of the innovators say that ICT played –at least to some extent– a *role in the process design*. In this respect, company size matters even more.
- The same picture emerges for the *implementation of the new processes*: among medium-sized and –particularly– among large enterprises, a significant share of innovators say that ICT played an important or at least some part in the implementation.

Exhibit 3-35: The role of ICT for process innovation in the GCC industries



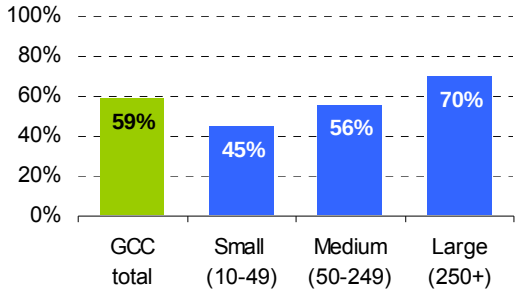
Source: e-Business Survey 2009

Of course, process innovation can mean a lot of different things to individual companies. The data presented in this section can only provide a very rough idea of the role which ICT plays for improving business processes. **Case studies** help to understand these links in more practical terms. The cases on Schott AG and Gmundner Keramik presented in Chapter 4 are both examples of how a company has introduced significant process innovations with support of ICT tools.

Involvement of external business partners

Those companies that hat introduced new processes in the past 12 months were asked whether external business partners had been involved in developing these processes. About 60% of the companies said that this was the case. In contrast to external contributions to product innovation, the likeliness that companies use external support for process innovation increases by company size. While more than half of the small companies develop and introduce new processes on their own, 70% of the large innovators involve external service providers. In many cases, these external business partners are consultants from ICT service companies who help their clients to design and implement new ICT-enabled business processes, for example in production.

Exhibit 3-36: % of process innovators saying that external business partners were involved in developing the new processes



Base (100%): Companies having launched new products / services in past 12 months (N = 247)

Source: e-Business Survey 2009

Comparison with other sectors

In a **cross-sectoral comparison**, the role of ICT for innovation processes is broadly in line with findings for other manufacturing sectors. Exhibit 3-37 shows that results for various sectors studied by e-Business Watch since 2005 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 3-37: Cross-sectoral comparison: percentage of product / process innovations where ICT has played an important role

Sector	Product innovation: % ICT-linked		Process innovation: % ICT-linked		Year of survey*
Manufacturing					
Glass, ceramics cement **	~50%	●●	~75%	●●●	2009
Chemical, rubber, plastics	~35%	●●	~75%	●●●	2007
Food	~15%	●	~60%	●●●	2006
Pulp and paper	~35%	●●	~60%	●●●	2006
ICT manufacturing	~55%	●●●	~70%	●●●	2006
Steel	~50%	●●	~65%	●●●	2007
Furniture	~45%	●●	~65%	●●●	2007
Automotive	~20%	●	~85%	●●●●	2005
Pharmaceutical	~20%	●	~70%	●●●	2005
Machinery & equipment	~25%	●	~65%	●●●	2005
Publishing	~65%	●●●	~85%	●●●●	2005
Retail and services					
Retail	~70%	●●●	~80%	●●●●	2007
Transport and logistics	~75%	●●●	~75%	●●●	2007
Telecommunications	~85%	●●●●	~90%	●●●●	2006

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

** The results for the GCC industries are not fully comparable to those for other sectors, because the survey question providing the data for this table was changed and expanded in 2009. Until 2008, it was only asked whether any of the product or process innovations was "directly related to or enabled by ICT", while in 2009 three different ways for possible links between ICT and the innovation were given. Figures refer to the percentage of companies which stated that at least one of these links "fully applies".

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, about 60% confirmed that ICT had played an important role in these process innovations."

Source: e-Business Surveys 2005 – 2009 of the SeBW

3.3.3 ICT as a means to improve environmental sustainability

There are high expectations for the potential of ICT for improving the energy efficiency and reducing greenhouse gas (GHG) emission levels. For instance, the Smart2020 report states that "*while the [ICT] sector plans to significantly step up the energy efficiency of its products and services, ICT's largest influence will be by enabling energy efficiencies in other sectors, an opportunity that could deliver carbon savings five times larger than the total emissions from the entire ICT sector in 2020.*"

ICT is similarly lauded by the EC in its Communication on "Mobilising ICT to facilitate the transition to an energy-efficient, low-carbon economy" (2009b) for its "economy-wide capacity for energy-saving" and for its "potential to effect rapid and propound change"[81]. The EC cites the Smart2020 report, as well as another study that predicts energy use reductions of 10% by consumers through the use of ICT, in support of its convictions.[82]

[81] COM(2009)111

[82] See European Commission (2008). Final Report on the Impacts of Information and Communication Technologies on Energy Efficiency or the ESMA (March 2008) Report on Methodology for Estimating Energy Savings.

In particular, the Communication identifies two roles for ICT in reducing GHG emissions through energy-efficiency:

- an "**enabling role**": ICT enables energy efficiency improvements by reducing the amount of energy required to deliver a given service.
- a "**quantifying role**": ICT provides the quantitative basis on which energy-efficient strategies can be devised, implemented, and evaluated.

Against this background, the Sectoral e-Business Watch has conducted a comprehensive economic study about the impact of ICT on GHG emissions in energy intensive industries parallel to this study.[83] The GCC sector is one of the sectors analysed in this study. In this Section, we summarise the main results of this study for this particular energy-intensive sector.

Econometric analysis of the ICT impact

This study conducted **parametric regressions** based on the environmental "Kuznets curve" theory[84] to model and estimate the relationship between ICT capital and greenhouse gas emissions. The objective of the parametric regressions is to test for and estimate the direct effects of ICT capital on GHG emissions while controlling for the effects of a variety of other variables that may influence the relationship.

For the GCC sector, the parametric analysis did not find conclusive results regarding the direct impact of ICT capital intensity on emission intensity. Instead, non-ICT capital was found to play an important role in emissions per output in former EU-15 Member States. Emissions per output increase significantly with non-ICT capital intensity in the sector for these EU Member States. The same relationship is suggested for the new Member States as well, but was not found to be significant. These estimation results suggest that the role of non-ICT capital in the GCC sector should be more carefully studied, especially in "older" EU Member States.

As in the other sectors studied, structural effects were found to be significant in the GCC sector. It was the only sector in which structural effects were estimated as fixed effects, demonstrating that the decision about how much to invest in ICT capital stock in the sector is not unrelated to the specific policy or structural characteristics of the country as a whole.

In parallel to the parametric regressions, the study also applied **semi-parametric analyses**. This approach employs a production-theory take on GHG emissions to construct a measure of sustainable efficiency and test for the significance and direction of the impact of ICT capital share on a country's sustainable efficiency within a given sector. In this way, the results of this analysis add depth and specificity to the conclusions derived from the parametric analysis.

The semi-parametric analysis offers fresh insight into the role of ICT in the GCC sector in Europe, finding consistent effects of ICT for the sector across all sample countries where the parametric analysis did not. The semi-parametric analysis clearly suggests that countries with higher ICT capital share are better able to increase output at constant levels of

[83] Sectoral e-Business Watch study on the "ICT Impact on Greenhouse Gas Emissions in Energy-Intensive Industries", conducted by DIW econ (2009)

[84] The environmental Kuznets curve (EKC) hypothesis presumes that pollution levels initially increase with economic development – typically measured by income – and subsequently decreases after development and income have reached a certain threshold. Graphically, this leads to an inverted parabolic or U-shaped relationship between the two variables

emissions. A one percentage point increase in ICT capital share of total capital was estimated to increase output-oriented efficiency by 2.6 percentage points. This corresponds to enabling a given year's output to be increased by approximately 280 million Euros, given constant inputs, *without also increasing emissions levels.*[85]

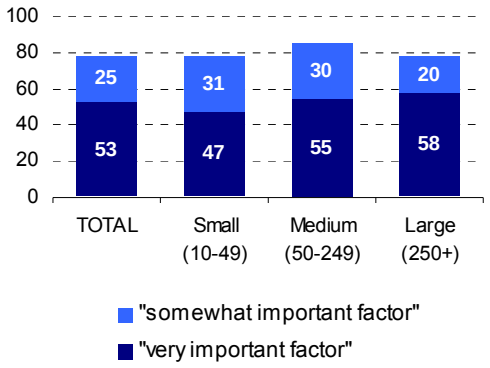
When only "older" EU Member States are considered, higher ICT capital relative total capital is also suggested to help countries reduce emissions at constant levels of output and improve conventional production efficiency.

Use of specific ICT systems for energy management

Complementary to the econometric analysis, the study also explores the extent to which companies in the GCC sector use specific ICT systems for managing and reducing energy consumption and emissions, and the potential they attribute to ICT in these areas. To this end, a specific module was included in the e-Business Survey 2009 (see Annex II). The results of this survey module are presented in detail in the quoted Sectoral e-Business Watch study by DIW econ (2009) and in a statistical table report that can be downloaded from the project website. This section just summarises the main results.

Rising energy costs are clearly a business concern in the GCC industries. More than 50% of the companies interviewed said that energy costs represented a "very important" factor for their competitiveness; another 25% said that it was a "somewhat important" factor (see Exhibit 3-38). To counteract rising energy costs, the industry has already made enormous efforts to become **more energy efficient** in production. The glass industry, for example, has significantly decreased its energy consumption levels since the 1970s. The German industry association has calculated that energy efficiency has increased by 77% since 1970, mostly due to continuous innovation in production technologies.[86]

Exhibit 3-38: % of companies saying that energy costs are a very / somewhat important competition factor



Source: e-Business Survey in the GCC sector (2009)

There are different opinions regarding the **potential for further improvements** in energy efficiency, irrespective of the role that ICT could play in this context. Although the various industries of the GCC sector continue to seek new ways of further reducing their emissions and energy consumption, industry associations question whether there is much further potential in the foreseeable future. Representatives of the ceramics industry believe that the remaining potential to further bring down energy costs in production is only about 5%.[87]

[85] This value was calculated off the data mean gross output of 9723.71 million Euros (1995 prices).

[86] Information by BV Glas (the association of the German glass industry), http://www.bvglas.de/umwelt-energie/energie-klimaschutz/ (accessed in May 2009)

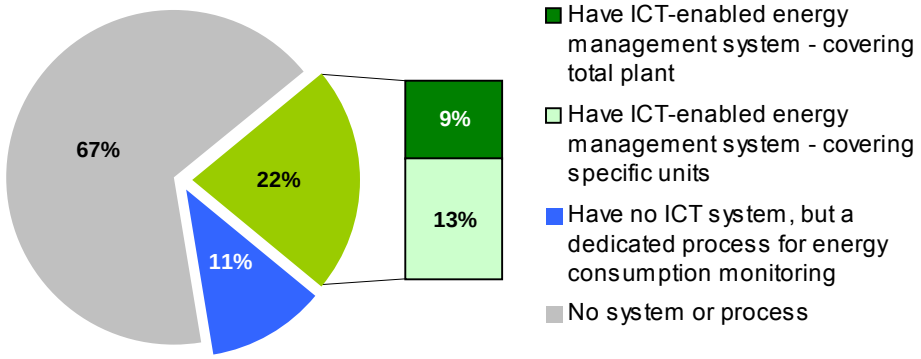
[87] Interview with Renaud Batier, Managing Director, Cérame-Unie, April 2009.

In the cement industry, the co-processing of alternative fuels (e.g. used tyres) might be one way of recovering energy and material from waste.[88]

The hope that innovation in ICT systems might enable companies to further increase their energy efficiency, i.e. reduce their energy consumption at given output or increase production with the same amount of energy, focuses in particular on systems for monitoring and analysing energy consumption. So called **energy management systems (EMS)** or energy control systems (ECS) are ICT-enabled systems used by energy consumers for monitoring, analysing and improving their energy consumption patterns. In more advanced forms of application, EMS/ECS automate energy consumption processes within a facility. EMS can include different modules and devices, ranging from a relatively simple time clock controlling a single circuit to sophisticated direct digital controls (DDC) that manage all of the energy intensive systems in a building.[89]

In total, companies representing 22% of the GCC industries said they have an ICT-enabled EMS (see Exhibit 3-39). A further 11% say they do not have an ICT solution for this purpose, but have implemented a dedicated process for systematically monitoring and analysing their energy consumption. This leaves two thirds of the companies which apparently have no systematic approach to energy management. As to be expected, relatively more large companies have ICT-enabled management systems. Adoption rates increase by firm-size, from 12% among small companies to 20% of medium-sized and 25% of large ones.

Exhibit 3-39: % of companies using an ICT-enabled system or a dedicated process to monitor and analyse their energy consumption



Figures are weighted by employment (companies representing x% of the sector's employment).

Source: e-Business Survey 2009 by the SeBW

Companies that said that they had used an EMS for at least one year were then asked for an **assessment of the system's effectiveness**. About 20% believed that the energy efficiency of their company had "significantly improved" due to the system in place, about a third of the companies said the efficiency had "somewhat improved". Nearly a 50% share[90] of the EMS-

[88] See "Sustainable cement production: Co-processing of alternative fuels and raw materials in the European cement industry", brochure by CEMBUREAU. In 2006, the European cement industry used an energy equivalent of about 26 million tonnes of coal, a non renewable fossil fuel, for the production of 266 million tonnes of cement. Alternative fuels constituted 18% of this across Europe, saving about 5 million tonnes of coal.

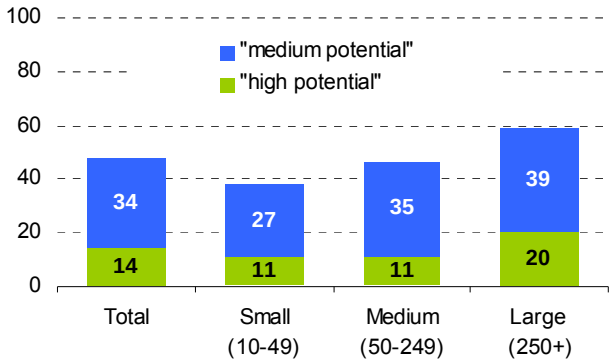
[89] Cf. product description of EMS solutions by Energy Conservation & Supply, Inc., see www.enerconsupply.com (accessed in June 2009)

[90] Weighted by employment (= companies representing x% of the sector's employment). N (total) = 86

using companies have not yet observed any impact on the energy efficiency. While this might look like a disappointing result, it must be considered that improving the energy efficiency is often only an indirect objective that companies may pursue with EMS. The basic functionality of an EMS is to ease the control and overview of the energy flows in the company, with a view to safety and quality control in energy-intensive production processes.

The actual experience of EMS users corresponds largely to the wider expectations which companies have towards ICT in this respect. About half of the companies interviewed (by their share of employment) believe that ICT have a medium or high potential for energy efficiency, only 14% see a "high potential", however (see Exhibit 3-40). Larger companies are slightly more optimistic in this regard.

Exhibit 3-40: % of companies thinking that ICT has a high / medium potential for energy efficiency



Figures for "total" are weighted by employment (companies representing x% of the sector's employment).
Figures for size-bands in % of enterprises. N (total) = 676.

Source: e-Business Survey 2009

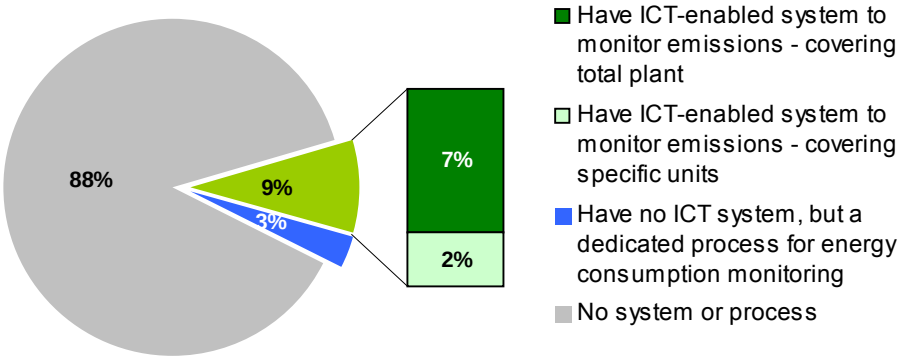
ICT usage for the management of greenhouse gas emissions

The GCC industries has expressed major concerns about the impact of the EU ETS on the competitiveness of the European industry (see Section 2.2.1). To cope with regulatory requirements such as the EU ETS, an increasing number of enterprises will be obliged to identify, understand and manage its carbon footprint. This footprint can encompass all emitted greenhouse gases which are then converted into CO2 tonnes equivalent. Emissions can result from different direct and indirect sources, including energy, transport, waste, water supply chain and other indirect contributors.[91] In larger companies, collecting and monitoring data about CO2 footprints could become a normal part of the overall enterprise resource planning (ERP) process. In addition to solutions that are fully integrated with an ERP system, there are also software solutions that are linked with energy management systems as well as specialised stand-alone solutions for monitoring the carbon footprint.

All in all, the market for emissions management tools is still in an early phase. Specific systems or modules for monitoring and measuring GHG emissions are **not yet widely diffused**. In the GCC industries, less than 10% of the companies interviewed said they had an ICT-enabled application to systematically monitor GHG emissions. A further 3% said they did not have an ICT solution for this purpose, but had implemented a dedicated process for systematically monitoring and analysing their emissions.

[91] cf. Energy Management Solutions: Carbon Management and Carbon Footprinting. http://www.ems.org.uk (accessed in June 2009)

Exhibit 3-41: % of companies using an ICT system or a dedicated process for monitoring their greenhouse gas emissions



Base (100%): companies with at least 10 employees using computers (N = 676).

Figures are weighted by employment (companies representing x% of the sector's employment).

Source: e-Business Survey 2009 by the SeBW

4 Micro-perspective (II): company case studies

Background information and overview

While Chapter 3 analysed the adoption of ICT-based applications and e-business activity in the industry from a broad perspective, this chapter looks in more detail at individual enterprises and their specific approaches to e-business. The case studies presented were selected with the goal to achieve a balanced mix of cases in terms of sub-sectors and application areas along the company value chain. Therefore, the cases are necessarily very heterogeneous in terms of topics and types of companies presented. They include mostly examples of **large, globally operating companies** with highly automated production processes (such as Schott AG, Holcim and Lafarge). The choice to focus on large companies in the case studies was made to counterbalance the SME-focus in the representative enterprise survey (see Section 3). While SMEs present the vast majority of enterprises in most segments of the GCC industries, the large enterprises are of course also very important for employment. The case studies indicate that the large companies of the sector are advanced ICT users, very much as in other manufacturing sectors. The case studies also include a medium-sized company from a labour-intensive subsector: the manufacture of ceramics tableware (Gmundner Keramik).

The study team encountered quite some **difficulties** –more than experienced in previous years in other sector studies– in finding companies that would agree to cooperate and be available for a case study about their e-business activity. The main reason was the severity of the **economic crisis**. Several companies which the study team had contacted politely declined the request (even if it was supported by the sector's federation), indicating that they just did not have the time for it[92], due to the enormous challenges their company was facing. The message between the lines was that the company had more important things to do in the current situation than talk about e-business. Some interview requests made to national associations were rejected with similar arguments. This evidence by itself indicates that e-business is not seen as a priority or an adequate instrument in large parts of the GCC industries to tackle and weather out the crisis.

Exhibit 4-1 provides an overview of the case studies, indicating the main ICT application areas studied. Cases (both in the overview and the subsequent sections of this chapter) are sorted by sectors (glass, ceramics, cement) and alphabetically within sectors.

Exhibit 4-1: Case studies in overview (sorted by sectors)

Section	Case company	Sector (NACE Rev. 2)	Country	Company size	Topic
4.1	Schott AG	Glass (23.1)	Germany	Large	e-RFQ
4.2	BA Vidro, SA	Glass (23.1)	Portugal	Large	ERP implementation and use
4.3	Gmundner Keramik	Ceramics table-ware (23.4)	Austria	Medium	Production planning (PPS)
4.4	Holcim Slovensko	Cement	Slovakia	Large	e-Procurement: reverse auctions
4.5	Lafarge Cement S.A.	Cement	Poland	Large	ERP / CRM

[92] the effort for a company is limited to about a person day in total, including 1-2 hours for the initial interview(s), and a few hours for clarifying open issues and reviewing the draft case study

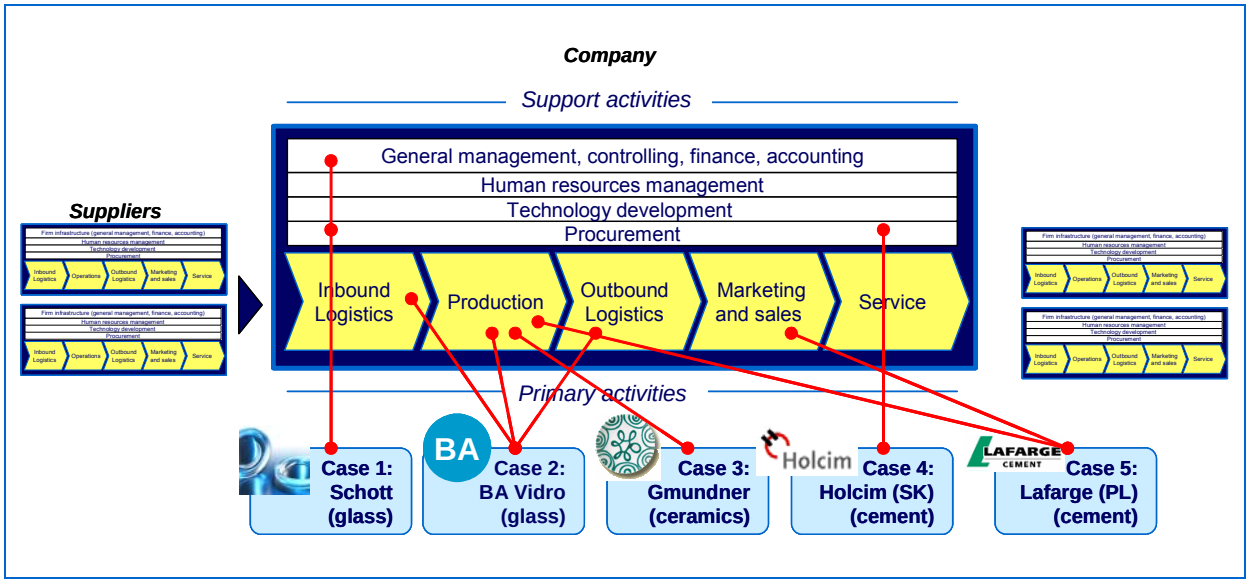
In addition to these case studies which are presented in full detail in the following pages, the report contains a number of business examples of **small companies** from the sector and their ICT use (or their reasons why they do *not* make much use of ICT). These examples are mostly presented in Section 3.2 ("e-Activity"). Some of these business examples are based on interviews with companies representatives, others on desk research.

Except for the smallest companies which rely almost entirely on traditional exchanges[93], there are some common points that emerge from the case studies and business examples presented: ICT and e-business, if used in the right way, are key to managing information in today's economy. ICT helps companies becoming more organised and controlled, whether it is about managing global operations, optimising internal work-flows or communicating with customers.

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 1.3). 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 case studies presented in this chapter can be seen as examples how companies use ICT to achieve this goal, focusing on different functional areas of the value chain. Exhibit 4.2 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 4-2: e-Business focus of case studies according to Porter's value chain framework



[93] The ICT use of many small companies is restricted to e-mail and web access. They do not used any advanced software systems or applications to manage their internal operations and external relations, and only few use e-commerce (see Sections 3.1 and 3.2).

4.1 Schott AG (Germany)

Abstract

Schott AG is a multinational technology-based manufacturer of glass and glass products for various industries. In 2003, the company implemented a new e-sourcing solution based on electronic Request-For-Quotations (e-RFQs) to support the worldwide sourcing of strategic goods and materials. This case study shows that e-sourcing in a large multinational company goes far beyond the implementation of electronic tendering tools. Schott also uses the solution to support collaboration between procurement, business and technical departments from the very beginning of the sourcing process, i.e. when the specification process starts.

Case study fact sheet

• *Name of the company:*	*Schott AG*
• *Location:*	*HQ in Mainz, Germany; production sites and sales offices in 42 countries*
• *Main business activity:*	*Manufacture of special glass, materials, components and systems for a wide range of applications (including flat glass, pharmaceutical systems, photovoltaic, lighting and imaging)*
• *Year of foundation*	*1884 (Schott & Genossen, Jena)*
• *Number of employees:*	*17,300 worldwide (of those 6,700 in Germany)*
• *Turnover in last financial year:*	*2.2 billion euros (worldwide); 74% generated outside Germany*
• *Primary customers:*	*Companies, e.g. in the pharmaceutical, solar energy, hometech, electronics, optics, architecture, aviation and automotive industry*
• *Most significant market:*	*Europe (59%), Asia (18%), North-America (18%)*
• *e-Business applications in focus:*	*e-RFQ, e-sourcing, SRM (Supplier Relationship Management), e-procurement*
• *Case contact person:*	*Michael E. Glaninger, Director Global Purchasing e-Procurement, Schott AG*

4.1.1 Background and objectives

Schott is a multinational technology-based company that develops and manufactures special glass, special materials, components and systems for various industries, including the pharmaceutical, solar energy, hometech, architecture, electronics, optics, aviation and automotive industry. The product portfolio ranges from micro components for the electronics industry to large-sized fire-resistant glazing. The German-based company holds plants and sales offices in more than 40 countries. During the 2007/2008 fiscal year it generated global sales of 2.3 billion euros. Almost three fourth of the sales were generated outside Germany. By the end of 2008, Schott employed 17,000 people, of whom 6,700 were based in Germany.

Sourcing and procurement at Schott has a strong impact on the company's overall success. The purchasing volume accounts for about 1.2 billion euros. Thus, savings gained by improving sourcing and procurement processes significantly affect the company's earnings. Particularly, the sourcing of so called A goods (also strategic goods) –i.e. goods

with large purchasing volume that are of strategic importance– yields a large savings potential. Nevertheless, Michael E. Glaninger, Director Global Purchasing e-Procurement (SRM Tool: SPO-Schott Procurement Office), points out that sourcing does not mean to search the cheapest offer. He rather defines sourcing as "*finding reliable goods and products of those suppliers at the market, that meet the needs of the company at an optimal price and in adequate quality*."

Certainly, before the implementation of e-sourcing procedures, Schott had already used **RFQs** (Request for Quotations) as a method of finding the best offer in terms of price and quality. However, carrying out RFQs is a challenging task, in particular with regard to sourcing of complex goods with high strategic importance – such as production plants in large, multinational companies like Schott. It is a long multi-stage process from the first specification of the need to the choice of the suppliers. In this process many different parties are involved. Stakeholders include technical engineers, purchasers, product developers, maintenance, security and marketing executives as well as external engineering and consulting services. On the one hand, carrying out RFQs requires an intense exchange of information between internal stakeholders. On the other hand, suppliers must have direct access to all information related to the RFQ in due time and in the same quality. Furthermore, it should be possible to analyse and compare submitted offers in terms of price and quality. Last but not least, compliance rules and security aspects have to be taken into consideration during the whole process.

Having all these challenges in mind, it becomes obvious that carrying out RFQs in the traditional way –without using a specific ICT system– is difficult to coordinate, prone to errors and extremely time consuming. As a consequence, RFQs were less frequently used and the results often turned out to be suboptimal. Following from that, Schott implemented an **e-sourcing system** named SPO – SCHOTT Procurement Office in 2003 that helps to carry out RFQ procedures in a more structured and transparent way.

Objectives

The company's set the goal to organise its global procurement processes in an entirely new way. In particular, procurement executives should be able to accompany the sourcing process from the very beginning. As Mr. Glaninger explains: "*The collaboration of business, technical and procurement departments in early stages, i.e. when needs get defined and specified before an RFQ is sent out, has an outstanding importance to the success of the entire sourcing efforts. At this stage, the main task of procurement executives are to question the necessity of expensive add-ons, to enforce the integration of standard products and the consideration of follow-up costs. This procedure not only promotes competition, but also ensures that the RFQ is based on TCO (Total Cost of Ownership) considerations."*

In the past, procurement executives were only involved at a later stage of the process when the RFQ had already been carried out. Back then, it was common practise that technical departments chose their favourite suppliers at the beginning of RFQ process, in order to discuss their needs and possible solutions. Specifications of RFQs based on discussions with single suppliers, without intensive collaboration between purchasers and other stakeholders, turned out to be much less efficient. As a consequence of the low degree of standardisation, the number of possible suppliers got diminished. Additionally, follow-up costs were not adequately considered when formulating requests for certain positions. Therefore, a central goal of the e-sourcing initiative was to facilitate collaboration between the business, technical and procurement departments already from an early stage of the process.

4.1.2 e-Business activity

Technology used

In 2001, Schott started to search for a technology partner able to develop a solution that would meet the needs of Schott at an affordable price. This task turned out to be more complex than originally thought. Many suppliers offered tools to support simple RFQ procedures. However, only a few were able to map the entire process, including the collaboration between different stakeholders from the early beginning up to the analyses of the offers. In fact, one software supplier charged with the e-sourcing project, failed to manage the project's complexity. In the end, in year 2002, **Onventis**, a specialised software supplier in the field of e-procurement and supplier relationship management turned out to be able to fulfil the requirements.

Mr. Karl-Heinz Theiling, CEO at Onventis reports that "*Schott was one of the first companies that realised the idea of doing global procurement in a holistic and more collaborative way, using e-business technologies.*" As a matter of fact, various e-sourcing features originally developed for the needs of Schott have been integrated as a standard in Onventis TradeCore SRM software suite. "*Today, the number of companies asking for sourcing solutions that increase transparency for all stakeholders as well as ensure frictionless and uncomplicated collaboration processes from the first specifications to the closing of contracts has significantly increased*." (Theiling)

The e-sourcing system was launched in 2003. Since this time it has been continuously enhanced and further developed. RFQs carried out over the system generally consist of three parts:

1. a text part, containing all necessary information needed by the supplier, e.g. RFQ guidelines, and specification sheets;
2. an item list including prices for each position, providing the basis for monetary assessment;
3. a list of questions related to the offer (e.g. support requirements), providing the basis for qualitative assessment.

Generally speaking, the e-sourcing platform ensures that information related to these three parts of an RFQ can be compiled and accessed in a structured way. Players on the buy side such as purchasers, technical engineers and external engineering offices are – with different rights and duties – organised in virtual e-RFQ teams, which are built up with the start of the sourcing process. These teams are responsible for the coordination of the sourcing process and for defining and specifying the needs of a specific RFQ. The rights and duties of the different players and related coordination processes are mapped by the system. On the supply side, the players have access to all information regarding the RFQ in a structured way.

In addition, the solution yields a large set of functions facilitating the work of all players involved on the buy and supply side. Examples are:

- Version management. This ensures that all players involved have access to relevant information in the current version in real time.
- Templates. Templates with predefined text parts, positions and questions regarding the main product groups (e.g. equipment, plants or refractory) help to simplify and speed up the composition of information of the RFQ.

- Archiving. Specifications of finished RFQs are stored and can be reloaded for similar tasks.
- Analysis. The system contains various features that facilitate the comparison and analyses of the offers.
- Use of material codes. All products and materials as well as players involved in related RFQ procedures are provided with a material group code (defined by Schott and based on various industry standards), which facilitates process management.
- XLS export/import helps buyers and suppliers to work on the offer internally before submitting it to the system.

4.1.3 Impacts and lessons learned

Business impacts

Today, the e-sourcing platform is of central importance to the global procurement activities of Schott. The procurement volume negotiated by e-RFQs over the platform in 2008 accounted for about **368 million euros**, i.e. almost one third of the overall procurement volume. All in all, Schott carried out about **1,700 electronic RFQs** in 2008. Almost 900 internal users, more than 60 external engineering services as well as more than 4,200 suppliers and almost 2,000 additional document suppliers used the platform.

According to Mr. Glaninger, the use of the e-sourcing platform significantly improved the results of global procurement activities at Schott. Improvements were achieved in terms of:

- **Transparency**: As a main advantage of the e-sourcing solution, there is one database with up-to-date information that can be accessed in real time by all stakeholders. This is the basis for sourcing in a more collaborative way and thus for optimising the entire sourcing process.
- **Competition on price and quality**: The use of electronic RFQs facilitates the comparison of market offers in terms of both monetary and qualitative aspects. In this way, TCO considerations have become a far more important factor in competition between suppliers.
- **Quality**: The use of templates with predefined text parts, position and question structures allows for the enforcement of company-wide standards. For example, TCO considerations or security aspects related to a certain group of purchasing goods can be implemented “as a must” in the list of questions to ensure quality standards. Moreover, improving quality is a continuous process as questions can be adjusted according to past experience.
- **Compliance**: The e-sourcing solution supports the proceeding of RFQs in a structured and comprehensible way. Thus, it can be ensured that orders are assigned in line with compliance rules and national law. This point is of particular importance in large projects.
- **Orientation and comfort for suppliers**: Not only internal stakeholders profit from the increased transparency and a uniform structure, in which the information is presented. The IT solution also provides a better orientation for suppliers.
- **Agility and Velocity**: The entire sourcing process can be speed up at a constantly high quality, due to the use of templates and the opportunity to reproduce parts of

former RFQs. "*Simple RFQs, that proceeded over days or even weeks in the conventional way, can be sent out in a few seconds today.*" (Glaninger)

Overall, the e-sourcing solution provides the basis for carrying out global procurement activities at Schott in a new, innovative way. The procurement department, which is in charge of the solution, acts as a mediator by supporting the information exchange during the entire process. Thus, it has the opportunity to control and influence the sourcing process from the very beginning. This is the basis for the various process improvements listed above. Beyond doubt, significant savings can be gained due to the above mentioned process improvements and the early integration of procurement professionals, who question expensive add-ons and enforce a higher degree of standardisation.

However, measuring the exact savings would be highly speculative and an almost impossible task. One of the core advantages of the solution is the higher weight of TCO considerations, including follow-up costs and quality aspects. Therefore, a simple comparison of purchasing prices would be misleading. In order to illustrate the large potential of electronic RFQs, Mr. Glaninger refers to the market price range, i.e. the difference between minimum and maximum bids submitted via the e-sourcing platform of Schott. This market range was at almost 30% in 2008, making up more than 120 million euros. Within that range Schott's purchasers could realize the real savings for the bottom line, after all.

Challenges and success factors

After more than five years of e-sourcing at Schott, some of the company's initial expectations have changed significantly. Important lessons learned about limitations and challenges include:

- **Broadness of use**: At the start of the e-sourcing initiative, forcing competition in all fields and thus broadening the use of e-RFQs to the largest extent was one of the company's central goals. Today, the procurement department at Schott knows that e-RFQs are not practicable for single product groups. If a supply good is of strategic importance and suppliers have a large market power, the company prefers to establish long-term partnerships.
- **Degree of automation**: At the beginning of the e-sourcing initiative, the vision prevailed that all related tasks could be carried out automatically via the system, including the management of processes by material group codes or the automatic choice of the best offer. However, some functionalities turned out to be too complex and simply not practicable. Today, the company not only tries to keep the sourcing system as simple as possible, but also allows for individual judgements. "From today's perspective, the opportunity to export or import results as Excel sheets is more important than any complex functionalities to the analysis of offers."
- **Quality of content**: During the five years carrying out electronic RFQs, the procurement department of Schott learned that the quality of content, e.g. regarding complete and exact specifications, is of outstanding importance to the success of the sourcing efforts. Electronic tools may help to increase quality, e.g. by using templates with a predefined question structure. However, electronic tools cannot entirely ensure the quality of content and thus can not substitute for a dedicated quality control.
- **Process standards missing**: The success of e-RFQ solutions strongly depends on their usability for suppliers. Certainly, Schott made the effort to enforce company-wide standards and to present information in a structured and comprehensible ways, in order to increase usability. However, gathering all the information is still difficult and

time consuming for many suppliers, since there is no common logic for the presentation of information in e-RFQs. "*Some suppliers have to deal with more than 100 international e-procurement and e-sourcing systems, that all follow a different logic. Thus, the absence of global standards in this field certainly limits the potential of e-RFQ solutions."* (Glaninger)

Overall, Mr. Glaninger emphasises that the success of e-RFQs depends on **technical and organisational issues**. From the technical point of view, he considers an "easy to use" solution for both internal and external stakeholders as being of outstanding importance. "*The solution can only be successful if it is accepted by all parties involved*." Otherwise, there is a risk that suppliers or internal players stay away from the process, and goods will be procured in other –less efficient– ways. A simple and practicable way is that all technical applications offered fit the needs of the parties involved.

From the organisational point of view, there are several issues that have to be addressed to make the e-sourcing solution a success. In order to produce e-RFQ templates, for example, company-wide procurement standards (minimum requirements in terms of quality, security etc.) are needed. Moreover, ensuring a high quality of content and defining measures of quality improvements are necessary requirements. This presumes that the success of e-RFQs in terms of quality criteria is continuously measured. Therefore, it is of great importance that a team within the company is in charge of managing, monitoring and improving e-sourcing procedures. At Schott, this is the task of the Schott procurement office.

Mr. Glaninger concludes: "*Electronic tools supporting the RFQ process have a significant potential for streamlining sourcing processes, improving quality and achieving significant savings. However, e-RFQs cannot be implemented from one day to another. It takes time to solve the various related technical and organisational issues.*"

Lessons learned

The case study illustrates chances and challenges of e-sourcing solutions, in particular of electronic RFQs in large multinational companies. The e-sourcing-solution is not only considered as a mix of tools supporting negotiations, based on the RFQ method. Rather, it is perceived as an holistic solution supporting global procurement and related collaboration processes. In fact, Schott used the e-RFQ solution to significantly improve processes and move the procurement department in a central position already at the specification process.

Naturally, the procurement office wants to realise cost savings by applying the e-sourcing solution for finding the best offer in terms of quality and cost. However, the solution also yields chances for suppliers. Since the solution provides the opportunity to compare offers in terms of quality and different cost aspects, it lowers entry barriers for innovative suppliers, which are able to provide the best offer in terms of TCO. However, from a supplier's point of view, taking part in RFQ procedures is time and cost consuming. e-Business solutions should help to reduce efforts by providing information in a structured way. In this regard, differing e-RFQ structures among buying companies are still a problem. From this perspective, Mr. Glaninger's hint at regarding the absence of process standards for e-RFQs should be taken seriously.

Finally, the case demonstrates that the success of technical innovations significantly depends on organisational issues. Furthermore, the success of e-RFQs depends on the quality of content and the availability of company-wide procurement standards. If these issues are not solved, the most innovative technical solution will not yield the desired success.

4.1.4 References

Research for this case study was conducted by Dr. Andreas Stiehler and Timo Zumbro, Berlecon Research GmbH (http://www.berlecon.de). Sources and references:

- Interview with Michael E. Glaninger, Director Global Purchasing e-Procurement, Schott AG, 30th April 2009.
- Interview with Karl-Heinz Theiling, CEO, Onventis, 30th April 2009.
- Websites of Onventis GmbH (http://www.onventis.de) and Schott AG (http://www.schott.com)

4.2 BA Vidro, SA (Portugal)

Abstract

The Portuguese company BA Vidro, SA manufactures glass flasks and bottles. BA Vidro uses two central business software systems that are critical for its information management: an enterprise resource planning (ERP) system to support the business both at the operational level and in decision making, and a shop floor control (SFC) System to effectively manage the production floor. The ERP system was initially introduced in 1998. Since then, the main challenges were the maintenance of the software and its continuous adaptation in line with business changes and new needs. The SFC System was designed and implemented internally in 2002 and proved to be an essential tool to standardise concepts.

Case study fact sheet

• *Name of the company:*	*BA Vidro, SA*
• *Location:*	*HQ: Avintes* *Factories: León, Xinzo Limia, Vila Franca de los Barros, Marinha Grande,Venda Nova* *Offices: Lisboa, Madrid, Sevilla, Barcelona, Rioja, Murcia*
• *Main business activity:*	*the manufacture of glass flasks and bottles*
• *Year of foundation*	*1912 (at the time it was called Barbosa & Almeida)*
• *Number of employees:*	*1508 (in 2008), of those 964 in Portugal, 544 in Spain*
• *Turnover in last financial year:*	*about 291 million euros*
• *Primary customers:*	*Unicer, Heineken, Nestlé, Unilever, Kraft, Compal, Sogrape*
• *Most significant market:*	*Iberia (nearly 88% of the sales volume)*
• *e-Business applications in focus:*	*Use of ERP (SAP R/3) and SFC systems*
• *Case contact person:*	*Mr António Magalhães*

4.2.1 Background and objectives

The company

BA Vidro produces glass containers (bottles and flasks) for the food and beverages industry. Founded in 1912, the company started by selling bottles and, in 1930, initiated its further industrial activities. In the 1990s, BA Vidro achieved a leading position in Portugal and began to successfully expand its operations to the Spanish market. BA acquired a factory in Marinha Grande (CIVE) in 1993, built a factory in Extremadura in 1998 and acquired a factory in León (Vidriera Leonesa) in 1999. Today, BA is the second largest Iberian supplier of glass containers, employing about 1500 people and generating a turnover of about €290 million (2008). BA's share capital increased significantly as it grew from a family business into a corporate structure and reaches nowadays €37.5 million (2008).

Production is spread over six factories, three in Portugal and three in Spain. The Iberian market accounts for the vast majority of sales (between 80% and 90%). Products are mostly distributed and delivered directly to customers.

Almost all products are destined to food and beverage manufacturers with a high quality, hygiene and tracking standards.

In its ongoing pursuit of high quality standards and efficiency, BA certified all its manufacturing units under Standard ISO 9001 and signed an "Environmental Improvement Contract" with Portugal's Ministry of Environment. This contract stipulates measures to reduce greenhouse gas emissions, to become more efficient in the use of natural resources, to implement an environmental management system, to register the company in the EU Eco-Management and Audit Scheme (EMAS) and to carry out an ambitious investment plan at the León and Avintes factories.

The industry

The container glass industry is a mature sector, facing strong competition from potential substitute products such as packaging solutions made of plastics. A competitive price is, besides innovative design, the key critical success factor in this competition. As a result, the industry is quite concentrated, with a few large business groups in Europe. The market entrance of new competitors is difficult. Entry costs are very high, and for customers it is rather difficult to switch suppliers quickly.

From a production perspective, the manufacture of glass containers for food and beverages is characterised by a high cost in the case of production changes. This leads to a specialisation of production lines and a high level of stocks. This limitation of the production process is in sharp contrast to the market trend of having increasingly shorter product cycles and to be less and less predictable.

The importance of e-business

The evolution and growth of BA Vidro significantly increased the number of clients, products, production lines, plants and workers. As a result, the coordination and management of all activities became exponentially more difficult. In 1997, the company decided that it had to invest in advanced business software to manage its increasingly complex operational workflows and to support strategic decision-making. Therefore, BA Vidro decided to implement an **ERP** (Enterprise Resource Planning) system. This should enable the company to integrate information about clients' consumption forecast with finished products' existence, and to forecast more accurately the production of twenty-eight production lines spread over six factories.

In addition, in order to achieve the best possible use of production resources, including facilities, materials, and employees, in 2002, BA Vidro internally designed, developed and implemented an **SFC** (Shop Floor Control) system. An SFC helps a company track materials, tools, machines and the time utilised in production, so that the activities of production are visible throughout the organisation to authorised users.

4.2.2 e-Business activity

Rationale for the e-business project

In 1997, BA Vidro started a growth and internationalisation process. At this stage, the existing software used to manage and coordinate resources, information and functions was clearly obsolete. The existing set of S400 computer applications had limited responsiveness, was not properly integrated and was not ready to run in a multi-lingual and multi-legal environment. In order to support its new, more complex configuration, the company

considered the replacement of this software and decided to implement an ERP system. Since its implementation in 1998, the ERP system has been steadily evolved, reflecting business growth, additional sales areas and other specificities. Today, it is clear that this software is the central platform that supports most business processes and is thus the main information and communication system of BA Vidro.

In 2002, BA Vidro realised that the company needed a single software to provide data for daily meetings concerning the production process. Until then, staff used predominantly MS Excel spreadsheets and MS Access databases to create the reports for these meetings. This procedure was not only inefficient, but also led to different and sometimes conflicting results for the same aspect of production, depending on the standpoint. As a consequence, the company started in the same year to design, develop and implement a Shop Floor Control system.

Implementation of the ERP and SFC systems

ERP system

After analysing several solutions available in the market, BA Vidro decided to acquire an ERP system from SAP, the "My SAP Business Suite". The initial phase of the implementation started in 1997, lasted for about a year and a half, and comprised the replacement of former applications. In order to achieve the objectives outlined for the project and limit interferences with regular operations, the company decided to implement the new software but not to re-engineer processes. At the end of this first stage, which laid the foundations for the logistics and financial processes, BA Vidro had an information system capable of monitoring processes changes and incorporate new units. Since then, the system has been expanded by adding the following **functionalities** for various business functions:

- **Human Resources**: initially, attendance management and basic calculation of salaries according to the law in each of the workplaces were implemented; later on, performance evaluation and variable compensation management were included.
- **Production planning and monitoring**: in production planning, the basic steps for implementing repetitive and discrete production standards were enabled. Regarding production monitoring, sophisticated data collection systems capable of automatically obtain real-time information of production processes and especially of quality control were developed.
- **Warehouses management**: the need to manage the existence and ensure the traceability of hundreds of thousands of pallets spread across multiple warehouses led to the implementation of a complex and rigorous management system of warehouses. In this process, complex systems of bar codes reading and communication were assembled and specific software was integrated into the ERP system.
- **Purchase- and sales-related internal transactions**: the need to expedite the transfer of goods between factories led to the automation of internal processes of purchase and sale so that handling and trade of goods in different factories would become transparent.
- **Product development**: to accelerate product development, BA Vidro added a module to deal with technical and production information of product and production lines. The communication process necessary for the development and approval of new product projects, communication with suppliers of moulds and production specifications were included. Based on this information, the company expedited production displacements between plants.

Although BA Vidro bought "My SAP Business Suite" applications, it currently uses the following modules: MM – Materials Maintenance, SD – Sales and Distribution, WM – Warehouse Management, PP – Production Planning, QM – Quality Management, PM – Production Management, HR – Human Resources, FI - Finance, CO - Controlling, PLM – Product Lifecycle Management and SAP PORTAL.

The **cost** of the SAP ERP system was about €350,000, to be paid within three years. Meanwhile, BA Vidro spent another €65.000 for licences from SAP. SAP charges 17% of the sum of these values per year. The company resorted to consultancy services, paying €220,000 in the first year and about €150,000 in the second year. Consultancy costs went down to about €30,000 per year in the following years and are insignificant today.

BA Vidro had six persons (internal staff) working in the ERP implementation during the first year with a total cost of about €160,000 per year. From 1998 on, there were three persons concerned with the ERP software maintenance, costing a total of approximately €90.000 per year.

The additional hardware required to run the ERP system costs about €40.000 euro per year, as it needs to be constantly updated.

From the standpoint of keeping up with organization changes, Mr. António Magalhães, head of the IT Department of BA Vidro, emphasizes the following:

- Incorporation of four factories, three in Spain and one in Portugal - after its initial development, the ERP incorporated three companies and four plants replicating the benefits of procedures systematization.
- Centralisation / decentraliqation of services - over time BA Vidro made structural changes leading sometimes to concentration and others to decentralization of services, and the ERP was able to easily answer to these changes.

SFC system

As for the Shop Floor Control system, it consists of a system of computers and controllers used to schedule, dispatch and track the progress of work orders through manufacturing, based on defined routings. It was designed and developed internally to effectively manage the company's production floor through planning, visibility, expediting and comprehensive material management at the shop order level. It started to run in 2002 and has been constantly updated according to the company's needs. The system includes extremely accurate activity-based costing and real-time visibility to where the order stands in the production cycle.

The situation today

BA Vidro has great confidence in its ERP system. it is used at different levels of the organisation and comprises the majority of processes. Its development remains a priority to ensure that it continues to meet future business demands. Even if the ERP is prepared to exchange data with customers and suppliers, BA Vidro only sends a XML message (DESADV – Advanced Shipment Note) to some customers reporting the lot number and the identification of the pallets (SSCC).

Today, with support of the SFC System, the company manages very well all of the resources related to manufacturing and captures the detail to fully understand its costs and plant efficiency. To meet operational demands which are not supported by the ERP system, BA Vidro selected the OutSystems platform. To answer to management requests, BA Vidro is developing Business Intelligence solutions on the BW and SAP Portal platforms.

4.2.3 Impacts and lessons learned

Impacts

It is difficult to measure the ERP implementation impact because the present situation cannot be reasonably compared with the situation before. However, BA Vidro has been conducting a benchmarking exercise with comparable companies, and the results are favourable for BA Vidro. From a strategic perspective, BA is confident with the actual software platforms as the solution for future challenges.

The ERP system has proven to be beneficial to all major functional units of the company and is thus a truly horizontal system for company-wide information management. The experienced benefits in different functional areas of the company are:

- **Sales**: the effective management of orders, consumption forecasts and products' development enables BA Vidro to anticipate actions (which in turn increase customers' loyalty) and to identify new business opportunities.
- **Production planning**: customers' needs, finished products and production capacity crosschecking enables planning of production so as to avoid stock-outs and maximise output.
- **Production**: a more systematic production set and detailed monitoring of the manufacturing process allows the company to anticipate correction actions and to store information needed for future improvements.
- **Provisioning**: based on the production plan, it is better possible to schedule raw materials purchasing and delivery in order to balance best purchase conditions and low stock level.
- **Management**: managers are supported in predicting deviations and can act in time to avoid problems, as they can access in real time data integrated from different areas of the organisation.

The SFC System provides detailed information so as to manage activities and the flow of materials inside the plant. It tracks materials, tools, machines and time used in production, so that the activities of production are visible throughout the organisation to authorised users. SFC System functions include assigning priorities to manufacturing orders, management of productivity and operating rate control.

However, the main advantage of the implementation of the SFC System in BA Vidro was the standardisation of concepts for all factories of the company, according to international standards. This avoids misunderstandings regarding different indicators under the same name and allows BA Vidro to carry out benchmarking with companies all over the world.

Lessons learned

The implementation of an over-arching information system such as an ERP system is a lengthy and complex process, which critically depends on the capacity of the infrastructure to grow and to adapt to business changes. This process requires a clear definition of objectives and great persistence to its attainment.

The use of such software systems will be more successful if they are built along with business development, and if the necessary adjustments are made at each moment, so that it is natural to use the system at the operational level and that it presents an added value for decision making.

Still, even if BA Vidro has the capability to use the ERP system to communicate electronically with business partners, e-business is not seen as an advantage in this industry. BA Vidro customers, as well as this industry's common customers, are large manufacturers that make a small number of big orders. As for suppliers, namely for electricity, sand and caustic soda, BA Vidro has a single supplier; consequently, business processes are relatively simple.

4.2.4 References

Research for this case study was conducted by André Azevedo and Diana Magalhães, Inova+. Sources and references:

- Company visit and personal interview with Mr. António Magalhães, head of the IT Department of BA Vidro, with subsequent exchanges by e-mail and telephone
- Company annual reports
- Company website (http://www.bavidro.com)

4.3 Gmundner Keramik (Austria)

Abstract

For more than 100 years, Gmundner Keramik has been manufacturing ceramics table and ornamental ware. A special feature of the products is that all designs are hand-painted; therefore, each of the up to 10,000 pieces produced per day is unique. 65 of the company's 230 employees – mostly women– are highly skilled and trained ceramics painters.

The multitude of different articles (all sorts of tableware) and colour designs, and the fact that products are typically ordered in small volumes (often comprising a few items only), creates a challenge for demand forecasting and production planning. For decades, the company used to produce on stock. However, as it is impossible to precisely anticipate the demand for specific designs and items, this procedure was inevitably inefficient. This case study shows how a technologically simple, self-programmed ICT solution (a production planning system based on a MS Access database) has enabled the company to move from on-stock to order-based production, with a huge positive impact on process efficiency and reduced demand for storage capacity. The case study is an example of ICT-enabled process innovation in a medium-sized enterprise, while also demonstrating that "ICT-enabled" does not necessarily imply major investments in hardware or software.

Case study fact sheet

• *Name of the company:*	*Gmundner Keramik Manufaktur GesmbH*
• *Location:*	*Gmunden, Austria*
• *Main business activity:*	*Manufacture of ceramics tableware*
• *Year of foundation*	*1903*
• *Number of employees:*	*230*
• *Turnover in last financial year:*	*about 10 million euros (2008)*
• *Primary customers:*	*Mainly consumers (via specialised retail stores selling ceramics table ware, including large furniture stores), but B2B is increasing*
• *Most significant market:*	*Austria (75%); exports go mainly to Germany, but also to Switzerland, Italy, Slovenia, France, USA and Japan.*
• *e-Business applications in focus:*	*Internal processes: ICT for production planning and management (PPS)*
• *Case contact person:*	*Mr Josef Feichtinger*

4.3.1 Background and objectives

Already in the 17th century, Gmunden, a small city in Upper Austria, has been a centre of fine and decorative ceramics. Gmundner Keramik Manufaktur GesmbH (in the following "Gmundner"), founded in 1903, produces hand-made, high quality ceramics **table and ornamental ware**, mainly in a country-style design. The company is the market leader and

the best known brand in Austria in this sector.[94] A special feature of the products is that all designs are **hand-painted**. Therefore, each of the about 10,000 pieces of ceramics produced per day is unique. 65 of the company's 230 employees are highly trained and qualified ceramics painters, mostly women. Each of the over 500 different forms (in total) is handled and processed in up to 60 steps, mostly manual ones, before it can be offered for sale.[95]

Exhibit 4-3: Gmundner Keramik design lines

Gmundner produces a wide range of forms (such as different plates, cups and bowls – about 500 in total), which are available in 20 design lines (the most important ones are depicted below). In total, there are about 7,600 different articles, all of them hand-made and hand-painted. This makes production planning extremely difficult, as the demand for different designs and items cannot be precisely forecast.

Source: Gmundner Keramik (http://www.gmundner-keramik.at)

The **production process** consists of several phases. First, the raw material is prepared and worked into shape. The various forms, such as plates, coffee pots and milk jugs are either cast (i.e. made in plaster moulds), shaped on a potter's wheel or pressed. The raw product is then fired for the first time, glazed and then goes to the heart of the factory, the painting department. Here, the pottery painters paint (by hand) the dots, flowers and chequered patterns, keeping strictly to detail. Finally, the product is fired for the second time, which gives it the necessary hardness.

Gmundner ceramics are mainly bought by private households, although the business customers segment[96] increases in importance. In **distribution**, Gmundner cooperates with a large network of trading partners, in particular specialised retail stores selling ceramics table ware, including some of the large furniture store chains in Austria that sell Gmundner in their

[94] According to Gmundner market research, the brand is known by 87% of the people in Austria.

[95] This example demonstrates that the tableware segment is highly labour intensive, in contrast to many of the other segments in the glass and ceramics industries whose products are used for industrial purposes.

[96] The B2B market consists mainly of companies ordering ceramics tableware in the colours of their corporate design, or ordering specific pieces of ceramics art for representational purposes or as presents. These products are typically designed and produced on-demand.

household articles department. The trading partners are attended to by 6-8 (employed) sales representatives of Gmundner. If a trading partner wants to replenish his stock or order new items, he will contact the sales representatives who will then prepare the order and send it to the company. The company receives on average about 500 orders per day; these include a lot of small volume orders, often only a few pieces. Exports account for about 25% of the production, mainly to Germany.

Products can also be bought directly at the production site company's own factory outlet; in particular, seconds (i.e. products with minor design or glazing imperfections) are sold there at reduced prices. At the time when the interviews for this case study were conducted (April 2009), the company did not use e-commerce as a sales channel, but preparations for introducing a web-shop were in progress. The e-shop was finally launched in autumn 2009.[97]

The multitude of about 7,600 articles (i.e. forms in different designs), together with the requirement to deal with a relatively large number of highly specific and small volume orders, creates a significant **challenge for production planning** and management. For decades, the company used to produce on stock. In accordance with the production process, the company has two warehouses (in addition to storage of raw materials): one for the finished products and one for the semi-finished products (i.e. the not-yet-painted shapes). Whenever specific products were running out of stock, warehouse staff informed production about the need to replenish. However, as it is impossible to precisely anticipate the demand for specific shapes or designs, this ad-hoc procedure was inevitably inefficient. If demand for specific products had been overestimated, this resulted in unnecessarily high stocks and storage room needed. If, by contrast, a specific item was ordered in numbers exceeding the available stock, it needed to be produced on short notice and in short time, which tended to disrupt the standard production routines.

In the late 1980s, with growing demand and an increase in the number of designs offered, it became clear that the company needed to change its production process: the longer-term goal was to shift from producing on stock to **order-based production**. It was also clear, however, that this required a much more systematic and accurate approach to production planning and management. From a business organisation perspective, it meant that the links between sales (incoming orders) and production had to be reorganised. This required the set-up of an information system which would generate accurate data on orders and the stock available for each item, and on a day-to-day basis, in order to manage production on this basis.

4.3.2 e-Business activity

The business requirements outlined above led Gmundner to develop their own **PPS** (production planning and management) system. This enables them to bundle incoming orders and translate this information into weekly production plans.

PPS – production planning and management

PPS is a German acronym for "Produktionsplanung- und Steuerung", which translates into production planning and management. The goal of PPS is generally the optimisation of the production process in the company, considering critical interfaces with other departments

[97] See http://www.gmundner-shop.de

such as sales and procurement. The "planning" part concerns the calculation of the short and medium-term demand, i.e. the definition of output targets for specific products and a specific period of time. "Management" refers to the control of the processes, including the issuing of production plans and the controlling of their fulfilment. In SMEs, these two functions are typically integrated within one department.

The use of PPS directly supports key operational objectives of a manufacturing company. This includes producing on schedule, achieving a high and steady capacity utilisation, short lead times and minimum use of stock. Thus, in essence, PPS is an information management function focusing on production processes.

Implementation history and technologies used

Production planning is always closely linked with **order management** and depends on it. The roots of the PPS system used by Gmundner date back to the early 1990s when the company started to digitise incoming orders in a systematic way. About at the same time when first ideas for implementing PPS were discussed, Gmundner introduced an SAP system for managing order-related data. All new orders received from sales representatives are entered into this system. By 1993, this process was a routine, and digital order data were available. This was the basis for taking the next step in the improvement of internal processes by implementing PPS.

Technically, Gmundner's PPS system is based on **Microsoft Access**, a relational database management system that combines the relational Microsoft Jet Database Engine with a graphical user interface and software development tools. Data are stored in its own format, but can be imported or linked to data stored in other databases and formats such as MS Excel, text formats, XML, HTML, dBase or any ODBC-compliant data. Version 1.0 of MS Access was released in November 1992, which is about the time when Mr Feichtinger, who has been with the company since 1974, started to plan and develop a PPS system.

Since the mid 1990s, the PPS system has been **continuously refined** and enhanced. It was soon used as a tool to support analyses and forecasts, for example for a (rough) annual planning of capacity needed. More and more data about the production process were collected and entered into the system, which in turn allowed a more precise calculation of lead times and continuous improvements of the production planning.

In a way, the development of this software application shows that systematic information management in a company can be a "loop" which reinforces itself: the PPS system enabled the company to measure and better understand its own production processes; this knowledge, in turn, enabled the team to further improve the PPS system by feeding it with new, more accurate data. As a result, the production processes have become much more efficient.

Initially, the company had also considered buying an available PPS solution from one of the vendors, or to use the available PPS module of the SAP system used in the company, but found that none of the available solutions would be sufficiently adequate for its highly specific production processes. Therefore Gmundner decided to develop its own PPS system in-house, as Mr Feichtinger explains: "*I have seen several existing PPS systems in use in other companies, but these global PPS systems are too general for our purpose. I also got the impression that companies tend to use only few of the functionalities offered by these systems, or even use them for generating weekly reports only rather than for their actual purpose, namely planning the production. Our simple system, by contrast, is tailored to our specific needs and is really the central tool for production planning*."

An obvious advantage of this approach was that the company had hardly any investment costs in software technology and related services. The circumstances in this case were highly specific and fortunate: the same person who has been in charge of production planning and management had the self-learned IT skills and an intuitive understanding for innovation needs to develop a tailored solution that would greatly facilitate his own job. This resulted in a low-cost and highly-effective PPS solution.

The process today

The PPS system receives key data inputs from the SAP system, notably data on incoming orders and the available stock of semi-finished and finished products. There is a semi-automatic link between the SAP and PPS system: the SAP data are extracted in a structured format (in *.txt format) by means of an automatic routine which runs every night, taking about 30 minutes. The resulting data are then entered into the PPS system in the morning, which takes only two minutes to accomplish. This way, the PPS is always based on the latest data.

Gmundner has organised its PPS processes into **two main domains**: production planning of semi-finished products (i.e. the manufacture of the unpainted shapes) and of the finished products (i.e. the application of the various designs to the raw products). Besides Mr Feichtinger, who oversees the overall PPS, there are two further employees in the department, one for each of the two main domains.

The **production planning** processes starts with an annual plan, which delivers a rough forecast of the expected production volumes for all specific articles and the resulting estimation of the required personnel capacity in the production department, based on total production hours. This annual plan is the baseline which is then updated on a daily basis, based on actual incoming orders.

The PPS system is then used to calculate the shorter-term (weekly) production demand. This is then translated into **production orders** which are issued to the production department. In the finished articles domain, production orders are issued on a daily basis, about 500-600 per week in total. For raw products, the number is much smaller, and orders are issued on a weekly (not daily) basis.

In addition to the planning and managing the ongoing production, data available from the PPS system are used to derive **specific analyses**, such as quality statistics.

Once the production plans and orders have been issued to the production department, the lead times depend on whether the semi-finished products are already on stock or not. If, for example, the cups are already on stock and need only to be painted in the requested design, lead times are short, typically a few days. If the raw tableware forms are not on stock, lead times are about three weeks longer. A certain amount of semi-finished forms (cups, plates, etc.) is always produced on stock. However, thanks to more accurate production planning and management, it was possible to significantly reduce stock (by about three quarters) without compromising lead times.

The production planning process is not directly linked with the procurement of raw materials, which is a completely separate process. Raw materials must always be on stock and are procured accordingly, without regard of short-term fluctuations in orders.

Outlook: focus on quality improvement

As of spring 2009, Gmundner has not been severely affected by the world-wide economic crisis. Demand for its products, which is the single most important success factor, has been stable. Direct competition and rivalry in the market are less relevant issues for Gmundner, as

it occupies a niche market with a strong brand and highly specific products which are difficult (if not impossible) to imitate. Nonetheless, searching opportunities for **innovation** in processes and products is a must for this traditional company as well. The PPS system is a supporting tool in this context.

Gmundner is satisfied with the way this in-house-developed PPS system works and believes that it can be continuously improved and expanded in its functionality, in the sense of "**kaizen**".[98] The company does not see a need for a disruptive change in its approach, e.g. by introducing a more sophisticated system from an ICT vendor.

Mr Feichtinger expects that the system and the use of the data it delivers can be enhanced, in particular with a view to further improvements in **quality assurance**. For example, he plans to go into more detail in the collection and analysis of data on rejects and seconds. His unit started to systematically measure rejects in 2000. He believes that the evidence of why and where things go wrong in production processes could still be improved by systematically collecting more specific data (e.g. by adding information about the cause), and that this knowledge could be utilised to further improve production processes.

4.3.3 Impacts and lessons learned

Impacts

The introduction of systematic production planning and management, based on a self-programmed low-cost PPS system, enabled Gmundner Keramik to move from on-stock to order-based production. This had significant positive impacts on process efficiency and reduced demand for storage capacity in the warehouse:

- **Stock reductions**: although overall production has increased, the warehouse today is only about a quarter of the size compared to the warehouse needed when the company still used to produce on stock.
- **Improved process efficiency – reduced lead times**: the introduction of a systematic production planning and management has improved the information transparency and information flows between different departments. The company has today a much more accurate understanding of its own processes. This enables it to calculate and plan work flows more precisely and has led to reduced lead times.
- **Improved business intelligence**: besides being the basis for short-term and medium-term production planning, the PPS system is also a relevant source of information for general operational and strategic planning in the company.

Lessons learned

High potential of low-cost solutions. This case study demonstrates that ICT-enabled innovation in SMEs does not necessarily require major investments in hardware or software. In this case, a self-programmed ICT solution based on a standard software programme (essentially a production planning and management system based on a MS Access database) was absolutely sufficient to enable organisational innovation with a major business impact. Thus, the case study also points towards a caveat in the macro-economic

[98] Kaizen, Japanese for "improvement", is a business philosophy that focuses on continuous improvement in all areas and functions of a company, from production to management.

analysis of ICT impacts: the importance of ICT for organisational innovation may not always be fully reflected by the amount of ICT capital stock a company uses (see Chapter 5).

Entrepreneurial thinking and e-skills. This case study exhibits a fortunate coincidence: an individual employee has an intuitive understanding of business requirements (i.e. the need to introduce systematic production planning), the e-skills to develop a company-specific ICT solution, and full management support to implement his planning tool with all organisational consequences. Thus, it is also a story of the importance of individual innovators and an innovation-friendly climate in the company (cf. Drucker, 1985).

Process needs and ICT as a tool: The story confirms once again that ICT can be a crucial tool to enable process innovation. ICT was definitely not the "driver" of innovation by itself – the source of innovation in this case was clearly process-need (cf. Drucker, 1985)– but without ICT (both the SAP and the PPS system), the company would not be able to plan and manage production processes in this way.

Continuous upgrading: One of the advantages of using a self-developed tool is that the functions can be continuously updated and expanded with little or no cost implications. No additional modules have to be purchased from a vendor, no service fees have to be paid.

A latent risk often associated with highly customised, self-made software solutions in SMEs is that the technical know-how about the tool can be confined to a specific person, for instance the person who programmed it. Should this person leave the company, a problem arises. Mr Feichtinger argues, however, that this is not the case here, as the PPS system is based on a widely used standard software (MS Access).

4.3.4 References

Research for this case study was conducted by Hannes Selhofer, empirica GmbH. Sources and references:

- Company visit & guided tour, and personal interview at the production site with Mr Josef Feichtinger in Gmunden, 15 April 2009
- Company documents about work-flows
- Company website (http://www.gmundner-keramik.at)

4.4 Holcim Slovensko (Slovakia)

Abstract

Holcim Slovensko is a leading supplier of building materials and services in Slovakia, producing cement, ready-mixed concrete and aggregates. The company has placed great emphasis in the past 5-10 years to continuously improve the effectiveness and efficiency of its business processes. Procurement processes were identified as particularly relevant in this context.

In 2005, Holcim Slovensko decided to introduce e-auctioning (including reverse auctions) in order to improve the transparency in purchasing negotiations, and thus to achieve cost savings in the procurement of supply goods and services. It selected PROe.biz, an application that is used based on a SaaS licence with the service provider. As of 2009, Holcim Slovensko procures about 15% of its total purchasing volume through online auctions, using this solution. The company is very satisfied with the outcomes. The internet-based reverse auctions had significant positive effects on procurement costs and on the process efficiency. It improved the transparency of purchasing processes in general, led to more objectivity in the specification of prices, cost savings and reduced negotiation times.

Case study fact sheet

• *Name of the company:*	*Holcim (Slovensko) a.s.*
• *Location:*	*Bratislava (Slovakia)*
• *Main business activity:*	*The production and sale of cement, ready-mixed concrete and aggregates.*
• *Year of foundation*	*1971 (founded under the name "Western Slovak Cement Factory and limekiln - ZVC), since 2001 Holcim (Slovensko), a.s.*
• *Number of employees:*	*584*
• *Turnover in last financial year:*	*€ 150 million*
• *Primary customers:*	*Construction industry*
• *Most significant market:*	*mainly Slovakia, some exports to neighbour countries*
• *e-Business applications in focus:*	*Electronic reverse auctions implementation into purchasing and sourcing processes*
• *Case contact person:*	*Mr Peter Szabó – sourcing specialist in Holcim (Slovensko) a.s.*

4.4.1 Background and objectives

Company history

In 1971, the "Western Slovak Cement Factory and limekiln (ZVC)", also named Kombinát Záhorie, was founded at the industrial complex in Rohožník. In the 1970s, the consumption of cement in Slovakia used to be very high with about 750-850 kg per capita. Kombinát Záhorie, which was expanded in several phases until 1986, became one of the most modern plants in Eastern Europe at that time. Two kiln lines were built for the dry production of up to

1.5 million tons of Portland cement. Other kilns were used for the production of white cement (100 kt), for lime and equipment (160 kt) and plaster mixtures (40 kt). In the 1980s, the company began with production of additional products such as lime, white cement and dry plaster mixtures. After the privatisation of the company in 1992, and reflecting changes in the structure of its shareholders, the company changed its name in 2001 to Holcim Slovensko a.s. (http://www.holcim.sk).

Today, Holcim Slovensko is the leading supplier of building materials and services in Slovakia. The core business is the production and sale of cement, ready-mixed concrete and aggregates. Besides, the company also provides services such as product transport and application consulting. The parent company, Holcim Group (http://www.holcim.com), is one of the world's leading suppliers of cement and aggregates (such as crushed stone, gravel and sand). The Group holds majority and minority interests in about 70 countries on all continents.

Holcim Slovensko a.s. - facts and figures 2008

Workforce as of December 31, 2008	584
Net sales (million EUR)	150
Sales cement (t)	1,560,000
Sales ready-mixed concrete (m3)	499,000
Sales aggregates (t)	1,333,000

Business objectives

One of the most important business objectives in the past 10 years has been the continuous improvement of the effectiveness and efficiency in **business processes**. The company has placed great emphasis in this context on building a dominant set of technologies and skills that support its core processes. One of the most important factors to improve efficiency in a firm's allocation of its resources is seen in **spend management**. An effective sourcing strategy is a requirement for being able to offer the most competitive prices on the market. This is particularly relevant in a sector such as the cement industry, where product differentiation is difficult and competition is largely price-based.

The management of Holcim Slovensko identified this challenge as a crucial success factor. In the beginning of 2005, they decided to make use of opportunities posed by innovative procurement systems, focusing on dynamic purchasing. These systems were a rather new and thus an unknown tool for most companies in the Slovak and Czech Republic. The main objective was to increase the **transparency in purchasing negotiations**, and thus to achieve cost savings in the procurement of supply goods and services. Transparency was seen as a key driver for competition among suppliers. At the same time, the management wanted to reduce the average time of purchasing processes, especially by reducing the need for personal negotiations with all potential suppliers.

4.4.2 e-Business activity

B2B online negotiations called "**e-auctions**" are interactive negotiations about the price and other conditions of the anticipated supply contract, conducted simultaneously with a group of potential suppliers via the internet. Holcim Slovensko decided in 2005 to use this approach in order to realise the above mentioned business objectives.

Selection of the e-auctioning system

After scanning the market of e-procurement solutions with the respective functionality, Holcim Slovensko selected the "PROe.biz" solution by NAR Marketing, s.r.o., Ostrava. (http://www.proe.biz). The service provider had proposed a suitable configuration of the solution for Holcim Slovensko, estimated the profitability (based on real reference cases), and let Holcim Slovensko conduct practical tests with the solution. Seven pilot auctions were conducted under real conditions, free of charge. The testing phase started in June 2005. After the tests had been evaluated as successful, the management gave green lights for buying a license to use the system. NAR Marketing then supported the sourcing specialist at Holcim Slovensko in how to integrate the system into the company's sourcing processes.

The application is used as **SaaS** (software as a service, i.e. the software is hosted and made available online by the service provider). It is accessible from the provider's server with OS LINUX and web server Apache, programmed in PHP language. Holcim Slovensko has used the PROe.biz system for a long-time now and not experienced any problems with regard to stability or reliability. The software is programmed in PHP, an XML language. The database is based on MySQL, the most widely used open source database in the world.

The integration of the auctioning system with the company's procurement processes took about five months. The multilingual versions for Central Europe had to be customised and enhanced, as it was very important that the system enabled the purchasing manager to communicate with suppliers in different languages. This included the technical support and consultancy in local time and language. A good deal of training and consultancy was necessary during the first year, partly due to the fact that this way of e-procurement and the solution itself were relatively new in the market; thus, nobody had any experience with it. The first real auction realised fully internally was performed in August 2005.

NAR Marketing offered Holcim Slovensko different **business models** for the **licensing** of the solution, including a full-time license and a model based on transaction fees. The management decided to purchase the full time license, after doing some research on various models offered by different providers and about customers' experiences with the different models. Calculations indicated that the potential savings could be under a full time license costs arrangement.

The PROe.biz solution has rapidly progressed over the last few years in the Czech, Slovak and Polish markets. In early 2009, it was used by about 900 enterprises, which had successfully conducted about 16,000 online reverse auctions (with a total value of € 3.3 billion) with the system.

Technology and functions of the chosen solution

PROe.biz is an online negotiation system. It is used for e-procurement activities in the supply chain. It promises the seller to **purchase supplies at a better price** and, at the same time, to **reduce transaction times** and costs by about 50%. Besides its main function, the system also fulfilled all requirements of Holcim Slovensko with regard to security, stability and reliability. It is based on widely used programming technologies.

With regard to **security**, the authentication for participating in an e-auction is made by user name and password (chosen by the participant) and a ten-digit number generated key (the accidental combination of numbers and letters). Login information sent by the client on the server is hashed by the MD5 algorithm. The authentication for the administration (the administrator – a person who prepares the process) is also made by user name and

password. Data exchanges during the e-auction are secured by an SSL certificate with the cipher algorithm RSA 1024 bits.

The PROe.biz software is regularly updated and upgraded, to comply with the dynamic development of e-business technologies, and taking into account feed-back obtained from users and administrators. A crucial factor for the successful use has been the excellent cooperation between Holcim Slovensko and the ICT service provider.

The auction process

Holcim Slovensko has conducted all reverse auctions as **restricted auctions**, inviting only selected suppliers to participate. Although auctions were identified as an effective procurement approach in general, it was clear that reverse auctions could not be used for all types of commodities. The decisive factor is the typical market situation. If only a small number of suppliers participate in the auction (up to 3), it is very hard to negotiate significantly better conditions through an auction.

In 2009, Holcim Slovensko procures about **15%** of its total purchasing volume through the PROe.biz solution. The company uses this approach for procuring raw materials and other supplies such as oil, real estates, vehicles, office supplies, electricity or services (e.g. crushing of dolomites).

For each auction, a time plan is developed. Each project has its own specifications which need to be examined. For online negotiations, sourcing specialists can use the multi-criteria comparison/evaluation. This means that not only the price of the product is evaluated, but also other criteria such as the maturity date, warranted time and delivery conditions. Each criterion has its own weight as assigned by the auction administrator. In the evaluation, the sourcing specialist compares offers received to the price identified as the market price accessible for Holcim Slovensko under particular time and market conditions, and based on the experiences from previous auctions.

The realisation of an auction consists of several steps, which are normally prepared and led by the sourcing specialist in the company. The first step is to describe in detail the product or service characteristics, and to set the requirements. The following steps are:

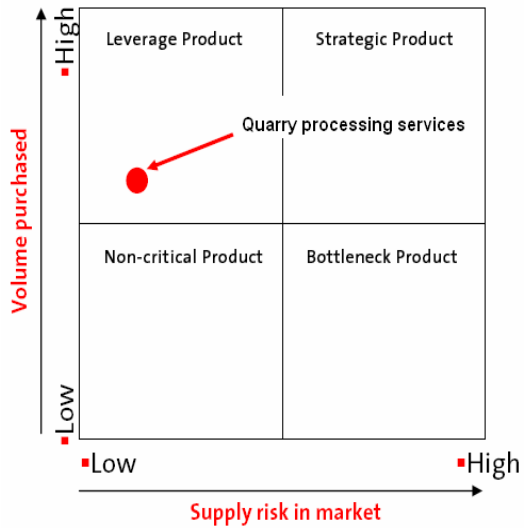
a) Data gathering & price benchmarking

The first task is to establish a list of the most suitable potential suppliers. This includes existing suppliers (in this case, internal references and information can be used to assess and describe the suppliers), as well as new suppliers. If new suppliers are to be invited, some market research is normally conducted to collect information about them.

b) Product analysis

The specific features of the product or service to be procured are analysed. Important factors for a successful auction are:

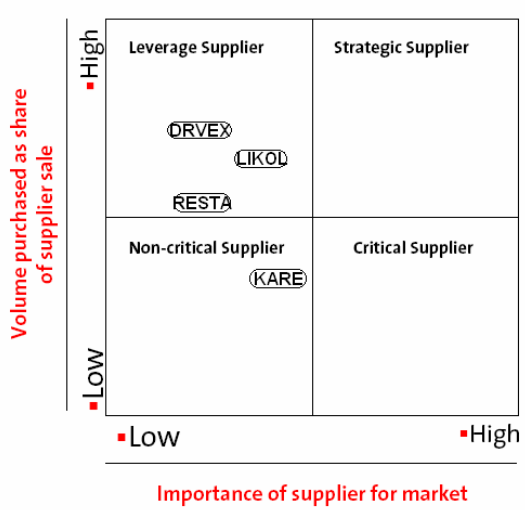
- a significant volume is requested (suppliers are attracted to offer better prices)
- the product / service must not be overly complex
- there are several alternative ways of product processing (in particular in the case of requests for delivering crushing services)



c) Market analysis

Market research about the potential suppliers is important to identify the savings potential of an auction. The following factors are considered:

- the technical background and references of suppliers
- suppliers with a relevant market position are preferred
- the auction will be more effective if a larger number of suppliers participates
- opportunities to invite new potential suppliers (who may want to expand their market)
- price levels of the suppliers to be invited



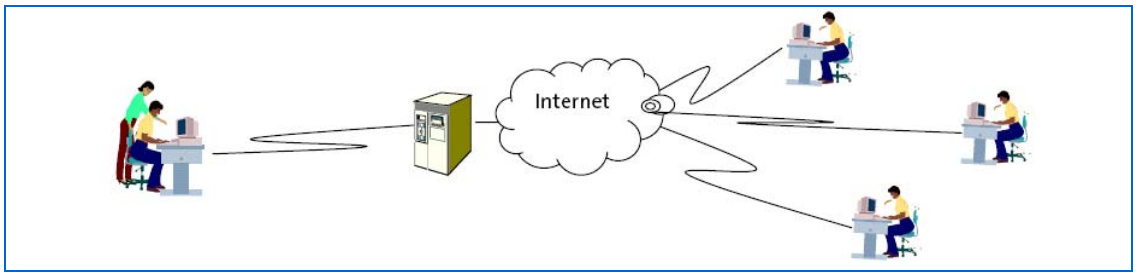
d) Sourcing strategy development

- A detailed Request-for-Quotation (RFQ), specifying technical, service and commercial details. In some cases, it is paradoxically impossible to negotiate about the price, but only about the percentage of discounts. The main point is to define contract requirements, i.e. what needs to be accepted and what can be negotiated.
- Instead of a price breakdown and TCO model, what is usually required is the "all inclusive" price of final products (e.g. place delivery of machines, installation / reinstallation / movements on place, feeding, crushing, screening, deposing within an area of 100 meters, expedition to client's trucks ...)
- Tendering steps:
  - **1st round** – offers in common “paper” way. The purpose of the first round is to identify and attract an effective number of participants for the second round;
  - Qualification of suppliers for 2nd round: suppliers which have tendered in the 1st round must fulfil selection criteria to pass for the 2nd round;

- Definition of contract conditions – full acceptation by all participants. The conditions of the contract are specified in detail by Holcim Slovensko to avoid future problems in the understanding of contract clauses;
- **2nd round** – realisation of the actual e-auction.

e) Negotiation and contracting

- The first evaluation of offers focuses on the technical background, references, internal experiences with the supplier (if such exist), the service realisation time and ISO certificates.
- The second evaluation checks the acceptance and fulfilment of OH&S (occupation, health and safety conditions) requirements and of the contract conditions of Holcim Slovensko.
- After the e-auction, the final evaluation is conducted and the most suitable supplier is recommended. The supplier offering the best price in the auction is not necessarily the winning of the auction. Holcim Slovensko preserves the right to cancel or modify the auction according to specific requirements and conditions.



f) Project evaluation and reporting

The last step is very important for the visibility and accountability of spend management activities. Information is collected and analysed about achieved savings, problems that emerged during the auction or about specific aspects which emerged and can be helpful in preparing future auctions.

In the beginning, the **time allowed for an auction round** was about half an hour. After some time, based on experience, it was reduced to ten minutes. If there is intensive activity in an auction in the last minute, it is possible to extend the available time. The auction administrator (i.e. the internal sourcing specialist) can allow several extensions. In general, however, the shorter time for a bidding round was found to enhance competition between suppliers.

Sourcing specialists usually attend the conferences and workshops of NAR Marketing, the solution provider. They are interested in experiences of other users, with a view to adopt best practices into the Holcim Slovensko sourcing processes. It is normally easily possible for them to modify the solution accordingly.

4.4.3 Impacts and lessons learned

In general, the sourcing managers are very satisfied with this innovative way of purchasing supplies and services. Still, several challenges were identified. A very important issue has been to increasingly apply a **multi-criteria evaluation** procedure, rather than just focusing on the best price. Initially, many of the activities were determined by the goal to make the auction conditions and processes as simple as possible. Experience shows, however, that future improvements should rather focus on further improving multi-criteria evaluation procedures and coping with the complexities of this approach.

Impacts

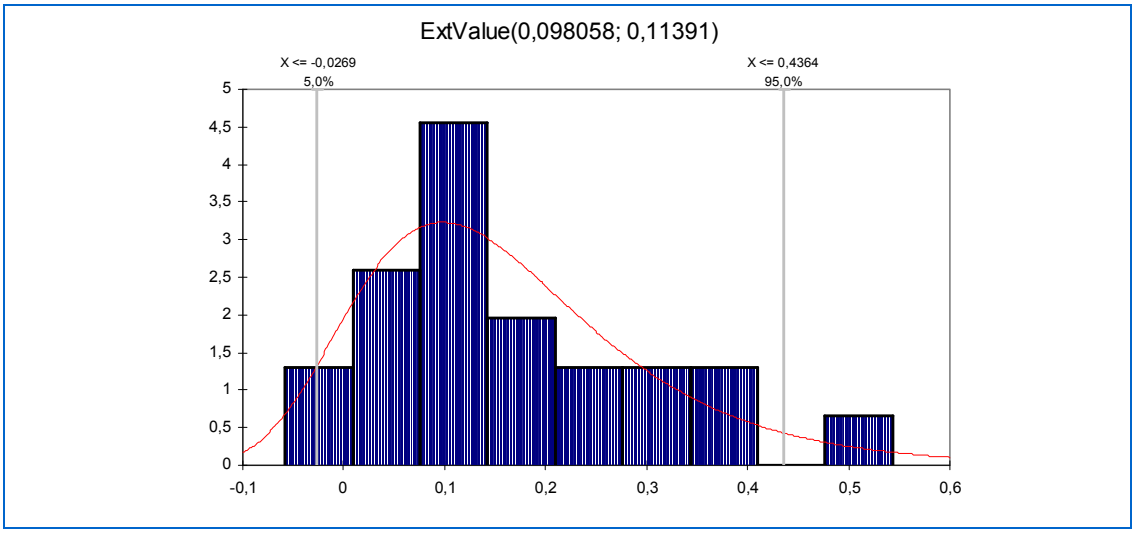
The introduction of internet-based reverse auctions into the procurement processes of Holcim Slovensko had significant positive effects on procurement costs and on the process efficiency. More specifically, the company reports the following impacts:

- improved transparency of purchasing processes in general, leading to more objectivity in the specification of prices
- reduction in purchasing costs
- improved effectiveness of the supplier marketing
- reduction of transaction times and costs
- better market intelligence, including a better knowledge of the company's negotiation power towards suppliers
- faster preparation process for procurement projects and shorter average negotiation periods (from weeks to hours)

The company was pleased by the fast achievement of cost savings. Several online auctions led to savings of about 30-35% compared to the traditional procedure, which was beyond expectations. In general, the cost saving potential of reverse auctions depends on the market situation and the structure of suppliers. It is not always possible to exactly assess the savings achieved, however, because prices of supplies have changed, and it becomes more and more difficult to compare them with the average price paid prior to using the system. Apart from financial benefits, time reductions were also significant. In this respect, both sides (purchaser and supplier) benefit from the fastened procedure. Also, the negotiation results are clearly documented and fully transparent, and available immediately after the e-auction.

According to an analysis of auction projects conducted in 2006, the **average cost saving** was about 13% with maximum of 54% in one case. The distribution of achieved savings which can be used as the base for future predictions is shown in the Exhibit below.

Exhibit: Distribution of savings achieved from 2006 in %



Calculations are based on 25 auction projects. Within one auction project, it was possible to merge several purchasing request for different commodities.

The following table presents basic statistical results from auction projects with real historical values and values estimated by fitting the ExtValue statistical distribution for prediction possibilities and estimations. This provides information about other aspects of auction projects (length, prolongations, items purchased within one auction project). In summary, the whole reverse e-auction project was very successful from a financial point of view.

Table: Statistical results from auction projects realized from 2006

Indicator	Fit results	Real values
Minimum savings		-5.8%
Maximum savings		54.4%
Mean (savings)	16.4%	16.4%
Mode (savings)	9.8%	12.8% [estimated]
Median (savings)	14.0%	13.1%
Std. Deviation (savings)	14.6%	14.7%
max. number of auction prolongation		27
max. length of auction		117
min. length of auction		10
max. No of items in one auction		41
max. No of suppliers in one auction		16

Lessons learned

Holcim Slovensko warns that simply implementing an e-auction may not be successful without having in place precisely defined sourcing processes. The integration of the tool into these processes must be carefully prepared and takes time. Tests should be conducted. The company has identified the following success factors for e-auction processes:

- **Adequate amount of demand / "critical mass"**. Suppliers will only then actively engage in a reverse auction if the value of purchases is interesting enough for them. The process costs of the auction usually have to be several times lower than the savings to be achieved. The profitability depends on the product, material or service and the length of the contract.

- **Provide information about conditions beforehand**. Before the auction takes place, it is necessary to communicate with suppliers about the contract conditions and execution.
- **Adequate number of suppliers**. There should be at least three suppliers with a comparable offer, requested certificates and references.
- **Longer-term contracts**. Sometimes it is more effective to offer/request longer term contracts than would usually be used. Suppliers tend to offer better prices and contract conditions, in particular when purchasing vehicles.
- The **financial credibility of the purchaser** should be carefully checked beforehand.

As explained above, the company decided to reduce the time for auction negotiations, because the time pressure was found to be a driving factor for competition among bidders. A crucial factor is the preparation of the auction project. According to Peter Szabó, sourcing specialist in Holcim Slovensko: "*People have to identify themselves with the system in order to achieve the best results. One cannot expect that each and every auction will deliver better conditions than in the previous project; still, you have to plan and prepare the best auction strategy for each project, considering the present market situation. The online system by itself will not deliver success, even if it has proven to be a very practical tool to improve our procurement processes. But in the end, it's still about people*".

The online auctions have also helped (both parties, the purchaser and suppliers) to get objective, realistic (market based) evidence about the actual market price for products. In some cases, long-term trading partners of Holcim Slovensko were no longer able to offer their products at a realistic market price. The system gives them the possibility, however, to explain their present situation and state reasons for not participating in the auction.

4.4.4 References

Research for this case study was conducted by Radoslav Delina, Faculty of Economics, Technical University of Kosice. Sources and references:

- Personal interview with Mr Peter Szabó, sourcing specialist of Holcim Slovensko, a.s.
- Websites:
  - http://www.holcim.sk
  - http://www.proe.biz

4.5 Lafarge Cement S.A. (Poland)

Abstract

This case study describes the use of business software systems by the Polish cement plant Lafarge Cement S.A.. The company, previously state owned, has been part of the Lafarge group, one of the world's largest cement producers, since 1995. The merger was followed immediately by the modernisation of the production line and implementation of e-business solutions to improve the operating process, with the aim of turning the company into a modern and customer-responsive enterprise. The full ERP & CRM suites were implemented to support of virtually all business processes. A high degree of customisation has assured a full compatibility with company needs.

Case study fact sheet

• *Name of the company:*	*Lafarge Cement S.A.*
• *Location:*	*Lafarge Cement S.A. HQ in Warsaw, with plants in Kujawy and Malogoszcz*
• *Main business activity:*	*construction materials provider; cement, aggregates, concrete, gypsum*
• *Year of foundation*	*1883*
• *Number of employees:*	*Lafarge Cement S.A. about 600 employees in Poland*
• *Turnover in last financial year:*	*€19 billion global Lafarge sales (10.9 billion from cement sales)*
• *Primary customers:*	*primarily concrete producers, pre-cast concrete product manufacturers, building materials wholesalers, builders and masons*
• *Most significant market:*	*Polish market*
• *e-Business applications in focus:*	*ERP (JDEdwards), CRM (update.seven)*
• *Case contact person:*	*Board Members; Janusz Bulawa, Jaroslaw Wilk, Grzegorz Kusina*

4.5.1 Background and objectives

The company

The Lafarge Group is one of the world's largest cement producers with about 77,000 employees in 75 countries. The Group has been present in Poland since 1995, firstly as a shareholder in previously state owned plants such as Cementownia Kujawy. In 1997, after buy-outs, it consolidated the plants it owned (Cementownia Kujawy, Cementownia Malogoszcz and Mining Plant Kujawy) under one company called Lafarge Cement S.A that employs around 600 people. Today, Lafarge is one of the main cement manufacturers in Poland with a 20% market share. The company's products are used in residential, commercial and public works and construction projects across Poland. Only marginal amounts (about 1%) are exported to neighbouring countries.

Cement is a powder that is the principal strength-giving and property-controlling component of concrete. It is a high quality, cost-effective building material that is a key component of

construction projects throughout the world. It is used in three major segments of the construction industry: civil engineering projects, residential and commercial construction. Customers of cement producers are primarily concrete and concrete product manufacturers, contractors, builders and masons, as well as building materials wholesalers.

Lafarge has presently four major divisions: cement; aggregates and concrete; roofing; and gypsum. In 2007, consolidated cement sales globally reached approximately 136 million tonnes (while the present total capacity of entities controlled by Lafarge is of 178 million tonnes). Central and Eastern Europe accounted for 11% of the sales.

The entry of countries from this region into the European Union has positively influenced their long-term growth prospects. European funding, available now in those countries to help improve their infrastructure, has triggered a number of large construction works. Furthermore, a country's cement demand generally tracks growth in per capita income and correlates with the country's overall economic development. Increased expenditure on public works and housing construction causes cement consumption to grow rapidly. In Poland, it is assessed that the market can absorb yearly about 18 million tons in the next few years. After rapid growth in consumption in the last 10 years due to economic growth, a more steady increase is forecast. The world economic slowdown was counterweighted by the availability of European funds and investments for the UEFA Euro 2012. Any increase in demand can easily be fulfilled by the local cement producers which currently operate at about 71% of their capacity.

The Polish cement industry

Considering the level of production, the Polish cement industry is the 7th largest in Europe. The industry has significantly changed in the early 1990s, when the privatisation process and mergers with multinational companies took place. Since then, all the Polish plants are foreign-owned. They have received a large injection of capital which brought modernisation of the plants and processes, including cleaner technologies, which has reduced the impact on the environment. Energy consumption has been lowered significantly, with a positive impact on CO2 emissions. Back in 1989, CO2 was emitted at nearly 6kg per tonne of cement, compared to only 0,27kg per tonne in 2003. This has been a very important development, also with a view to EU policies aimed at restricting CO2 emissions. In short, foreign investment has made it possible to revive the old Polish industry and make it one of the most modern in the world, with lower than average energy consumption and CO2 emissions, using fuel waste materials and minimising usage of fossil fuels (accounting for 11% of energy consumption) as well as offering high quality, innovative products. As fuel is the primary expense of production costs (31% of total) it is very important to make efficient use of it in the production process.

The investment in ICT infrastructure for the cement plants has also been taken very seriously by investors. As of today, all major players on the market have full ERP suites and other ICT tools to support their business. To stay competitive and profitable, all leading cement and concrete companies have to deploy advanced ICT tools across their operations to support their business processes in becoming more efficient and to meet their customers' needs.

4.5.2 e-Business activity

Historically, Cementownia Kujawy used ICT tools with multiple disparate systems supporting processes across its business for over 10 years, mainly in finance, production and HR

departments. Director Jaroslaw Wilk remembers that the first computers appeared in the company in the mid 1980s. Though they were mainly used as typing and calculation machines, it helped the business speed up some tasks and to introduce people to ICT in general. The initial fear of new technology was overcome, new sets of skills were developed by employees and a base for further, more advanced implementations was laid.

When the Lafarge Group took over Cementownia Kujawy, the need to modernise the ICT hardware and software was evident. Today, nearly all departments, including finance, marketing, production, logistics and delivery operations, are managed with the help of advanced business software systems, such as ERP, CRM, web portal and MPEC for spare parts purchasing. These systems are highly synchronised and integrated. The following processes are supported by e-business applications in Lafarge Cement S.A.: cost accounting, material, warehouse, and quality management, plant maintenance, demand planning, supply network planning, transportation planning, and vehicle scheduling, driver self-service silo access, payroll, customer relationship management, order entry, credit management, materials availability, contracts management, pricing for complex agreements and marketing campaigns.

Enterprise Resources Planning

Lafarge had been using JD Edwards EnterpriseOne, an ERP solution based on Oracle, enterprise wide with standardised financial, procurement, sales management, production, and logistics processes for all lines of business and management across its geographical base. The decision to implement JD Edwards also in Lafarge Cement S.A. was thus logical to assure compatibility with the rest of Lafarge Group which already used this solution. It enabled the company to optimise and harmonise procedures as well as to draw on best practices already in place. The system offered broad functionalities and coverage creating a uniform data processing environment for the whole company. It replaced many fragmented programmes that were operational in Kujawy before.

The objective to have a common, centralised system was achieved rather quickly as all the management wholeheartedly supported the new possibilities and implementations. *"I remember my colleague, one of the directors at that time, only two years before her retirement:, she was one of the most keen persons around to support the introduction of the new ERP suites and other ICT tools. She was open to all improvements and strongly believed that it would benefit the business enormously. With the encouragement and strong will of the management board, the employees felt convinced and eager to learn how to use the new tools,*" says Jaroslaw Wilk, purchasing & logistics director at Lafarge Cement S.A.. *"We needed to implement the tools that Lafarge brought with its business organisation, but we went many steps further than what was required from us. Apart from arranging suitable modifications, we also deployed additional tools that felt adequate for our market and business. Luckily, we had full support in this matter from our headquarters*", Mr Wilk remembers.

With the help of the Oracle consulting team in Poland, the company had gradually deployed the new ERP suite within a span of about two years. The implementation process was carefully designed by looking and analysing business processes, then building on the experience of other Lafarge group businesses and players from the same sector. In this way best business practices, new ways of working and improved business processes were put in place. A lot of modifications appropriate to the Kujawy plant were also necessary, to reflect different and specific ways in which business was conducted in the Kujawy Cement plants as compared to other plants of Lafarge. For example, in the Polish market, there are more sales

of cement in bags than in other countries, and there are different accounting procedures required for Polish institutions like the Tax Office or National Insurance, and VAT calculations. A careful systems design and customisation was undertaken from the very start, ensuring that branch specific demands be contained, while also ensuring adequacy to the whole Lafarge Group, especially for delivering comprehensive working financial and sales reports to the executive management. Also, customised modules for logistical planning, plant maintenance and raw materials purchasing are playing an important role in the business.

Customer Relations Management

The Customer Relations Management (CRM) solution is another important business software system in Lafarge Cement S.A.. The company chose update.seven, a dynamic CRM solution. Besides a data modelling function, this system also offers specialised sector templates that had been quickly adapted to the company's own needs.

The main Implementation phases for the CRM solution were (i) the customisation phase, (ii) the integration with other systems, (iii) the application of user profiles and (iv) the technical installation in the company and the initial data load. Then the pilot version was run and integration tests, data transfer tests and performance tests were conducted. This was accompanied by cleaning and consolidating data from old systems. By customising (instead of software programming), all major elements of the system (such as masks, processes and interfaces) could be integrated into a complete solution. Moreover, the CRM functions are integrated with the company's ERP system, allowing real-time data view and usage across the whole company. An integrated view of customers is available on demand. Analysis tools help to channel the daily flood of information and show it in a descriptive manner. Users generate exact analyses for their CRM data and use these in user-defined reports.

"Information about our clients is drawn from different available sources across the company such as orders, sales, finance and payments departments. That allows us to create a fully up-to-date customer profile. However, it works the other way round as well: when any data related to clients is entered into the marketing manager tool, the rest of the departments automatically has full access to it. Marketing can concentrate on professional and targeted campaign management and automated procedures based on an optimised customer database, if it is up-to-date at any time ", says marketing director Grzegorz Kusina.

Web-based applications and an **electronic portal** also support customer management in Lafarge Cement S.A.. The company is now working on the next steps to enhance this tool. At the moment, a customer can log in to his account, place an order online and then track its delivery. The platform facilitates communication between the company and its customers, and it is used in marketing campaigns to distribute tailored mail. In the near future, options like online payments, statistics and online blogs are planned to be introduced.

Another web-based account for transport suppliers assures up-to-date information about the delivery status, as each truck driver is obliged to send SMS updates to the office when he leaves the company and the moment he delivers the load to a client.

"With help of our CRM system, we can make it easy for our customers to do business with us. When they place an order, they can know, with near certainty, that they are going to get their order on time, and that it will be complete and accurate. As we have a mobile connection with delivery drivers, we are immediately informed about a problem or delay, so that we can quickly react, and usually solve or minimise the problem, and keep the customer informed. This is an important development in client services, as many construction projects rely on timely deliveries of a cement load", says Mr. Kusina.

4.5.3 Impacts and lessons learned

Impacts

The process- and capital-intensive cement industry produces a heavy, bulky, low-cost commodity that is driven by price and costly to deliver. The production cost of cement typically consist of more than 30% of energy; close to 30% raw materials; consumables, production, labour and maintenance account for another 30% and depreciation for about 10%. Any savings in the above areas would therefore have vital impact on profit. Lowering the cost of energy use is limited, according to the interviewees, because it depends mainly on new technological advances in the process of burning raw materials. Therefore, savings in the production process are necessary to maximise profits and withstand competition from other players. Thanks to the consolidation of disparate information systems via advanced, interfaced e-business software, the management of Lafarge Cement S.A. has gained a single, enterprise-wide view across all business operations and access to accurate, real-time information is available. Increased control of key business processes in finance, inventory and sales management has lead to a streamlined production.

The rather small differentiation of products in this industry, and limited price competition, make the quality in customer relations and the services offered a critical success factor. The stronger one's knowledge of the needs of the customer, the better the possibility of profiting through competent co-operation. The advanced ICT systems (ERP, CRM) implemented by Lafarge Cement S.A. have brought the following benefits:

Savings realised on maintenance costs. The implementation of the plant maintenance module of the ERP system has led to significant savings and helped to assure continued production with minimal disruptions due to breakdowns on the production line. Inventory carrying costs have been reduced. "*All machines are catalogued in the database, which automatically schedules the need for maintenance and spare part deliveries. This is sent to the suppliers and maintenance team as orders that need to be executed at certain times. The system also calculates the cost of usage down to each machine, which helps to reduce the level of spare parts kept, and also to closely monitor the work of our maintenance contractors*", says Jaroslaw Wilk. *"We have increased the reliability of the production line, which is vital factor in our business. It is also easier now to calculate the real cost as opposed to estimates which results in more accurate planning and allows for a more detailed report of plant performance and costs incurred at the production lines*."

Improved control and purchasing of raw materials by updating inventory levels inflow and outflow online. As the cost of raw materials is another significant factor in the business, accurate planning is very important for appropriate production levels. The staff in the production and purchasing departments can follow daily the level of materials used and, with simple steps, produce accurate purchasing orders when needed. Before the integrated ICT solutions were implemented, orders for materials were calculated manually based on staff experience and rough predictions. Also, more accurate planning of purchases helps in negotiating prices with suppliers, explains Mr Wilk.

Increased profitability through a more accurate and efficient pricing model. Especially in times of lower demand, it is critical to price products accurately. The ICT system enables calculations based on real production cost data and sets the criteria accordingly. According to the sales department, an accurate view of profitability levels through the Actual Product Costing function has been gained. The system allows not only to monitor the profitability of a

specific product, but also in relation to the specific clients. This provides more flexibility and reduces the room for mistakes when negotiating delivery prices and contracts.

Improved ability to track and control processes in real time as they flow, resulting for example in accelerated times for order processing and invoicing. Processing orders used to take a few days sometimes as the document would travel from one desk to another for approval. Invoices are issued automatically at the end of each day. Thanks to a more efficient method of uploading data, manual entries were greatly reduced. Quick order processing and faster response times, lead to increased customer satisfaction when receiving orders quickly and according to specifications.

Improved communication with customers, for example regarding the status of orders and availability of products. Customer satisfaction has increased thanks to the availability of an accurate picture of the processing status of their orders. Customers are pleased, and the customer retention rate has been increased.

Lessons learned

The cement industry is vital to the ongoing industrial and economic development of virtually every country on earth, and it is growing steadily. At the same time, it is driven by price and dominated by macro-trends, like increasing internationalisation. In addition, the call for stringent emissions management and the reduction of carbon dioxide levels has caused the industry to operate with more concern for environmental, economic, and social factors.

In this business environment, the success of a company is to a large extent determined by its ability to control fixed costs and to drive down the mounting expense of energy it takes to produce cement and concrete products. Large investments needs to be protected by continuous reinvestment, not only in plant and facilities maintenance, but also in enabling technologies, innovation, process automation, and environment, health, and safety compliance.

This case shows that well and widely adapted e-business software systems are a critical enabler to improve business practices, even in a traditional industry such as cement. Lafarge Cement S.A. has recognised the challenges from its old business processes. The use of generic solutions was not thought to be adequate; customisation has been very important to cover the specific processes and challenges of the company. These solutions have been built to fit the way the company operates. It can also be helpful to draw on industry-specific best practices.

Together, the technologies have revealed how to operate the plant in a very different, much more efficient way. As the company director summarises: "*We have reduced costs of machine maintenance and increased production reliability, which in turn helps to increase customer satisfaction and allows for continuous improvement of our product quality. After the successful implementation of e-business tools, order fulfilment, finance, and pricing are now substantially optimised. We are now well positioned to meet any challenges in the future*."

4.5.4 References

Research for this case study was conducted by Aneta Herrenschmidt-Moller, independent economic analyst, on behalf of the Sectoral e-Business Watch. Sources and references:

- Interviews with

- Jaroslaw Wilk, director for purchasing and logistics and Grzegorz Kusina, marketing director at Lafarge Cement S.A., on 20th Septmber 2009
- Janusz Bulawa, Finance and Strategy director at Lafarge Cement SA, in September and October 2009

- Company Annual Report 2008.
- Websites of Lafarge Group:
  - http://www.lafarge.com
  - http://www.lafarge-cement.pl
  - http://www.lafarge-cement.pl/ofirmie/kujawy.asp

5 Macro-perspective: the economic impact of ICT

5.1 Methodological remarks

Review of results of the baseline study (2008)

In 2007/08, the Sectoral e-Business Watch conducted a study on the "economic impact and drivers of ICT adoption and diffusion" in six industries (2008).[99] This study found some significant (positive) impacts of ICT on firm performance at the micro (company) level, in particular with respect to turnover and market shares. At the industry level, however, the impacts were much less pronounced. In particular, no strong direct impact was found between the use of ICT and value added growth or change in labour productivity and employment. There were some variations between sectors,[100] but by and large the picture was quite consistent.

In this Chapter, the methodological framework that was established and piloted in the study of 2008 for the chemical and the metals industry is applied to assess the economic impact of ICT in the glass, ceramics and cement industry.[101] Thus, a comparison of results between the two studies (at least for these sectors) is possible. Furthermore, the analysis was also conducted for the manufacturing industry as an aggregate of business activities specified in NACE Rev 1.1 D “Manufacturing”. This enables a further comparison to an industry total and facilitates to determine to which extent the results for the GCC industries are sector specific.

Research questions

The statistical analysis of ICT impact focuses on two main aspects:

- **ICT and industry growth**: Section 5.2 looks at the overall development of value added growth in the GCC industries (from 1981-2005) and analyses the contribution of different factors including ICT-capital and non-ICT-capital, working hours and labour quality by means of growth accounting. The study analyses to what extent ICT capital contributes to industry growth (measured as value added growth), in comparison to other input factors, and whether the sector differs in this respect to the total manufacturing industry.
- **ICT and labour productivity growth**: Section 5.3 and assesses to what extent ICT capital and investments are linked with labour productivity growth at the industry level, in the period from 1991-2005. It also looks at implications of ICT for the amount of total hours worked, which is an indication of employment effects. Again, the GCC industries is compared with the total manufacturing industry.

The economic analysis is mainly based on growth accounting (Section 5.2) and correlation analysis (Section 5.3). The data for the variables analysed have been extracted from the EU

[99] The following sectors were analysed: chemical, rubber and plastics; steel; furniture; retail; banking; transport and logistics services. The study is available at http://www.ebusiness-watch.org/studies/special_topics/2007/impact_and_drivers.htm

[100] For example, the study confirmed that ICT impacts on productivity tend to be larger in service sectors such as banking and logistics than in manufacturing.

[101] Data used for this analysis comprise the whole Division of NACE Rev. 1.1 26 “Manufacture of other non-metallic mineral products.” It was not possible to exclude the groups 26.7 and 26.8 (cutting of stone, other non-metallic mineral products n.e.c.) as in the rest of the study. However, these are comparatively small sub-sectors and the results are therefore clearly representative for the GCC industries as defined for this study.

KLEMS data base. These methods and the main data source are briefly introduced in the following paragraphs.

Growth accounting

Growth accounting is a standard technique to identify the **contributions of different factor inputs** to overall output growth. The methodology assumes a specific functional relationship between an output variable (e.g. value added) and all necessary inputs, typically labour and capital and intermediate inputs. This procedure also allows to derive measures of multi-factor productivity (MFP) growth, which indicates the efficiency with which inputs are being used in the production process and is an important indicator of technological change.[102]

In regards to capital input, a distinction can be made between the contribution of ICT capital and of other factors, such as non-ICT capital. The extent to which changes in value added can be explained by related changes in one of the inputs is then estimated. The remaining value added changes, which cannot be explained (i.e. accounted for) by changes in the level of inputs, are defined as change in total factor productivity (TFP). The results presented in this study are based on growth accounting, using variables from the EU KLEMS data base (see "data source", below).

Correlation analysis

Correlation analysis is a common method to measure the strength and direction of a linear relationship between two variables. The correlation coefficient is a measure for how strong the relationship between two variables is.[103] It can take values between -1 and 1. The higher the absolute value of this coefficient is, the more interdependent the variables are. A negative value indicates a reciprocal relationship. As a rule of thumb, two variables are considered to be strongly correlated with a coefficient above 0.8 in absolute values, lightly correlated with absolute values between 0.6 and 0.8, and uncorrelated with a coefficient below 0.6 in absolute values.

Data source: the EU KLEMS data base

The analysis is based on data from the EU KLEMS data base as provided by the Groning Growth Development Centre (GGDC). 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 (see Annex I for more information).

The length of the available **time series** varies by country. After checking for data availability and gaps, the study team decided to focus the analysis on nine European countries and on the periods 1981-2005 (for value added growth) and 1991-2005 (for productivity implications). Data for the years 2006-2008 are not yet available, unfortunately. This is not a major concern for the analysis purpose in this Chapter, however, as the analysis does not focus on single years but on periods of time. It is highly unlikely that the results would be fundamentally different if the years since 2006 had also been included.

The selected **countries** are Austria (AT), Denmark (DK), Finland (FI), France (FR), Germany (DE), Italy (IT), the Netherlands (NL), Spain (ES) and the United Kingdom (UK). However, specific data about ICT capital such as investments in ICT were not available for Spain and

[102] cf. Marcel P. Timmer, Mary O'Mahony and Bart van Ark: EU KLEMS Growth and Productivity Accounts: Overview November 2007 Release. November 2007, available at www.euklems.net.

[103] The correlation coefficient is defined as the covariance of the two variables dived by the product of their standard deviation.

France (see Annex I, Exhibit A.I-1). Therefore, these two countries could only be included in the analysis of growth accounting results, but not in the analysis of the relationship between ICT capital and productivity growth and employment.

Methodological caveats

The econometric analysis conducted for this study had a rather limited scope. Some of the results raised (new) questions which, in the context of this study, could not be analysed in more detail. Advisory Board members, when reviewing this section in the interim report, pointed towards some caveats that should be taken into account.

One of the points challenged was that the model applied assumes that there is **full capacity utilisation**, which is not always the case. This could distort the results and lead to invalid conclusions. The capacity utilisation rate is an indicator of how efficiently the factors of production are being used. In the growth accounting, however, full utilisation of all input factors is assumed. Another point was that the model is entirely based on a **production function**,[104] while ignoring the demand function. Changes in the observed impact of ICT could stem from fluctuations in demand; testing this, however, would require a completely different model and was beyond the scope of this study.

A general point raised by reviewers was the absence of research **hypotheses**. It was felt that there was an implicit general assumption that "more ICT" would lead to "better results", and that the analysis could be biased towards this position. Such a bias was not intended, however. In contrast to the baseline study of 2007/08, the study team had decided not to use hypotheses, but conduct the analysis on the basis of research questions (see above).

It was also discussed to what extent a **comparison between sectors** in terms of the ICT impact is useful (the study compares the GCC industries with the total manufacturing sector in terms of ICT impact). As some sectors depend more on ICT simply by the nature of their products (e.g. automotive industry) than others, a higher impact can be expected and should not be used as a common benchmark for the role and importance of ICT. The study team agrees to this concern and aimed to avoid such simplistic, normative conclusions.

Finally, it was discussed that the model did not account for the **time lag** between ICT implementation and their productivity impact. In the short term, new ICT systems may even cause organisational disruption and thus *decrease* productivity. This point is considered in the assessment and conclusions drawn from the results (see Section 5.4). However, to include this in the model, an assumption about the average time it takes for ICT investments to become effective would have to be made. It could be interesting to see to what extent the results would be different if a time lag was built into the time-series model; however, it was not possible to test or adjust this within the scope of this analysis.

In addition to these issues, the **merits of the growth accounting method** are subject to debate among economists. One string of criticism is that growth accounting exercises are based on the assumption that an aggregate production function exists and contests this view. Critics argue that the conditions required to derive valid aggregate production functions from micro production functions are so stringent that "*it is difficult to believe that actual economies satisfy them.*"[105] Others argue that complementarity of factors is key, and that it

[104] The model specifies the output of the GCC industries as a function of inputs, such as ICT and non-ICT capital and labour.

[105] Felipe, J. and F.M. Fisher. 2003. “Aggregation in Production Functions: What Applied Economists Should Know.” Metroeconomica, Vol.54, No.2&3 (May-September): 208-262. For a critical debate of growth accounting, see also: - Felipe, J., and JSL McCombie. 2006. “The Tyranny of the Identity:

is pointless to divide up the credit for growth by treating the factors individually as if they were not complements. In fact, growth accounting by itself would probably not yield sufficient evidence about the strategic role which ICT plays in different industries. However, it offers complementary insights which can be compared with micro-data evidence (see Sections 3 and 4), and thus helps to put the findings into a broader perspective. The growth accounting exercises presented in this Chapter serve mainly the purpose of classifying growth into that part that can be traced to ICT capital inputs and that part which cannot be accounted for (the residual).

5.2 ICT capital and industry growth

5.2.1 Gross value added growth in the GCC industries

In most of the nine countries selected for this analysis, growth in the GCC sector was below the growth rate in the total manufacturing industry, in particular from 1981-1995 (see Exhibit 5-1). Spain and Italy are the exceptions; here, the GCC sector outperformed total manufacturing in most of the periods analysed (1981-1995, 1995-2000, 2000-2005).

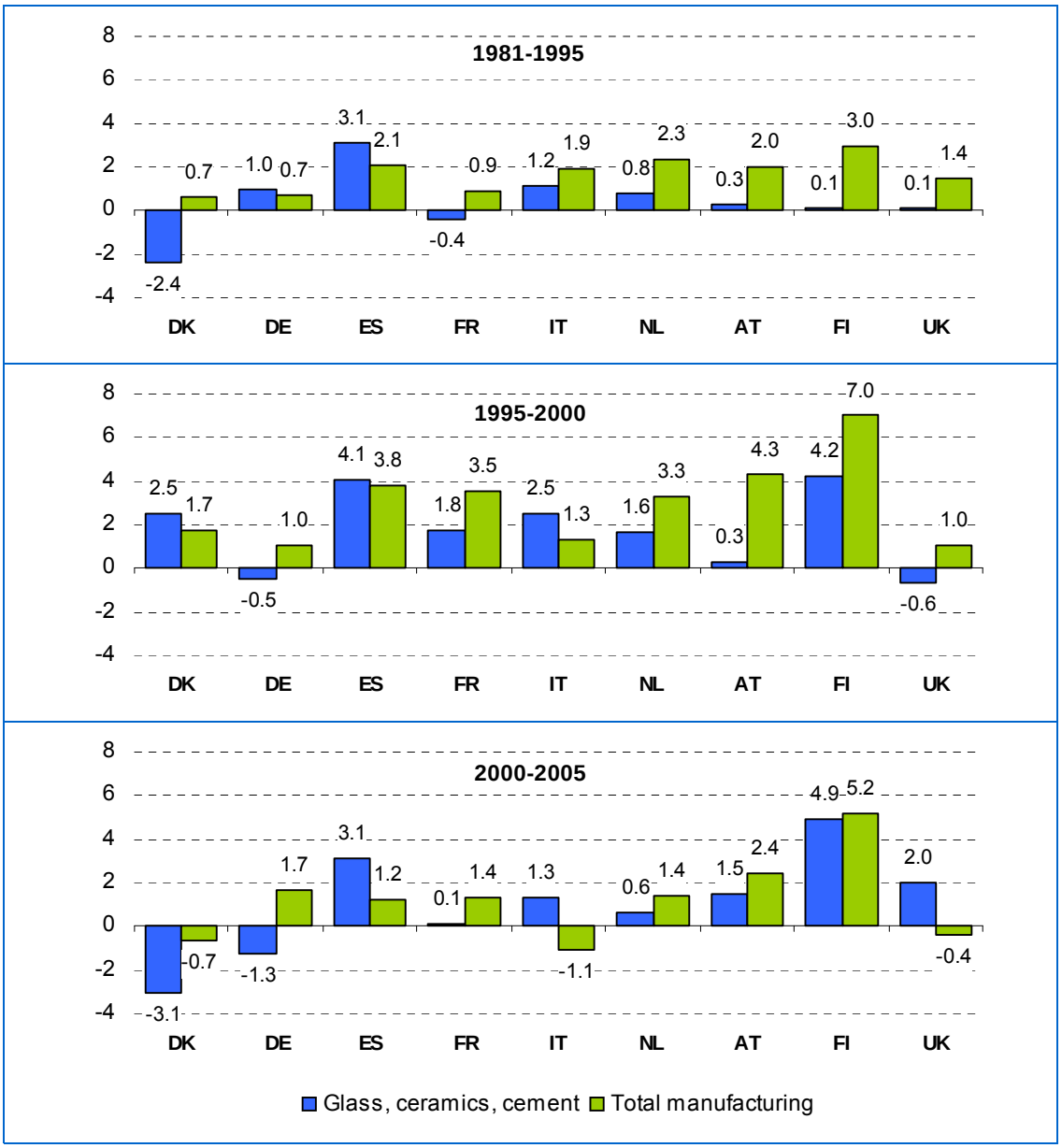
The country average[106] for the GCC industries was 0.4% growth in value added from 1981-1995, 1.8% from 1995 - 2000 and 1.0% from 2000 - 2005; for total manufacturing, the country average was 1.7% (1981-1995), 3.0% (1995-2000) and 1.2% (2000-2005). For the whole period, growth in total manufacturing was on average about 1 percentage point higher than in the GCC industries.

The modest growth rate (or, as in the case of Denmark and Germany, decrease) in value added in most of the countries in the most recent period (2000-2005) reflects that the industry has experienced a decrease in employment in most sub-sectors during these years, driven by consolidation and increasing global competition and imports.

Growth Accounting Revisited." International Review of Applied Economics, Vol.20, No.3 (July): pp.283-299.

[106] simple mathematical average of the nine countries, irrespectively of their respective market size

Exhibit 5-1: Annual growth in value added: GCC industries vs. total manufacturing (three periods, in %)



Source: DIW econ / empirica, developed from EU KLEMS data[107]

[107] EU KLEMS compiles industry data from different sources, including official statistics

5.2.2 Growth contributions of different input factors

Definition of the input factors analysed

Using a standard growth accounting approach, the contributions of different input factors to gross value added growth (as depicted and discussed above) can be identified. Ideally, one would like to divide capital inputs into a large number of distinct asset types.[108] While some European countries have such detailed capital formation matrices, most provide only a limited amount of detail. From the variables available in the EU KLEMS data base, the following input factors have been selected for the analysis:

- **ICT capital**. The EU KLEMS data base makes a distinction between three ICT assets: office and computing equipment, communication equipment and software.[109] "ICT capital" represents the total stock of these assets. ICT assets are deflated using a quality-adjusted investment deflator, except for those countries which have not yet implemented adequate quality adjustment. For some countries, data on gross fixed ICT capital formation by industry is available from the National Accounts. However, for many other countries, ICT had to be estimated and split off from "machinery" in general.[110]
- **Non-ICT capital**. EU KLEMS includes data for four non-ICT assets: transport equipment, other machinery and equipment, residential buildings and non-residential structures. "Non-ICT capital" represents the total stock of these assets. For both ICT and non-ICT capital, in order to achieve comparability across countries, a harmonised approach to capital measurement and one set of asset depreciation rates was used for all countries. Depreciation rates differ by asset type and industry, but not over country and also not over time.
- **Total working hours** and **composition of the labour force** by different skill levels. Series on hours worked by labour types are not part of the standard statistics reported by NSIs, not even at the aggregate economy level. Also, there is no single international data base on skills which can be used for this purpose. For each country covered in EU KLEMS, a choice was made to use survey data which provide the best sources for consistent wage and employment data at the industry level. In most cases, this was a labour force survey (LFS) or a social-security data base, or a mix of sources. [111] The composition of the labour force is thus calculated by the aggregated share of working hours by skill level.
- **Total factor productivity** (TFP): TFP is derived as a residual (after all other input factors have been statistically accounted for) and includes a host of effects such as improvements in allocative and technical efficiency, but also measurement errors and the effects from unmeasured output and inputs.

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[108] as available, for example, in the National Income and Product Accounts produced by the US Bureau of Economic Analysis (BEA) – Cf. EU KLEMS Growth and Productivity Accounts, Version 1.0, Part I Methodology. March 2007.

[109] Unfortunately, the definition of IT and CT assets in terms of products covered (based on CPA) has not been completely harmonised across all countries. In particular, data on software assets are not fully comparable.

[110] Methods used to do this, vary considerably across countries. While some are based on survey evidence, others use proportions from recent years, from the BEA or from other countries.

[111] cf. Marcel P. Timmer, Mary O'Mahony and Bart van Ark: EU KLEMS Growth and Productivity Accounts: Overview November 2007 Release. November 2007, available at www.euklems.net.

Results by input factor

In all of the nine countries analysed, **ICT capital** has been a positive contributor to growth in value added in the GCC industries as well as in the total manufacturing industry (see Exhibit 5-2). However, the contribution of ICT is relatively low for both industry aggregates and typically accounts for 0.1-0.5% annual growth throughout the three periods analysed. There are some exceptions among the nine countries and in specific periods analysed. In the GCC industries, ICT capital had the most pronounced effect of all in Denmark in the 1980s and the 1990s.

The contribution of **non-ICT capital** to industry growth is comparable to the one of ICT capital. It is mostly positive, but does not account for a major percentage of growth in most countries, even if it is somewhat more significant than the contribution of ICT capital. Non-ICT capital has the highest contributions to growth in Italy (with about 1.0 percentage points per year on average for the whole 25-year period analysed), in Spain (0.9 points) and France (0.5 points) – see Exhibit 5-3, orange segments of the bar charts.

Exhibit 5-2: Contribution of different input factors to value added growth in the GCC industries, 1981-2005[112]

	ICT capital	Non-ICT capital	Total hours worked	Labour compos.	TFP
Denmark	+	o	- - -	+	o
Germany	o	+	- - -	+	+++
Spain	+	++	-	+	+++
France	+	+	- - -	+	+++
Italy	o	++	- -	o	++
The Netherlands	+	+	o	+	o
Austria	o	+	- -	+	++
Finland	+	+	- -	+	+++
United Kingdom	+	+	- - -	o	+++

+ / - means a positive / negative contribution of 0.2-0.5 percentage points of VA growth

++ / -- means a positive / negative contribution of 0.6-1.0 percentage points

+++ / --- means a positive / negative contribution of more than 1.0 percentage points

Total hours worked is the factor with the highest impact on value added growth. The contribution is significantly negative in all countries with the exception of Spain (see Exhibit 5-3, dark blue segments of the bar charts). The result is linked with the fact that several segments of the GCC industries have decreased in terms of employment and thus also in the number of total hours worked. Although productivity gains may fully compensate for the subsequent reductions in production output, labour is still a critical production factor in most manufacturing industries, even in capital intensive industries. The cement industry, where labour costs account for only about 20% of total costs (see Section 2.1.3) may be an exception. In any case, the amount of hours worked had a more pronounced impact on total value added growth than capital (whether ICT or non-ICT) in most of the countries. The exceptions are Spain, Italy and the Netherlands.

[112] The "GCC industries" is here defined as NACE Rev. 1.1 Division 26.

Labour composition, i.e. the share of working hours according to skill levels of the employees (measured in terms of their education levels), has positively contributed to growth, in the sense that a higher share of working hours performed by high skilled employees tends to be beneficial for growth. However, the effects are not very pronounced, similar to those of ICT capital.

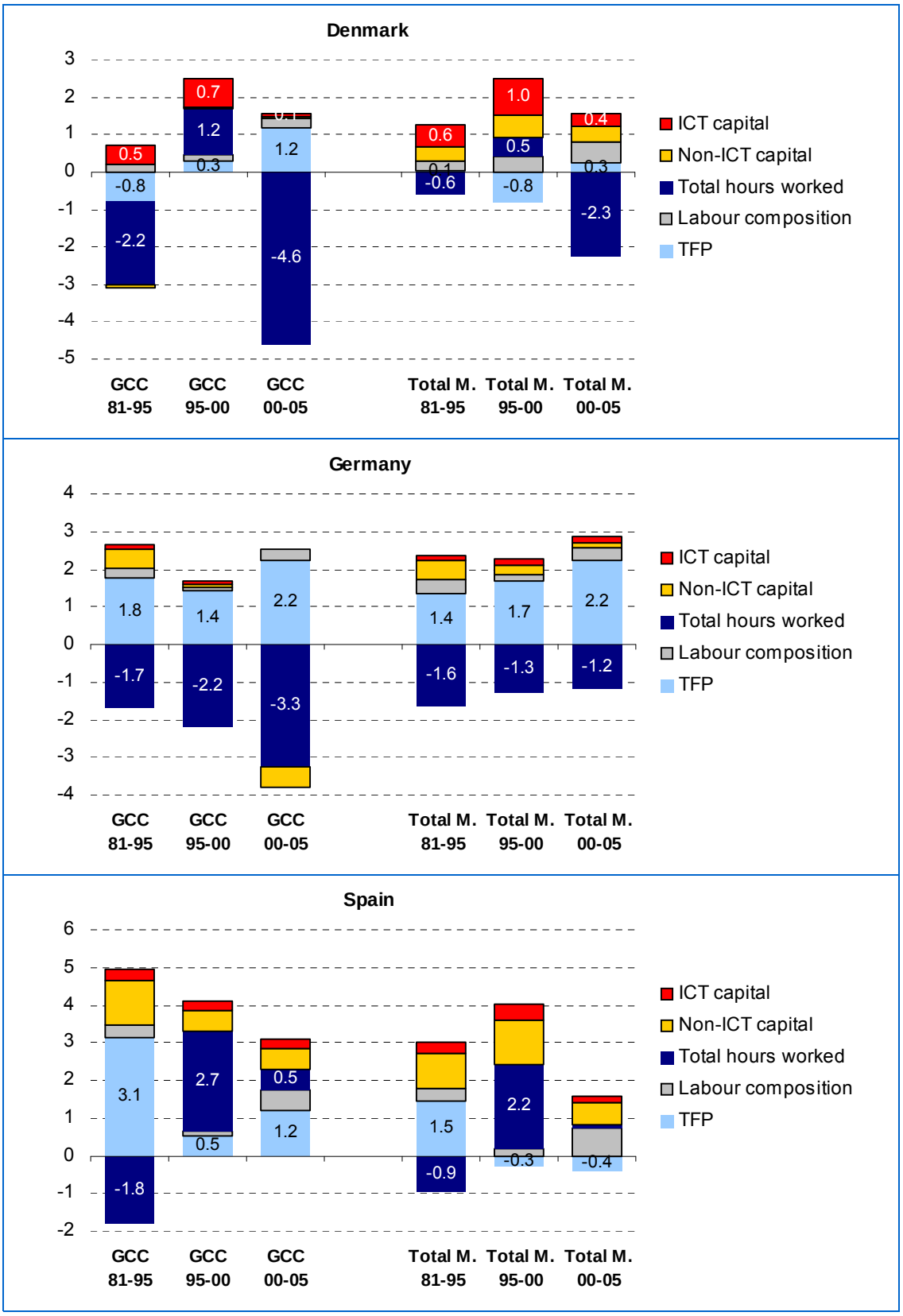
Total factor productivity (TFP), finally, accounts for a relatively high share of growth in most of the countries; Denmark and –for GCC– the Netherlands are the exceptions. The contribution is mostly positive. The share accounted for by TFP tends to be even higher in total manufacturing. In Austria, for example, TFP accounts for more than 50% of total value added growth in the manufacturing industry in all three periods analysed, in Finland and Germany for about 50% for total manufacturing and about a third in the GCC industries. As explained above, in growth accounting, TFP represents the residual that cannot be statistically explained (or accounted for) by the other input factors; as such, the real factors hidden within TFP remain somewhat speculative. As a rule of thumb, the higher TFP-growth is, the higher is the value added. The overall high capital-intensity of the GCC industries imply that labour inputs and moderate labour quality changes are of secondary importance. This finding is quite specific for capital intensive manufacturing industries such as the GCC or the chemical industry, in particular in comparison to service sectors such as financial intermediation and retailing, where labour inputs and skill-bias play a significantly more important role.[113]

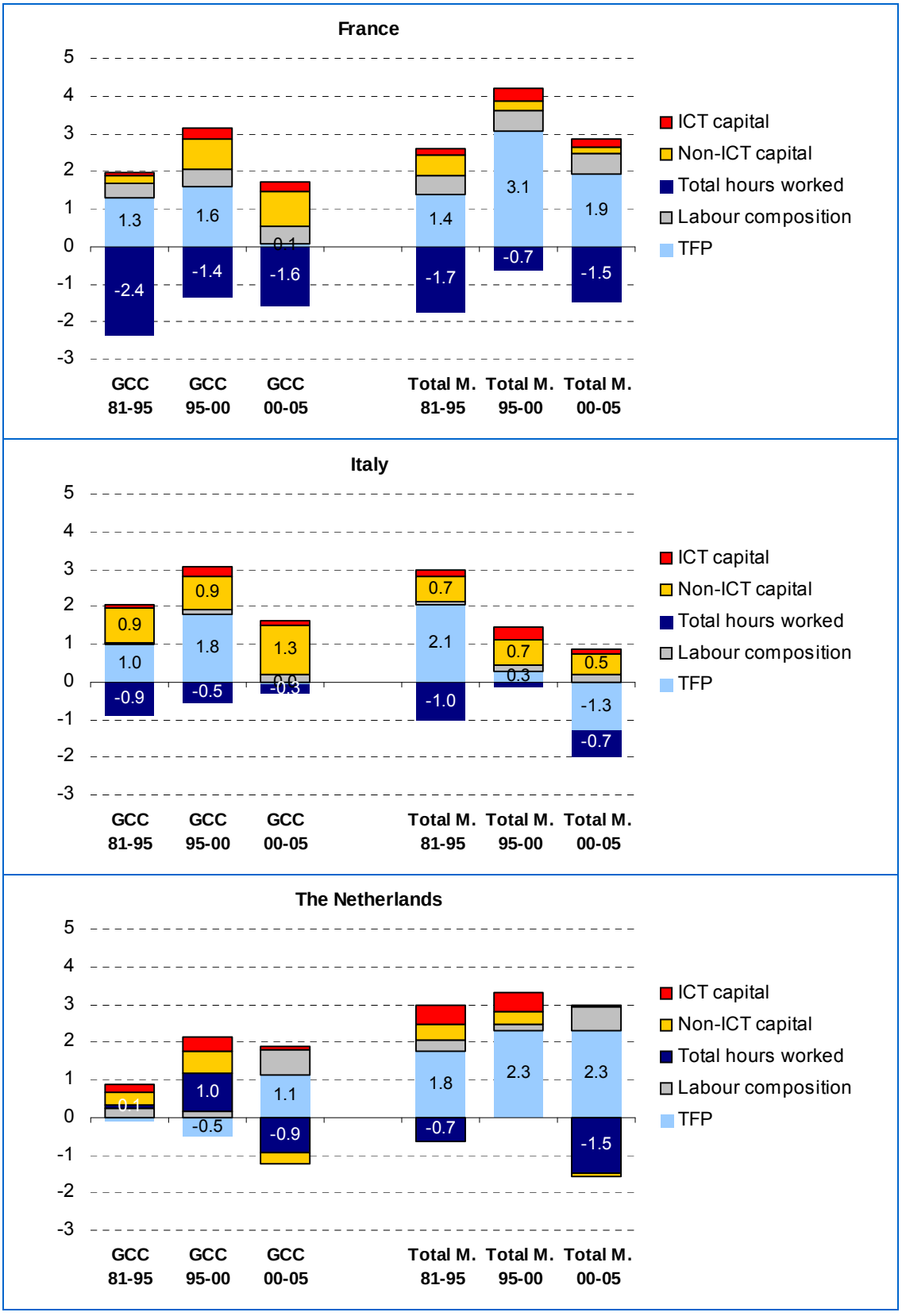
Exhibit 5-3 shows the results for the nine countries analysed. In each chart, the contributions of five input factors to value added growth are shown, broken down into three time periods, for the GCC industries[114] and for total manufacturing. Figures are only included for the most relevant contributions.

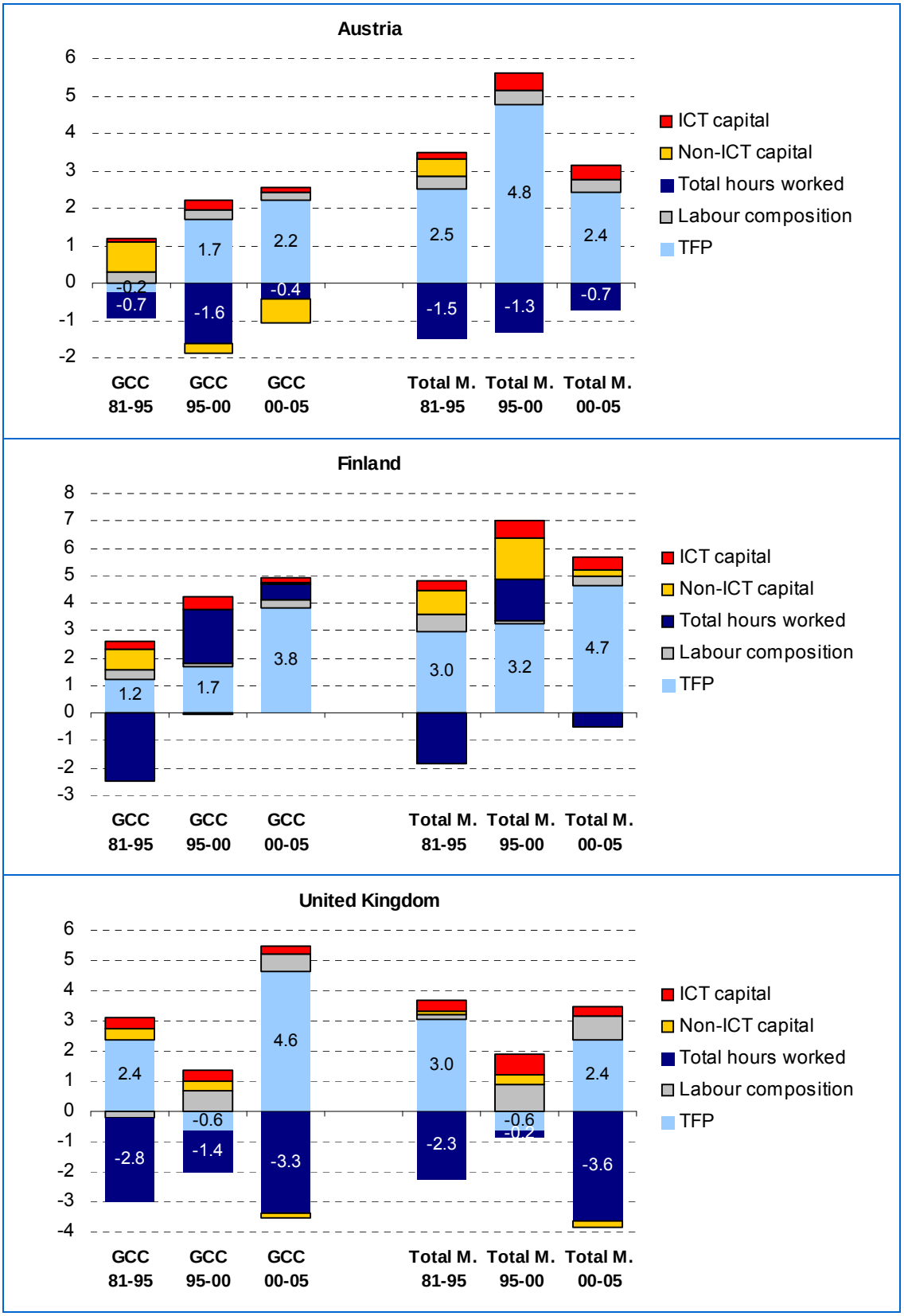
[113] See Sectoral e-Business Watch / European Commission (2008b) for results for other sectors

[114] The "GCC industries" is here defined as NACE Rev. 1.1 Division 26. Reading example: "ICT capital as an input factor accounted for 0.5% growth in value added in the Danish GCC industries in the period 1981 to 1995."

Exhibit 5-3: Contribution of different input factors to value added growth: GCC industries* vs. total manufacturing (nine countries, different periods of time)




France
5
4
3
2
1
0
-1
-2
-3
1.3
-2.4
1.6
-1.4
0.1
-1.6
1.4
-1.7
3.1
-0.7
1.9
-1.5
GCC 81-95
GCC 95-00
GCC 00-05
Total M. 81-95
Total M. 95-00
Total M. 00-05
ICT capital
Non-ICT capital
Total hours worked
Labour composition
TFP
Italy
0.9
1.0
-0.9
0.9
1.8
-0.5
1.3
0.7
2.1
-1.0
0.7
0.3
0.5
-1.3
-0.7
The Netherlands
0.1
1.0
-0.5
1.1
-0.9
1.8
-0.7
2.3
2.3
-1.5



Source: Data: DIW econ (developed from EU KLEMS)

Assessment of the results

To summarise and illustrate the differences in the importance of ICT as a contributor to value added growth, Exhibit 5-4 shows the ranking of ICT capital contributions in comparison to those of the other four input factors, and its total accounted contribution (in % annual growth). In the GCC industries, ICT is not the most significant contributor in any of the analysed countries (except for Denmark in the period 1981-1995). Moreover, there seems to be a trend of decreasing contribution to growth in most countries. These observations are similar in the GCC industries and in the manufacturing industry and apply to most countries.

Exhibit 5-4: Rank of ICT as a contributor to Value Added Growth (out of five factors) and contribution in % growth

	1981 - 1995		1995 - 2000		2000 - 2005	
Glass, ceramics and cement industry						
	Rank	% contr.	Rank	% contr.	Rank	% contr.
Denmark (DK)	**1**	**0.5%**	**2**	**0.7%**	3	0.1%
Germany (DE)	4	0.1%	**2**	0.1%	3	0.0%
Spain (ES)	4	0.3%	4	0.2%	5	0.3%
France (FR)	4	0.1%	4	0.3%	3	0.2%
Italy (IT)	3	0.1%	3	0.2%	3	0.1%
The Netherlands (NL)	3	0.2%	3	0.4%	3	0.1%
Austria (AT)	3	0.1%	3	0.2%	3	0.1%
Finland (FI)	4	0.3%	3	**0.5%**	4	0.2%
United Kingdom (UK)	3	0.4%	**2**	0.4%	3	0.3%
Total manufacturing						
Denmark (DK)	**1**	**0.6%**	**1**	**1.0%**	3	0.4%
Germany (DE)	4	0.1%	4	0.2%	3	0.1%
Spain (ES)	4	0.3%	3	0.4%	3	0.2%
France (FR)	4	0.2%	3	0.3%	3	0.2%
Italy (IT)	3	0.2%	**2**	0.3%	3	0.1%
The Netherlands (NL)	**2**	**0.5%**	**2**	**0.5%**	3	0.1%
Austria (AT)	4	0.2%	**2**	**0.5%**	**2**	0.4%
Finland (FI)	4	0.4%	4	**0.7%**	**2**	**0.5%**
United Kingdom (UK)	**2**	0.4%	**2**	**0.7%**	3	0.4%

Rank: 1 = highest contribution; 5 = lowest contribution (values 1 and 2 highlighted in green, 3 in yellow)

% contr. = % annual value added growth explained by ICT capital changes (values of 0.5%+ in bold)

Source: DIW econ (based on EU KLEMS)

Thus, all in all, when comparing the results for the three time periods analysed, there is no clear trend with respect to the importance of any given factor across the various countries. This suggests that the question whether changes in ICT or non-ICT capital, labour composition, the number of hours worked or TFP are key determinants for economic growth is country-specific, i.e. it depends on the general business context and situation of the respective industry in a given country. Of all factors analysed, TFP has clearly the most significant positive contribution to growth.

The results are also fairly consistent with those obtained for the chemical, rubber and plastics industry in 2008,[115] which also found that ICT capital was not a key driver of industry growth in most of the countries analysed. These results indicate that ICT-investments by themselves are not driving output in these manufacturing industries; these sectors appear not to depend on ICT in their core business in the same way as other sectors, notably service industries.

The results can also be linked to those of the **European Competitiveness Report** 2008 (European Commission, 2008b), which conducted a similar growth accounting exercise for the industry as a whole. This analysis also revealed that "TFP seems to be the main source of the difference in value added growth between the US and the EU for most industries, especially manufacturing, followed by ICT capital accumulation in some service industries" (p. 25). The authors conclude that the "relatively slow growth in TFP in the EU-15 is the prime cause of the GDP growth differential vis-à-vis the US". As TFP is a residual, "factors other than capital and labour that contribute to value added growth are obviously not being taken into account, and these other factors are apparently stronger in the US than in the EU" (p. 22).

However, there are some further considerations to made to put the growth accounting results into perspective. For example, it should be remembered that ICT is often embedded in the complex equipment of plants. This type of ICT cannot be separated by the approach to measure ICT-investment taken by the EU-KLEMS data base and will therefore not be fully accounted for in the "ICT capital" variable, but will rather be part of the "non-ICT capital" (which includes other machinery and equipment). The actual impact of this "**hidden ICT**" on output in manufacturing industries might be higher than the growth accounting results presented above suggest.

Another issue to be considered is that the main impact of ICT is mainly derived from optimally organising information flows, work and production processes, by exchanging and processing data electronically. Although this requires hardware and software, the investments in the technology part itself can be insignificant compared to the "investments" in implementing the **organisational changes**. In other words, the physical infrastructure accounted for as "ICT capital" may not always adequately match the far-reaching implications of actual ICT usage in the enterprise. What matters is the actual e-business activity, not the stock of ICT capital by itself. This could also help to explain the high contribution of TFP to growth in many countries, as organisational changes will not be covered by any of the direct input factors. The case study on Gmundner Keramik (see Section 4.2) is a good example of company where "simple" ICT solutions (in the sense of requiring only modest investments in ICT infrastructure) have nevertheless critical importance for efficient production planning and, ultimately, output.

[115] A similar analysis using the same methodological approach was conducted as part of the Sectoral e-Business Watch study on the chemical, rubber and plastics industry (2008), available at www.ebusiness-watch.org.

5.3 ICT and labour productivity

While Section 5.2 assessed the contribution of ICT capital to industry growth, this section explores the links between ICT and labour productivity. This analysis is accomplished in two steps: first, the general development of the presumably related factors (ICT capital and investments, hours worked, labour productivity) is presented in a descriptive way, based on existing industry statistics. Second, a correlation analysis of these variables is conducted, focusing on the period 1991-2005. The following variables from the EU KLEMS data base[116] are used for this analysis:

- **Real fixed ICT capital stock** by sector (K_ICT in EU KLEMS) denotes the real value of the stock of computing equipment, communications equipment and software (in 1995 prices). Data on "ICT capital" in EU KLEMS are broken down into the ICT asset classes office and computing equipment, communication equipment and software.
- **Investments in ICT capital** by sector (Iq_ICT in EU KLEMS) are gross investments in computing equipment, communications equipment and software (in 1995 prices). Investments are deflated using a quality-adjusted investment deflator, except for those countries which have not yet implemented adequate quality adjustment.
- **Labour productivity** by sector (LP_I in EU KLEMS) is the ratio of gross value added per hour worked in the respective sector (volume indices, 1995=100).
- **Hours worked by persons** engaged in the sector (H_EMP in EU KLEMS) is the total number of hours worked by all persons engaged in the respective sector (in millions).

While "fixed ICT capital stock" refers to the accumulated stock of capital in a given year, "investments in ICT capital" denote the gross annual additions of new capital. Over time, the capital stock increases due to investments and decreases due to depreciation (i.e. consumption of fixed capital).

General considerations on ICT and productivity

The **interest of policy** in the economic impact of ICT was mainly triggered by the productivity growth resurgence in the USA and a simultaneous diffusion of ICT products in the 1990s. It was assumed that a significant part of this increased productivity growth was attributable to increased ICT investments. In response, a lot of economic research has been conducted to better understand the relationship between ICT deployment and productivity growth. Rather unsurprisingly for such a complex and multidimensional issue, the various research results cannot easily be condensed into simple facts or conclusions. By and large, the studies found that some countries and specific sectors have seen a clear surge in productivity resulting from ICT investment, while the impact in other sectors is much less obvious. Thus the results are mixed, depending in particular on the sector and the time period analysed, but also on the chosen methodological approach.

Several studies found that ICT had positive effects on labour productivity and total factor productivity (e.g. Pilat, 2005). However, it has also become clear that ICT-induced pro-

[116] For more background information about the variables, see: EU KLEMS Growth and Productivity Accounts, Version 1.0, Part I Methodology. March 2007. Prepared by Marcel Timmer, Ton van Moergastel, Edwin Stuivenwold, Gerard Ypma (Groningen Growth and Development Centre) and Mary O'Mahony and Mari Kangasniemi (National Institute of Economic and Social Research). Available at:

http://www.euklems.net/data/EUKLEMS_Growth_and_Productivity_Accounts_Part_I_Methodology.pdf (accessed in April 2009)

ductivity **effects vary significantly between sectors** and among countries (Nordhaus, 2002). The largest productivity growth effects appear to occur 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 diverse results imply that the "**productivity paradox**" as observed by Robert Solow in 1987[117] is, to some extent, still valid. Despite ICT being pervasively used in all sectors and business functions, it is difficult to track their direct impact on productivity and growth at the aggregate level. This holds true, in particular, for traditional manufacturing sectors such as the GCC industries. An e-Business Watch study on the chemical industry (Sectoral e-Business Watch, 2008c), using a slightly different approach as applied in this study, found only a moderate impact of ICT-capital investment on labour productivity. The key driver for labour productivity growth was found to be related to the intensity of intermediate inputs such as energy, materials and services.

In summary, the existing literature indicates that ICT-induced productivity effects are relatively less pronounced in capital intensive, mature manufacturing industries such as glass, cement or chemicals. On the other hand, micro-data evidence shows that particularly the larger companies in the GCC industries make significant use of ICT for a variety of purposes, notably for managing production processes and the supply chain (see Section 3 and case studies in Section 4). This leads to the question to what extent these activities have led to a rise in ICT investments (i.e. in capital stock) at the aggregate level and to that extent this rise is statistically linked with productivity growth.

5.3.1 Development of ICT capital stock and labour productivity

ICT capital stock development

Real fixed **ICT capital stock** has significantly increased (in real terms) in the GCC sector since 1991 in all seven countries analysed. However, the average annual growth rate differs remarkably between countries and also between periods. In Denmark, Italy and Austria, ICT capital stock increased massively from 1991 to 2005 by 500-700%. The Netherlands and Finland also experienced significant growth of 200-300% (see Exhibit 5.5a).

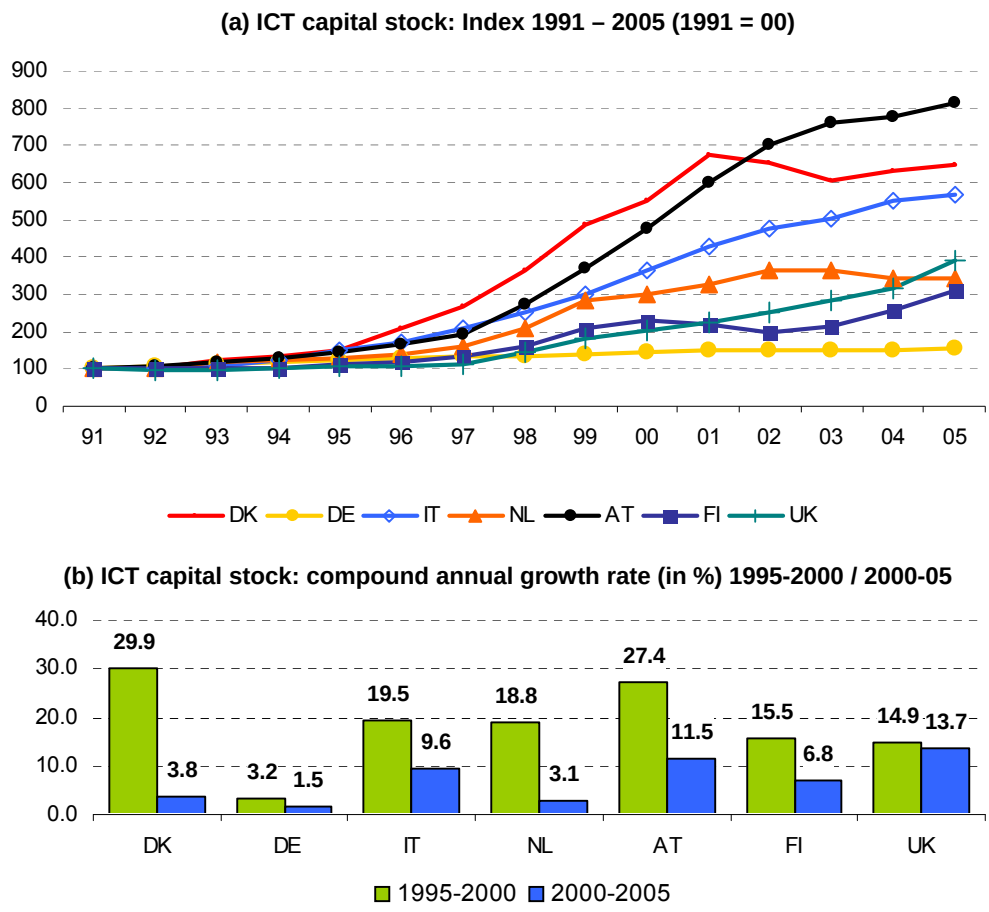
In the period 1995-2000, when ICT experienced a massive surge due to the emergence of the internet, annual growth rates in ICT capital stock amount to 15-30% in the countries analysed, with the exception of Germany.[118] The average annual growth rates of ICT capital stock in the period 2000-2005 were significantly lower, except for the UK, but still amount to 4-15%[119] (see Exhibit 5.5b). Over both periods (1995-2005), on average in the countries surveyed, the compound annual growth rate was 12.8%.

[117] In 1987, economist Robert M. Solow wrote the famous line "You can see the computer age everywhere but in the productivity statistics" (New York Review of Books, July 12, 1987).

[118] The marked difference in the data available for Germany may partly be linked to changes in the industry in this period; however, it cannot be excluded that the data for Germany as available from EU KLEMS are not fully comparable with those for other countries. It was not possible to identify the specific reason for this deviation in the scope of this study. The results for Germany should therefore be taken with care.

[119] Arithmetic mean of the 14 CAGR values (for seven countries and two periods).

Exhibit 5-5: Development of real fixed ICT capital stock in the GCC industries (7 countries)*



* GCC industries is here defined as NACE Rev. 1.1 Division 26

Source: DIW econ / empirica (developed from EU KLEMS)

There is no easy and straight forward explanation or single factor that fully accounts for the significant differences in ICT capital between the seven countries. An important factor is certainly the growth of the sector as such (in terms of production output) during the period. In Germany, for example, gross output in volumes was only 3% higher in 2005 than in 1991.[120] Considering productivity growth during the period, the industrial base in which ICT capital has been deployed and used has decreased. In Italy, by contrast, indexed gross output increased by about 25%. However, notwithstanding the differences between national industries in this respect, industry growth by itself cannot fully explain the enormous differences in the development of ICT capital stock.

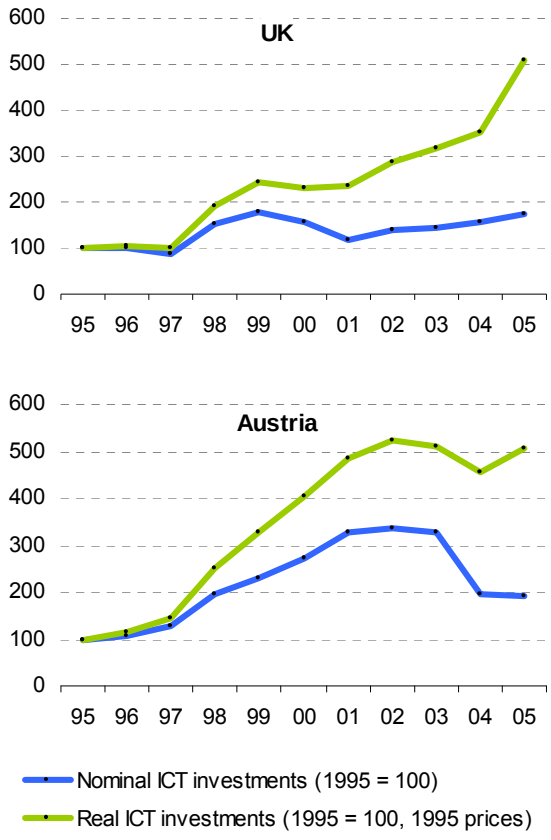
A second factor is that the base line could differ, i.e. the starting point when companies began to make significant investments in ICT, as the emerging technologies of the 1980s and 1990s. The indexed development shown in Exhibit 5-6 depends, of course, on the selected base line, i.e. the year 1 of the index (in this case 1991). If an industry made major investments already earlier than that, the fixed ICT capital stock in the starting year is already higher and the future (indexed) growth will be lower than for an industry that started from a lower base line.

[120] according to EU KLEMS, volume indices for gross output (GO_QI), NACE Rev. 1.1 26

Another factor that must be taken into account to understand the high growth is that **prices for ICT assets** have significantly decreased. Thus, investments in ICT and fixed ICT capital stock are much higher if measured in real terms based on past prices (e.g. of 1995) than in nominal terms.

Exhibit 5-6 shows for two countries how the development of ICT investments made by the GCC industries in a ten-years period (1995-2005) differ in nominal and real terms, with 1995 prices as the base for real investments. In the UK, for example, nominal annual investments in ICT assets increased in the late 1990s by about 80% compared to the average spending in the mid '90s, then decreased after the new economy crash and started to rise again since 2002. Measured in real terms (at 1995 prices), however, the increase is much more significant. In both countries (UK and Austria), the indexed increase of investments in ICT was 2.5 to 3 times higher in real terms than in nominal investments. The same principle applies to the measurement of ICT stock, i.e. accumulated investments reduced by depreciation.

Exhibit 5-6: Real vs. nominal gross ICT capital formation in the GCC industries (index, 1995 = 100)



Source: data from EU-KLEMS, developed by empirica

In summary, the figures illustrate the general development towards the information society since the 1990s in terms of massive increases in (real) fixed ICT capital stock during the 1990s and the first half of this decade.

Labour productivity and hours worked

Productivity levels (including labour productivity and total factor productivity) are an indicator of welfare and are closely related to innovation and competitiveness. According to the European Competitiveness Report 2008, average annual productivity growth in the EU in the period 2000-2007 was 2.8%,[121] with substantial intra-EU differences, however.

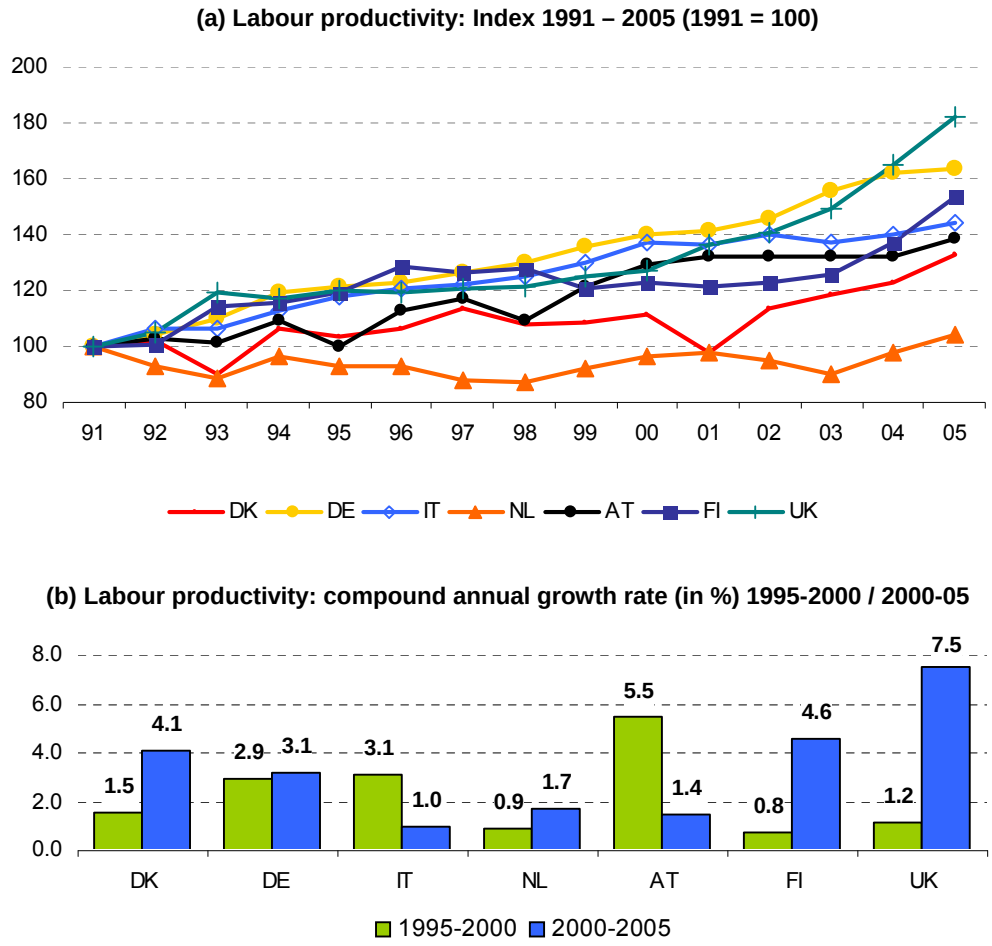
In the GCC industry, according to EU KLEMS data, the **labour productivity growth** rate has significantly increased after 2000. In the period 2000-2005, average annual growth was particularly high in the UK (7.5%), Denmark and Finland (more than 4%). Thus, somewhat counterintuitive for a rather traditional manufacturing sector, labour productivity growth was probably higher in this sector than (total) industry productivity growth. In the period 1995-

[121] cf. European Competitiveness Report 2008 (European Commission, 2008a, Section 1.2.3 Labour productivity)

2000, labour productivity had increased to lesser extent by 1-3% per year in most of the countries analysed (see Exhibit 5-7b). This indicates that many companies conducted significant investments and innovations in their production plants during this period, leading to industry-wide modernisation.

Taking a longer term (15 year) perspective and looking at the development since 1991, labour productivity has increased by 30-60% in most countries since. Among the countries in the sample, productivity growth over the whole period was highest in the UK with about 80% (see Exhibit 5-7a).

Exhibit 5-7: Development of labour productivity in the GCC industry* (7 countries)

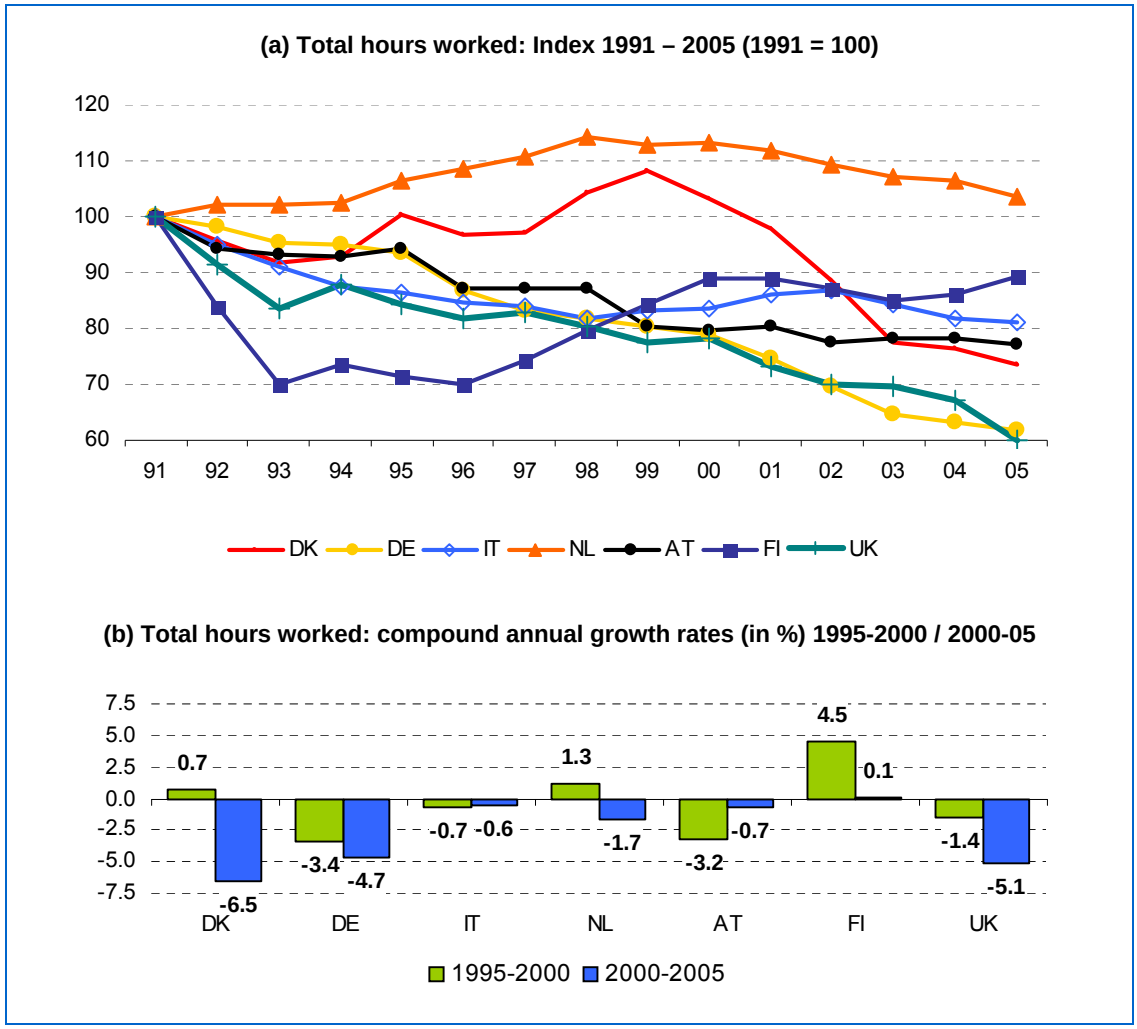


* GCC industry is here defined as NACE Rev. 1.1 Division 26

Source: empirica / DIW econ (developed from EU KLEMS)

While labour productivity has increased, the total number of **hours worked** in the GCC industries has decreased by about 1.5% per year (on average) in the sample countries, in particular since 2000 (see Exhibit 5-8b). A decrease in working hours can reflect productivity gains in a stagnating market environment (i.e. with output being stable or decreasing) or a general decrease of production volumes. In the case of the GCC industry, the figures correspond with the reduction of employment in most sub-sectors over the past few years (see Section 2.1). In Germany, the largest GCC industry in Europe, the number of working hours has been constantly decreasing from 1991 to 2005 to about 60% of the 1991 level (see Exhibit 5-8a).

Exhibit 5-8: Development of hours worked in the GCC industry (7 countries)*

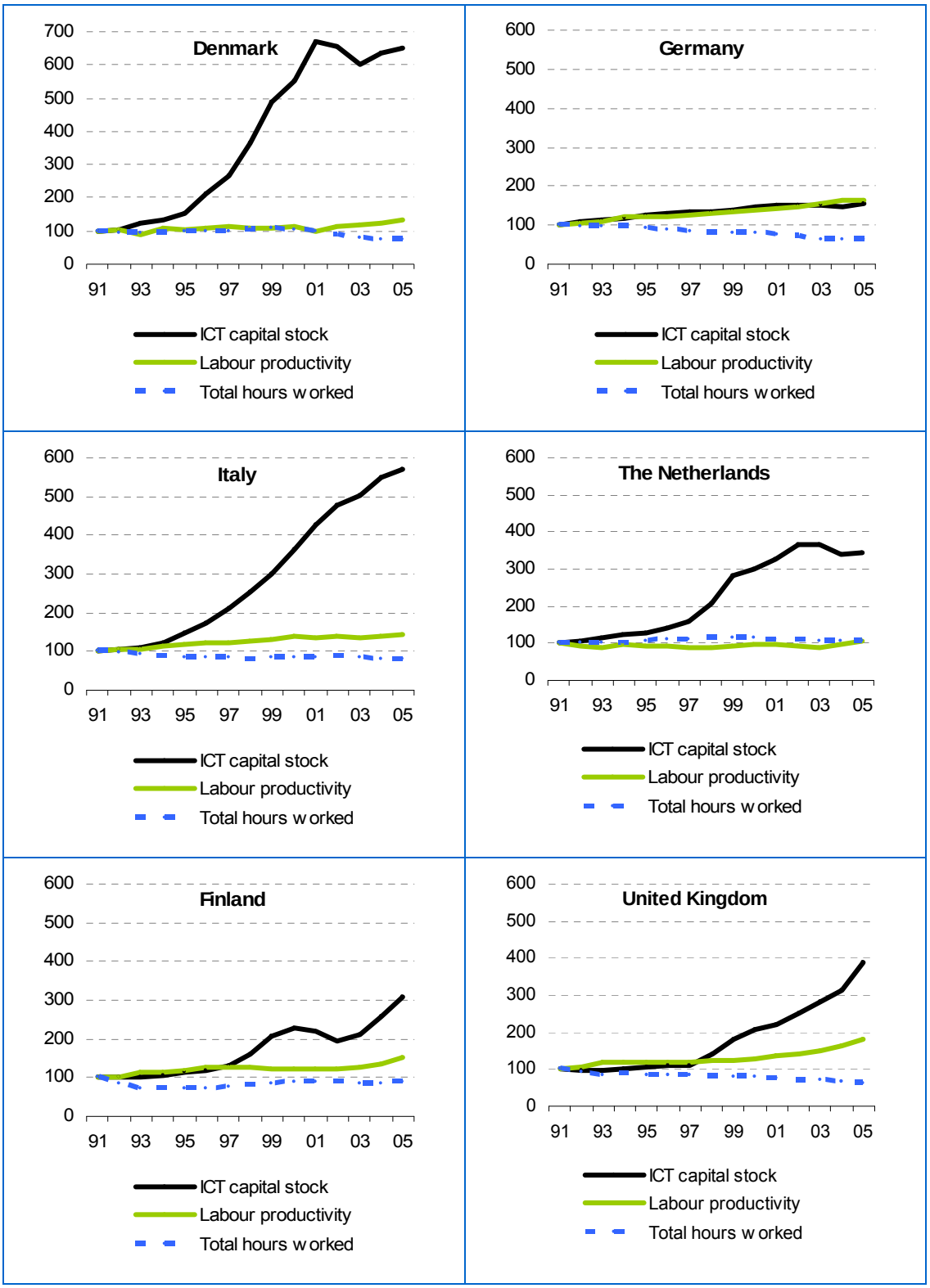


* GCC industry is here defined as NACE Rev. 1.1 Division 26

Source: empirica / DIW econ (developed from EU KLEMS)

The charts in Exhibit 5-9 summarise the indexed growth (or decrease) of ICT capital stock, labour productivity and total hours worked in the GCC industries for six countries from the sample and the period 1991-2005. They show how real fixed ICT capital stock has surged in most countries and that labour productivity has also increased (at a different level, of course), while the number of hours worked in this sector has decreased. The following section will analyse how these factors are correlated with each other.

Exhibit 5-9: Development of real fixed ICT capital stock, labour productivity and total hours worked in the GCC industries* (7 countries, 1991-2005, Index: 1991 = 100)



* NACE Rev. 1.1 26

Source: empirica / DIW econ (developed from EU KLEMS)

5.3.2 Correlation analysis: ICT and productivity development

Section 5.3.1 has shown that ICT capital stock and labour productivity in the GCC industries have significantly increased in all countries analysed in the past 15 years. The question is to what extent these variables are interdependent. This has been tested by means of a correlation analysis. The analysis has been conducted both for the GCC industries and the total manufacturing industry. The results are presented in Exhibit 5-10.

Exhibit 5-10: Correlations between ICT capital stock, labour productivity and hours worked

	Min *	Max *	Average
Real Fixed ICT Capital Stock vs. Labour Productivity			
Glass, ceramics and cement **	0.8019 (DK)	0.9832 (FI)	**0.9130 *****
Total manufacturing	0.5005 (NL)	0.9516 (DE)	**0.8052 *****
Real Fixed ICT Capital Stock vs. Total Hours Worked			
Glass, ceramics and cement **	-0.6607 (DK)	-0.8167 (IT)	-0.7611 **
Total manufacturing	0.4267 (NL)	-0.9461 (DE)	-0.6291 **

* Min / Max = minimum / maximum value for one of the countries analysed

** here: NACE Rev. 1.1 Division 26

Source: Analysis by DIW econ, based on EU KLEMS data

ICT capital stock and labour productivity / hours worked

ICT capital stock is strongly **positively correlated**[122] **with labour productivity** growth in the manufacturing industry and even more so in the GCC sector. A **negative correlation** was found between ICT capital stock and the **numbers of hours worked**. This indicates that a growth in ICT capital stock tends to go hand in hand with a reduction in the number of working hours, while labour productivity increases. However, as stated in the introduction to this Chapter, even a highly significant correlation is not a prove for direct causality. Other variables could also have an influence on the development of ICT capital stock, labour productivity and/or the number of hours worked. For example, growth of the ICT capital stock might simply be a result of output growth due to higher demand; the expansion of the production facilities may have required a parallel expansion of the ICT infrastructure. Demand increases could also stimulate investment in non-ICT capital such as specific machines, which could then in turn raise labour productivity. In this scenario, both the increase in ICT capital and in labour productivity would be caused by the same underlying factor – the demand increase.

Considering these caveats, the data do not allow to establish a simplistic causal relationship between the variables, i.e. higher investments in ICT do not necessarily and directly lead to labour productivity growth. Nonetheless, the correlation analysis indicates that these variables are somehow linked. It can be seen as further evidence for the widely supported view that ICT is an important tool to support innovation in manufacturing processes and thus productivity growth. To be successfully used, however, the technology (i.e. the capital stock) requires the right organisational context in terms of work processes and interfaces. This organisational planning is part of the "total factor productivity" which cannot be explained by factor inputs such as hardware or software (see also Section 5.2.2).

[122] Normally, two variables are considered to be strongly correlated if the coefficient is above 0.8 in absolute values, lightly correlated if the values are between 0.6 and 0.8, and uncorrelated with coefficient values below 0.6.

ICT investment and labour productivity / hours worked

To put this evidence to a test, not only the fixed ICT capital stock, but also the annual investments in new ICT capital have been analysed in terms of their correlation with changes in labour productivity and hours worked. The results of this analysis are shown in Exhibit 5.11 In contrast to the results for ICT capital, ICT capital investment is **neither significantly correlated with labour productivity growth nor with changes in working hours**. This may come as a surprise, given the results for accumulated ICT capital, but suggests that the relationship between ICT capital and productivity and employment may actually be much less pronounced than the simple correlation analysis for ICT capital has initially suggested. This finding is also consistent with the conclusions drawn in the SeBW study on ICT impact of 2008 (Sectoral e-Business Watch, 2008b), which found little evidence for direct links between ICT capital and labour productivity.

Exhibit 5-11: Correlations between ICT capital stock, labour productivity and hours worked

	Min *	Max *	Average
Investments in ICT vs. Labour Productivity Growth			
Glass, cement and ceramic **	0.0261 (DK)	0.7098 (FI)	0.2341
Total manufacturing	-0.016 (DK)	0.5164 (UK)	0.0643
Investments in ICT vs. Change in Total Hours Worked			
Glass, ceramics and cement **	0.0193 (DK)	0.4825 (DE)	0.1205
Total manufacturing	0.0012 (NL)	0.2319 (FI)	0.0380

* Min / Max = minimum / maximum value for one of the countries analysed

** here: NACE Rev. 1.1 Division 26

Source: Analysis by DIW econ, based on EU KLEMS data

The results of the correlation analysis could also point towards a **time lag** between the point of investment in ICT and the return on investment in terms of productivity growth. The fact that there is no significant correlation between investments in ICT and productivity growth or hours worked can be seen that as evidence that there is no effect *in the same year*, because investment represents only the "delta", i.e. the change in a given year. It is plausible that this investment will not immediately translate into substantial productivity increases (or labour reductions), but may take some time until the accompanying organisational effects are well established and become a routine. The amount spent on ICT can differ widely between years, depending on the type and scope of ICT projects to be implemented. The time-plan for financing these projects (i.e. investments) need not timely coincide with the return-on-investment. From this perspective, it makes sense that *accumulated* ICT capital stock (as a more stable and longer term variable) appears to be much more significantly linked with labour productivity and labour used over time than the year-to-year changes in capital.

5.4 Summary – the macro-perspective

This Chapter analysed the economic implications of ICT adoption for industry growth and labour productivity at the sector level, using a standard growth accounting framework and correlation analysis (see Section 5.1). A comparison was made between the GCC industries, here covering the whole NACE Rev. 1.1 Division 26, and the total manufacturing industry. The main findings of this analysis are:

- **Positive but modest ICT contribution to growth**: ICT capital contributes positively to value added growth in the GCC sector as well as in the total manufacturing industry, but the contribution is relatively low for both industry aggregates, typically accounting for 0.1-0.5% of annual growth. There are pronounced differences between countries and periods analysed (see Section 5.2.2)
- **TFP has highest contribution to growth**: Total factor productivity (TFP), the residual that cannot be statistically explained (or accounted for) by the other input factors, accounts for a relatively high share of growth in the GCC sector in most of the countries analysed. This finding is quite specific for capital intensive manufacturing industries such as the GCC or the chemical industry, in particular in comparison to service sectors. It indicates the importance of non-tangible "assets" such as organisational innovation (see Section 5.2.2).
- **Massive increase in ICT capital**: Real fixed ICT capital stock has surged in the GCC industries since the 1990s in nearly all countries analysed. The average annual growth rate (CAGR) from 1995-2005 was 12.8% across the seven EU countries (see Section 5.3.1).
- **ICT capital highly correlated with labour productivity growth**: ICT capital stock is strongly positively correlated with labour productivity growth in the manufacturing industry and even more so in the GCC sector. The correlation with the number of hours worked is negative (at a less significant level). This does not imply a simplistic, direct causality, though (see Section 5.3.2).
- **ICT investments not correlated with labour productivity growth**: In contrast to (accumulated) ICT capital stock, annual ICT investments are not correlated with labour productivity growth and hours worked. This could imply a time lag between the point of investment in ICT and the actual return on investment in terms of productivity growth (see Section 5.3.2).

6 Strategic responses for policy and industry

This chapter draws conclusions on implications for policy and the industry, based on the empirical evidence of ICT adoption and use presented in Sections 3-5. As much as possible, the conclusions are placed into the larger policy framework in order to indicate possibly synergies and links with ongoing initiatives. The activities of the European Commission's DG Enterprise and Industry serve as the main reference framework.[123] After presenting the 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).

6.1 General considerations on possible responses

Is there a need for ICT policy in the GCC sectors?

The empirical findings of this study do not allow any simplified conclusions and recommendations whether and to what extent there is a need for ICT-related policy initiatives specifically for the industries analysed. There is **mixed evidence** in this regard. Some of the findings do not support specific policy attention on ICT. An econometric analysis of the aggregate impact of ICT did not find convincing evidence for substantial productivity or growth effects of ICT capital in this sector (see Section 5). The empirical evidence was not fully conclusive; for instance, while ICT capital was highly correlated with labour productivity growth, investments in ICT were not. Growth accounting found that Total Factor Productivity (TFP), the residual that cannot be statistically explained ("accounted for") by the other input factors, accounts for a relatively high share of growth in the GCC sector. This indicates that the amount of technology in itself (measured in terms of capital stock) is not the key success factor; accompanying factors such as organisational know-how may be key. Case studies in this report tend to confirm this perspective.

Furthermore, the GCC industries are 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 companies and industrial policy than the use of ICT, even if ICT and e-business may play a certain role in these contexts.

On the other hand, the case studies and the representative company survey conducted for this study (see Sections 3 and 4) show that ICT and e-business are widely used even in this traditional sector and play an important role in many companies, in particular the larger ones. Many of the large companies, certainly the global players in the sector, make intensive use of advanced ICT systems to integrate their business processes, for procurement and supply chain management. This was to be expected and is not different to the activity of large companies in other manufacturing industries. Their business activity is characterised by a high degree of automation in production processes and the digitisation of data exchanges and information flows within the company and –increasingly– in their exchanges with suppliers and customers (at least in exchanges with other large companies).

[123] see DG Enterprise and Industry: "Our policies at a glance" (http://ec.europa.eu/enterprise/key_issues/index_en.htm), accessed in November 2009

A specific finding for the GCC industry, however, is the **low level of ICT adoption** and use among **small companies**. The "digital divide" between the large players and the small companies is even more pronounced than in most other manufacturing sectors. Many small companies do not use any ICT systems other than e-mail. One of the reasons is that the characteristics of production can be fundamentally different to those of larger companies. Many SMEs, in particular in the glass and ceramics industry, are highly labour-intensive, as they are selling hand-made products (see business examples in Section 3). Thus, in sharp contrast to the automated production schemes for example of flat glass producers, ICT has only a limited role (if any) to support production in these labour-intensive companies. ICT could help them nevertheless to plan production processes (see case study on Gmundner Keramik, Section 4.3), but only few companies make use of it. All in all, the approach to ICT exhibited by the sector's small companies seems to be too passive and defensive. Non-adoption may be a rational decision in many individual cases, but collective reluctance to go digital could be harmful for the industry as a whole with a view to international competition.

In summary, from a European perspective, the rising importance of ICT and e-business for the competitiveness of companies and, ultimately, industries, should not just be ignored. There are two main objectives that should be addressed:

- **to accelerate ICT-enabled innovation processes** by appropriate measures such as R&D activity, measures to improve the skills base, and awareness raising. This will be important order to sustain and enhance the –still existing– competitive advantage which the European GCC industries have in many segments.
- **to promote ICT and e-business for SMEs**, by addressing adoption barriers such as the widespread lack of understanding

ICT infrastructure and e-business can be seen as an important "**factor condition**" in an increasingly knowledge-based economy **to achieve competitive advantage**.[124]

ICT-related measures as part of a broader industrial policy framework

The studies of the Sectoral e-Business Watch are embedded in the European Commission's policy frameworks for **industrial and information society policy**. ICT is at the interface of these policy domains. In 2005, in consideration of globalisation and intense international competition, the European Commission launched a new industrial policy to create better framework conditions for manufacturing industries in the coming years. The i2010 policy, a follow-up to eEurope launched in 2005, also stresses the critical role of ICT for productivity and innovation (see Section 1.2). The EU is currently devising a new strategy –the "**EU 2020 strategy**"– for the period beyond 2010. This strategy aims to enable the EU to make a full recovery from the crisis, and help speed up the move towards a more sustainable and more innovative economy. The Commission intends to present a formal proposal for the EU 2020 strategy in 2010. In the meantime, a consultation on the future EU 2020 strategy is conducted.[125]

Within this broader frameworks, proposals for specific policy measures in the field of ICT should also be systemically linked with the policy agenda of the European Commission's DG Enterprise and Industry. This agenda includes, as a key area, promoting **sustainable**

[124] cf. Porter 1990

[125] for more information, see http://ec.europa.eu/eu2020/index_en.htm

industrial competitiveness, in which **innovation** plays a central role (see Exhibit 6-1). 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. In a wider sense, the recommendations are also linked with SME policy and the "Lisbon" area of promoting growth and jobs.

Exhibit 6-1: Key policy areas of DG Enterprise and Industry with ICT / e-business links

DG Enterprise policy area *	Key policy documents (for issues analysed in this study)	Initiatives / actions (examples)
ICT for competitiveness & innovation	eBSN report 2003-2009: How public policies help SMEs to thrive by fostering ICT-enabled innovation Modernising ICT Standardisation in the EU - The Way Forward (COM(2009) 324, 3.7.2009 Towards an increased contribution from standardisation to innovation in Europe (COM(2008) 133)	Policies aiming at the ICT sector itself or the use of ICT in other sectors - eSkills policy - ICT standardisation - eInvoicing - eBusiness and SMEs
Industrial competitiveness	Annual Competitiveness Report European Industry in a Changing World - Updated Sectoral Overview 2009 (SEC(2009)1111) Mid-term review of industrial policy (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)	Actions aim at stimulating innovation, competition and investment in know how; guaranteeing a level playing field in the Single Market and outside of it in third countries; and reducing frictions and transaction cost in the European economy, such as administrative burden.
Innovation	Reviewing Community innovation policy in a changing world (COM(2009) 442 final, 2.9.2009) Assessing Community innovation policies in the period 2005-2009 (SEC(2009)1194, 9.9.2009) Challenges for EU support to innovation in services – Fostering new markets and jobs through innovation (SEC(2009)1195, 9.9.2009) Putting knowledge into practice: a broad-based innovation strategy for the EU (COM(2006) 502, 13.9.2006)	- PRO INNO Europe - Europe Innova - EEN - Enterprise Europe Network - EIT - European Institute of Innovation and Technology - Lead Market Initiative
SMEs	Financing Innovation and SMEs (SEC(2009) 1196 final) "Think Small First" - A "Small Business Act" for Europe (COM(2008) 394, 25.6.2009) SMEs - Key for delivering more growth and jobs. A mid-term review of Modern SME Policy (COM(2007) 592, 4.10.2007)	- Small Business Act for Europe - Promoting entrepreneurship - Access to markets - Promoting best practices
Sustainable and responsible business	20 20 by 2020. Europe's climate change opportunity. (COM(2008) 13, 23.1.2008) Reports of the High Level Group on Com-petitiveness, Energy and the Environment	This area covers policies directed towards Corporate Social Responsibility (CSR), and climate change.

* see: http://ec.europa.eu/enterprise/index_en.htm

Linking recommendations of the Competitiveness Studies with ICT

Innovation was also identified as a key success factor specifically for the competitiveness of the glass and ceramics industries. The Competitiveness Studies on these sectors which DG Enterprise and Industry had issued in 2008[126] offer a SWOT analysis[127] for the two sectors and "possible strategic responses", mostly addressing the industry itself. Although there is very little explicit mention of ICT or e-business in these possible responses, some of the points made can easily be linked with ICT and e-business developments as discussed in this study. Exhibit 6-2 aims to identify the role of ICT with a view to the policy recommendations made by the competitiveness studies.

Exhibit 6-2: Strategic responses for policy proposed in the Competitiveness Studies on the glass and ceramics industries and their links with ICT

Strategic responses suggested in the competitiveness studies	Links to ICT and e-business
Seek product leadership The studies recommend that the EU glass and ceramics sectors should build on their strength in value-added products and focus on these segments, by delivering products with superior brands, marketing, design, quality and service. Strategic actions to support this are mainly addressed to industry. They include exploring customer's needs, develop brands, designs and service, focusing on product innovation and strengthening ties in the value chain.	ICT / e-business relevance: ●● (medium) This study finds that many companies in the GCC sectors make only little use e-marketing, e-commerce and online customer service (see Section 3.2.3). Small companies in particular are quite passive in this respect. The economic crisis has distracted many SMEs from considering ICT-based opportunities, as they have to devote all their attention on the current business. On the whole, there is probably still considerable unexploited potential of using ICT for marketing the brands and products of European companies in the sector.
Take advantage of the climate change challenge The studies points towards compliance costs due to environmental legislation and the increasing energy prices as severe challenges. It argues that, on the other hand, demand for energy-saving products may give new opportunities, and the intensified environmental regulation as a driver for innovation. The studies propose several action lines (addressing both industry and policy), such as branding glass as an energy-friendly product, increased R&D in energy, and improving recycling. The ceramics study also points towards energy management systems (EMS) as an "important tool" to assist these goals and suggests that Member States or the EU could "identify the best available technologies or to provide a more diverse eco-label scheme."	ICT / e-business relevance: ● (low) Challenges stemming from environmental legislation and increasing energy prices are clearly a major concern. While these issues are not directly ICT-related, ICT systems can support the monitoring and reporting of energy consumption and greenhouse gas emissions (see Section 3.3.3). These are rather new applications which are not yet widely adopted. It is recommended to promote and possibly support the adoption of related systems, in order to facilitate the compliance of EU companies with environmental regulation.

[126] Studies by ECORYS SCS Group (2008a, 2008b), conducted on behalf of DG Enterprise and Industry – see also Annex I.

[127] An analysis of the specific strengths and weaknesses of the European industry, and the opportunities and threats that arise from these strengths and weaknesses when viewed against general developments in the business environment.

An efficient and flexible production process: investment in technology and systems The studies conclude that the capability for developing and implementing new technology is among the strengths of the EU glass and ceramics sectors and should be further enhanced. The studies propose increasing R&D in automation technology, stating that this "must primarily be the industry's responsibility". The ceramics study also refers to EU RTD programmes as a means to support innovation.	ICT / e-business relevance: ●●● (high) The degree of automation in their production schemes is clearly a critical success factor for competitiveness, in particular for medium-sized and large companies. This study confirms the important role of ICT in this context; not only to enable the automation of production processes themselves (see examples in Section 3.2.2), but also the integration of production processes with supply chain management and customer service (Sections 3.2.3, 3.2.4), and the role of ICT for process innovation in general (3.3.2). Industrial R&D is needed to further develop automation technologies. When it comes to the adoption and use of ICT in this context, skills (both organisational skills and individual ICT skills) are critical (see following issue).
Increase skills base EU companies still have a competitive advantage in terms of core competencies. They should build on this strength. The study recommends to support life-long-learning initiatives. Skills needed for automation technology are explicitly mentioned. Addressees: Industry, Member States, EU	ICT / e-business relevance: ●● (medium) The sufficient supply of ICT specialists is therefore an important success factor to sustain product leadership. Currently, there is no critical shortage of ICT practitioners (see Section 3.1.3), but the demand could increase when the economy recovers.[128] It is recommended to take measures to ensure the adequate supply of ICT professionals in Europe that help companies maintain their technology-based product leadership.
Support a level playing field The studies point towards competitive disadvantages for EU producers caused by less strict regulation in other regions, in particular in environmental regulation. The recommendations, which address mainly policy (EU and Member States), are to reduce tariff and non-tariff barriers, to foster market pull for sustainable products, the evaluation of potential effects of new regulation and to fight counterfeiting.	ICT / e-business relevance: -- (none) There are no direct links to ICT and e-business in this respect that emerged from this study. Indirectly, to some extent, specific ICT systems can help companies complying with regulation (by supporting internal monitoring, data collection and reporting procedures) – see above.

The following specific suggestions (Section 6.2-1) can therefore be considered as add-ons to the above mentioned general recommendations, rather than as completely different issues. They also address the competitiveness of European enterprises in the sectors discussed. 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.

[128] see study by IDC / empirica (2009)

6.2 Recommendations for strategic responses

Overview

Against these general considerations, the study findings suggest four priority areas for measures to support the competitiveness of the European GCC industries through ICT and e-business. Specific measures within each priority area are addressed to policy and / or industry. All suggestions should be considered as part of a general industrial policy in which innovation plays a central role. Any specific measures to create a favourable framework for ICT adoption should ideally be embedded in a larger innovation policy framework. Some of the proposed strategic responses are sector specific, others are horizontal and apply to other sectors as well. The study proposes the following priority areas to enhance and exploit ICT-enabled innovation potential in the GCC industries:

Exhibit 6-3: Strategic responses to foster the competitiveness of the GCC industries in the EU

Domain	Strategic response	Addressee(s)
Skills	**Improving e-business skills of SMEs** (sector specific) Measures aiming at narrowing the pronounced "digital divide" in the sector by supporting the development of e-skills in SMEs; possibly with a specific focus on marketing, sales and customer service.	1. Competence centres, regional development agencies 2. Industry 3. Member States / regions (3. EC)
Standards	**Promoting agreements on standards and architectures for e-business within sectoral value chains** (sector specific) Consider sectoral initiatives to facilitate data exchanges within the sector and with its main supplier and customer industries, e.g. by agreeing on e-business standards.	1. Industry (2. Member States & EC as facilitators)
Regulatory	**Continue improving the framework conditions for e-business by removing legal uncertainties** (horizontal) The EC and Member States should continue their efforts to improve the framework conditions for e-business in Europe, in particular by harmonising the legal framework. Initiatives in the field of e-invoicing are a good example.	1. EC 2. Member States
Regulatory	**Use ICT to facilitate compliance with environmental regulation** (horizontal) Explore opportunities to make it easier for companies to comply with legal requirements (e.g. ETS, REACH) through using ICT.	1. EC 2. Member States

6.2.1 Improving e-business skills of SMEs

Several sector studies conducted by the Sectoral e-Business Watch in recent years discussed the implications of the "digital divide" between large and small companies in e-business practices, notably when it comes to advanced forms of data exchange.[129] This hampers the network effect of e-business and reduces the potential of productivity gains on the aggregate (industry) level.

This study finds that the digital divide in the GCC industries is probably even more pronounced than in most other manufacturing sectors. Many small companies do not use any ICT systems other than e-mail. Nearly half of all small companies in the sector say that none of their processes are conducted electronically (see Section 3.2.1), and the use of e-commerce (both with suppliers and with customers) is much lower than in other manufacturing sectors (see Sections 3.2.3 and 3.2.4).

It is acknowledged that it may be perfectly economically rational for individual companies not to make investments in ICT and e-business.[130] Companies base their decision on anticipated returns from the investment in relation to the costs. The challenge for many small firms, however, is to **take an informed decision**. Interviews with managers / owners of small firms from the sector indicate show that they often just do not have the time and opportunity to consider ICT-related issues (see, for instance, business example in Section 3.2.1). As a result, they do not have a proper understanding of how ICT could be useful for their company. This implies a risk that the ICT approach exhibited by the small companies of this sector is too passive and defensive, simply due to a lack of e-skills. If so, the decision not to invest in ICT may be short-sighted. The **opportunity cost** of non-investment may be higher than those of investment in ICT, even in consideration of the huge challenges which SMEs are confronted with due to the constrained economic conditions.

Against this background, sector-specific **actions to improve the e-business skills of SMEs** could be considered. Possible measures include awareness raising and targeted provision of information about ICT solutions for SMEs. This suggestion addresses in particular industry associations, SME support organisations, knowledge-transfer centres and regional development agencies. Currently, the promotion of ICT and e-business to their members is not on the agenda of most industry associations of the GCC sectors. They might consider to add this topic to their portfolio.

[129] Examples are the studies on the pulp and paper industry (2006) and on the chemical, rubber and plastics industry (2007). In both sectors, large companies are advanced ICT users, while many of the small companies are rather late adopters with little ICT use.

[130] For a more detailed discussion of rational choices for / against investments in ICT from a game theory perspective, see the Sectoral e-Business Watch study "An economic assessment of ICT-related industrial policy" by empirica and DIW econ (2009).

Exhibit 6-4: Strategic response 1: improving e-business skills of SMEs

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 • Awareness raising and information activities (road shows, workshops) • Establishment of peer-to-peer platforms where SMEs can exchange their experiences
Stakeholders to be involved:	• Industry associations in the glass, ceramics and cement industry • SME support centres with a dedicated role to promote the knowledge transfer (e.g. e-competence centres) • Other intermediaries such as chambers of commerce • Business advisors working with SMEs • Regional and national e-business policy makers • Large companies from the sector (in order to leverage their relations with suppliers)
Links with DG Enterprise industrial policy:	• e-Skills policy of DG Enterprise and Industry • 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: one of the action lines focuses on "upgrading the skills in SMEs". • The "promoting entrepreneurship" and "promoting best practices" action lines within the SME policy of the DG

6.2.2 Promoting agreements on standards for e-business within sectoral value chains

"e-Business", understood as the **digitalisation of business processes** within and between enterprises, is an opportunity to improve the competitiveness of European enterprises, raise productivity and customer satisfaction. As shown in Section 3.2.1, almost 70% of all companies in the GCC industries (by their share of employment) confirmed that they conduct at least some of their business processes electronically. This trend is irreversible. Sectors and companies that are faster in climbing the e-maturity ladder towards more advanced forms of electronic data exchanges have a competitive advantage over other companies and industries.

However, the study also shows that e-business with suppliers and customers is not as widespread in the GCC industries as in other sectors. This focus of ICT use in the GCC industry is on improving the efficiency of internal processes, in particular those related to production. Data exchanges with suppliers and customers are only of secondary importance for many companies. Small companies in particular are hesitant to adopt e-business. Thus, there is clearly scope for improvement.

Apart from structural conditions, one of the reasons for the delayed adoption of e-commerce could be that the industry itself has not taken any coordinated initiatives to advance e-business. In several other manufacturing sectors, the industry has launched initiatives to promote and facilitate electronic data exchanges within the sector and with the main supplier/customer sectors. The approaches differ, as the following examples show, while the goal to facilitate e-business is essentially the same.

- 22 leading companies of the **chemical and oil industries** founded in 1999 "**Elemica**" to facilitate supply chain process integration and collaboration in the sector. Today, Elemica is a major B2B connectivity hub that integrates disparate enterprise business systems and processes. It presents a unified network for all its customers, suppliers and third party service providers. The slogan is: "connect once – connect to all" (see http://www.elemica.com/)
- The **paper industry** has developed the **papiNet** e-business standard to support supply chain processes in the forest and paper industries. papiNet dates back to 1999, when a group of paper producing companies, together with major customers from the publishing industry, started a project to develop XML-based transaction standards adapted to their business needs (see http://www.papinet.org/).
- In the **steel industry**, Eurofer, the European Federation of Iron and Steel Industries, supported the development of the European Steel Industry Data Exchange Language (**ESIDEL**) standard. ESIDEL version 1.0 was introduced in 2004.[131]

In general, the broad agreement on widely used standards among companies should be in the interest of the industry as a whole. A Sectoral e-Business Watch study on ICT-related industrial policy[132] refers to possible market failures in electronic value systems due to a lack of interoperability: "*If large firms invest in proprietary e-business solutions so that small firms can use their e-business solutions for data exchange with specific firms only, the small firms' risk of becoming locked-in is high. In contrast, compatible e-business solutions or the use of common platforms increase the expected number of trading partners and thus tend to decrease efficiency losses due to inefficiently low investments.*"

In an expert survey conducted for the same study, 82% of the respondents agreed that there is a "lack of widely used e-business standards that impedes e-business communication". There was also almost unequivocal agreement that electronic data exchange between companies in general needs to be improved (89% agreement) and that electronic data exchange between large companies and SMEs needs to be improved (96%). These findings certainly apply to the GCC industries.

Experts also supported the view that the EC and Member States should foster regional or sectoral electronic networks of ICT-using companies. A recent study by the e-BSN (2007) about sectoral e-business policies (2007) concluded that "*initiatives with a sectoral focus are not successful per se*", but "*can certainly be recommended*".[133]

Based on these considerations, the industry could consider initiatives to either promote the use of existing e-business standards among companies, or to copy initiatives which other sectors have taken to facilitate e-business (see examples above).

[131] see case study on ESIDEL in the Sectoral e-Business Watch sector study on the steel industry (2008), available at http://www.ebusiness-watch.org.

[132] "An economic assessment of ICT-related industrial policy" (2009), study by empirica and DIW econ, see http://www.ebusiness-watch.org.

[133] see European Commission (2007a), p. 26.

Exhibit 6-5: Strategic response 2: promoting agreements on standards for e-business

Possible measures:	• Industry associations might adopt the issue of electronic standards in their agenda and promote their use among member companies • Initiate sectoral pilot projects where companies jointly develop e-business architectures and agree on data exchange formats • Consider industry-led initiatives to facilitate e-business in the sector, for example by developing standards adapted to the needs of specific segments of the glass, ceramics and cement industries.
Stakeholders to be involved:	• Industry associations and federations • Large companies from the sector • Standardisation organisations and e-business experts • EC / Member States (through support and coordination of pilot projects)
Links with DG Enterprise industrial policy:	• Work of the eBSN – eBusiness Support Network, in particular its pilot projects to harmonise architectures in different sectors (eBSN could consider to launch a project in the GCC industries) • ICT standardisation policy as part of the policy area "ICT for competitiveness & innovation"

6.2.3 Improving the framework conditions for e-business by removing legal uncertainty

A specific business process which is well suited to be digitised is invoicing. The migration to **structured electronic invoicing** has been on the agenda of European institutions and a number of Member States for some years and is receiving increasing policy encouragement. In business, large enterprises have taken the lead and are eager to adopt e-invoicing. Sector studies by e-Business Watch confirm the fast adoption over the past few years. In the GCC industries, 35-40% of the companies said that they sent and/or received electronic invoices in 2009. On average, these companies estimated that they sent about 18% and received about 14% of their invoices as e-invoices, if all variations such as signed PDF documents and EDI-based invoices are included (see Section 3.2.1).

However, there are still complex issues to be solved in order to exploit the full potential. For all the evidence that e-invoicing is already an accepted and rapidly growing practice, there are still barriers standing in the way of wider adoption, especially by smaller businesses and particularly when it comes to cross-border e-invoicing. This includes technical, business and legal barriers. A central issue of debate in recent years used to be legal uncertainties for companies, as it still not entirely clear which e-invoicing practices would comply with legal requirements for invoices concerning VAT regulation. Companies stressed that there was a strong need for harmonisation of the legal frameworks in the European Union.

Work of the Expert Group on e-Invoicing

The European Commission has early responded to this challenge. Initially, an informal Task Force on e-Invoicing was set up in 2006/07. It concluded in its final report (July 2007) 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).[134] This led to the implemented of an **Expert Group on e-Invoicing** in early 2008 to make suggestions how the framework conditions shall be improved. The Expert Group has recently (in November 2009) submitted its final report.[135] The report proposes a European Electronic Invoicing Framework (EEIF). The report specifies an ambitious vision for e-invoicing in Europe, including the following objectives:

- Within five to eight years, structured e-invoicing will become the predominant invoicing method throughout Europe.
- The legal and tax environment for the conduct of e-invoicing will have been harmonised across all Member States.
- Trading parties will have a wide choice of solutions and services to support e-invoicing, which may be conducted on a bilateral basis directly between counterparties, or through service providers of various kinds.
- End-users and SMEs in particular will be using low-cost and user-friendly solutions and services that can be easily accessed and integrated with internal systems as well as being interoperable with external systems.

To achieve these objectives, the Expert Group has made six recommendations which are detailed in the report:

Recommendations of the Expert Group on e-Invoicing (2009)

The Expert Group recommends …

1) *… meeting the needs of SMEs as a priority focus, by concentrating on a number of specific business requirements;*
2) *… the harmonisation of and the provision of clarity for the legal and VAT framework across the EU on the basis of equal treatment between paper and e-invoices and supported by a Code of Practice prepared by the Expert Group;*
3) *… the creation of an e-invoicing eco-system that provides maximum interoperability and reach;*
4) *… that all actors within both the private and public sector adopt a common invoice content standard and data model – the UNCEFACT Cross-Industry Invoice (CII) v.2;*
5) *… the establishment of an organisational process for implementation of the EEIF at Member State and EU level;*
6) *… the wide communication of the key messages of this report.*

Source: Final Report of the Expert Group on e-Invoicing (Nov. 2009)

This study confirms the relevance of the work of the Expert Group. It is strongly recommended to continue the efforts to improve the framework conditions for electronic data exchanges in the single market, in particular through the harmonisation of and the provision of clarity for the legal and VAT framework across the EU.

[134] European Electronic Invoicing – Final Report of the Informal Task Force on e-Invoicing, Version 3.2 final, July 2007.

[135] DG Enterprise and Industry: Final Report of the Expert Group on e-Invoicing (Nov. 2009), see http://ec.europa.eu/enterprise/newsroom/cf/document.cfm?action=display&doc_id=5544&userservice_id=1 (accessed in November 2009).

In this regard, the Expert Group points out that "*a consistent national implementation of the proposed new Invoicing Directive and any further evolution of this legislation is a pre-condition for the creation of a common legal framework across Europe*." The report recommends that Member States should "*eliminate any national discrepancies with the harmonised provisions of European legislation, thereby removing the unnecessary complexity that is currently a major barrier for technical interoperability*."

Exhibit 6-6: Strategic response 3: improving the framework conditions for e-business by removing legal uncertainty

Issues to be addressed / possible measures:	• Address the recommendations made by the Expert Group on e-Invoicing (November 2009) • Establish 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) • Large enterprises (as the pioneers and multipliers for e-invoicing)
Links with DG Enterprise industrial policy:	• e-Invoicing is a key topic within the "ICT for competitiveness & innovation" policy. This includes work of the e-Invoicing Expert Group and former activities of the eBSN • Industrial competitiveness policy (actions to reduce frictions and transaction cost in the European economy, such as administrative burden) • SEPA – Single Euro Payments Area

6.2.4 Use ICT to facilitate compliance with environmental regulation

Compliance with environmental legislation is a challenge for many companies in the glass, ceramics and cement industries and has significant implications for their competitiveness. Important regulation in this context include the EU Emissions Trading System, the Directive IPPC (Integrated Pollution Prevention and Control, 96/61/EC) and REACH (Regulation Concerning the Registration, Evaluation and Authorisation of Chemicals, EC 1907/2006).

The Competitiveness Studies on the glass industry (ECORYS SCS Group, 2008a) concludes in the SWOT analysis (in the threats section) that "environmental regulation is a major cost component in most sub-sectors" and that "the main challenge is that non-EU producers, especially from developing countries, have significantly less strict environmental legislation" (p. 138).

While these issues are not directly ICT-related, ICT systems can at least facilitate the compliance with regulations, as they help companies monitoring and reporting their energy consumption and greenhouse gas emission levels. However, such Energy Management Systems (EMS) are not yet widely used. Only about 20% of the companies in the sector (by their share of employment) said they used an ICT-enabled EMS (see Section 3.3.3). On the other hand, about 50% of the companies believe that EMS hold a high or at least medium potential for improving energy efficiency. It is therefore recommended to promote and possibly support the adoption of ICT systems for energy and emissions management, in order to facilitate the compliance of EU companies with environmental regulation. The goal

should be to maximise the potential of ICT to make the compliance with these regulations as efficient as possible – for both sides, the companies and the regulatory authorities.

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 GCC sectors) and provide targeted information about opportunities to SMEs.

Exhibit 6.2-4: Strategic response 4: use ICT to facilitate compliance with environmental regulation

Possible measures:	• Stakeholder coordination, e.g. agreement on processes and interfaces for reporting procedures in close cooperation with ICT vendors • Provide information, in particular to SMEs, about available software solutions for energy and emissions management (EMS)
Stakeholders to be involved:	• European Commission • European and national industry federations • Large companies from the sector • ICT service providers offering EMS solutions
Links with DG Enterprise industrial policy:	• Sustainable and responsible business (climate change) • Innovation policy • Industrial competitiveness (reducing transaction cost in the European economy through administrative burden)

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Kevin Bream, European Commission, DG Enterprise and Industry, 09 February 2009, Brussels.

Jean-Francois Mottint, Head of Intelligence Unit, CEMBUREAU, 01 April 2009, Brussels

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Annex I: Secondary data sources

EU KLEMS Growth and Productivity Accounts

The analysis of the economic impact of ICT at industry level (as presented in Chapter 5) is based on data from the EU KLEMS data base, as provided by the Groning Growth Development Centre (GGDC). The EU KLEMS Growth and Productivity Accounts (http://www.euklems.net) are the result of a research project, financed by the European Commission, to analyse productivity in the European Union at the industry level. The data base includes measures of economic growth, productivity, employment creation, capital formation and technological change. It contains data breakdowns for 63 industries, based on the NACE classification revision 1.1, for most of the EU-25 member states, Australia, Japan and the USA (EU KLEMS, 2008).

Sources that were used to create the EU-KLEMS data series are largely 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 data base 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.[136]

The variables contained by the EU KLEMS data base that were used for this study are:

- **fixed ICT capital** stock by sector (K_ICT),
- **investments in ICT** capital by sector (Iq_ICT),
- **labour productivity** by sector (LP_I), and
- **hours worked** by persons engaged in the sector (H_EMP).

Depending on the country concerned, the length of the available time series varies. The following table illustrates the data availability on EU KLEMS for the GCC sectors and the total manufacturing industry. Due to limited data availability, our analysis will focus on nine European countries during the years of 1991 and 2005. These countries are Austria (AUT), Denmark (DNK), France (FRA), Germany (DEU), Finland (FIN), the Netherlands (NDL), Italy (ITA), Spain (ESP) and the United Kingdom (GBR). However, specific data about ICT capital such as investments in ICT is not available for Spain and France (marked in Exhibit A1-1). Therefore, these two countries can only be considered in the analysis of growth accounting results, but they cannot be included in the analysis of the relationship between ICT capital and productivity growth and employment dynamics respectively.

[136] For more information about the data base, 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/.

*Exhibit A1-1: EU KLEMS data availability in the glass, cement and ceramic industry**

Country	Investments in ICT	Real fixed ICT capital stock	Labour Productivity	Total hours worked by persons engaged	Number of persons engaged
	(Iq_ICT)	*(K_ICT)*	*(LP_I)*	*(H_EMP)*	*(EMP)*
DK	1970-2005	1970-2005	1970-2005	1970-2005	1970-2005
DE	1991-2005	1991-2005	1970-2005	1970-2005	1970-2005
ES	x	x	1970-2005	1970-2005	1970-2005
FR	x	x	1970-2005	1970-2005	1970-2005
IT	1970-2005	1970-2005	1970-2005	1970-2005	1970-2005
NL	1970-2005	1970-2005	1970-2005	1970-2005	1970-2005
AT	1976-2005	1976-2005	1970-2005	1970-2005	1970-2005
FI	1970-2005	1970-2005	1970-2005	1970-2005	1970-2005
UK	1970-2005	1970-2005	1970-2005	1970-2005	1970-2005

* Nace Rev. 1.1: 26

Source: EU KLEMS

EU competitiveness studies on the glass and ceramics industry

In 2005 the EC set out an integrated approach to industrial policy with horizontal and vertical initiatives. The Mid-term Review of Industrial Policy in 2007 concluded that this approach has been successful and should be continued. In this context, in order to further improve the evidence and understanding of conditions affecting the competitiveness of specific industries, the European Commission's DG Enterprise and Industry issued in 2007 a Framework Contract of Sectoral Competitiveness Studies (No. ENTR/06/054). Under this contract, the first set of competitiveness studies was commissioned towards the end of 2007, including the glass and ceramics sectors.

The Terms of Reference identified five key requirements for these studies:

1. The collection and presentation of key data about the sectors
2. A synthetic literature review
3. An assessment of the industry's competitive position on EU and global markets
4. An analysis of regulatory and other framework conditions which have an impact on the competitiveness of the EU glass industry
5. A strategic outlook

The studies were conducted by ECORYS SCS Group, Rotterdam, in cooperation with other international research and consulting organisations.

The two study reports (glass, ceramics) can be downloaded from the DG Enterprise and Industry web portal for the non-metallic mineral products industry at:

http://ec.europa.eu/enterprise/non_metallic_mineral_products/ (accessed in April 2009)

Annex II: Methodology report: e-Business Survey 2009

Background and scope

The Sectoral e-Business Watch has been collecting data relating to the use of ICT and e-business in European enterprises by means of representative surveys since 2002. The survey of 2009 among companies from the glass, ceramics and cement industries consisted of 676 telephone interviews with ICT decision-makers in six EU countries. Interviews were carried out in March 2009, using computer-aided telephone interview (CATI) technology.

Questionnaire

The questionnaire contained about 90 questions which were structured into the following modules:

- A: Use of ICT systems and e-business software
- B: e-Commerce and automated data exchange
- C: e-Standards and interoperability issues (Project 1)
- D: Innovation activity and the role of ICT
- E: ICT skills requirements
- F: ICT investments
- G: ICT, energy efficiency and emissions
- H: Background information about the company

Some of the questions were the same or similar to those used in previous surveys, partly to enable comparisons with other sectors. Other questions were newly introduced or substantially modified, in order to reflect recent developments and priorities. A special focus in this survey was to assess the degree of process automation in companies, i.e. to what extent paper-based and manually processed exchanges with business partners are substituted by electronic data exchanges.

Some questions were filtered, for example follow-up questions which were only relevant for companies depending on their answer to the entry question. No open questions were used.

The survey questionnaire (as well as those used in previous e-Business Watch surveys since 2002) can be downloaded from the project website (http://).

Population and sampling

The survey population was defined as companies with at least 10 employees[137] which used computers, were active within the national territory of one of the six countries covered, and which had their primary business activity in the glass, ceramics or cement industry as specified by NACE Rev. 2 Groups 23.1-6. Exhibit A.2-1 shows the distribution of interviews across the different sub-sectors. 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.

The sample drawn was a stratified random sample of companies from the population in each of the six countries, with the objective of fulfilling minimum strata with respect to company size-bands per country-sector cell (see Exhibit A.2-2).

[137] Evidence from previous surveys shows that computer use can be expected to be 99% or more in all sectors among medium-sized and large firms.

Exhibit A.2-1: Population coverage of the e-Business Survey 2009 in the glass, ceramics and cement industries

No.	Sector name	NACE Rev. 2 activities covered	Population definition	No. of interviews conducted
1	Glass and glass products	23.1	Companies using computers and having at least 10 employees	159
2	Refractory products	23.2		20
3	Clay building materials	23.3		75
4	Other porcelain and ceramic products	23.4		60
5	Cement, lime and plaster	23.5		25
6	Articles of concrete, cement and plaster	23.6		337

Exhibit A.2-2: Strata by company-size

Size-band	Quota	
	Target quota	Actual quota (int. conducted)
Micro enterprises (up to 9 employees)	--	--
Small companies (10-49 employees)	up to 55%*	54% (365)
Medium-sized companies (50-250 employees)	at least 35%*	34% (227)
Large companies I (250-999 employees)	at least 10%*	10% (71)
Large companies II (1000+ employees)	as many as possible	2% (14)

Samples were drawn locally by fieldwork organisations based on official statistical records and widely recognised business directories, such as Dun & Bradstreet, Heins und Partner Business Pool and Hoppenstedt Bonnier Information.

Fieldwork

Fieldwork was coordinated and conducted by the German branch of Ipsos GmbH (http://www.ipsos.de), in cooperation with local partner organisations in some of the countries covered (see Exhibit A.2-3) on behalf of the Sectoral e-Business Watch.

Exhibit A.2-3: Institutes that conducted the fieldwork of the e-Business Survey 2009 in the glass, ceramics and cement industry and number of interviews conducted per country

Country	Institute conducting the interviews	No. of interviews conducted
France	Ipsos GmbH, 23879 Mölln, Germany	87
Germany	Ipsos GmbH, 23879 Mölln, Germany	180
Italy	Demoskopea S.p.A., 20123 Milan, Italy	101
Poland	IQS and Quant Group Sp.z.o.o, 00-610 Warszawa, Poland	120
Spain	Ipsos Spain, 28036 Madrid, Spain	125
UK	Ipsos GmbH, 23879 Mölln, Germany	64
TOTAL		**677**

Pilot interviews prior to the regular fieldwork were conducted with about 15 companies in Germany in February 2009, in order to test the questionnaire (structure, comprehensibility of questions, average interview length).

Non response: In a voluntary telephone survey, in order to achieve the targeted interview totals, it is always necessary to contact more companies than just the number equal to the target. 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 A.2-4 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 raises 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 (be it telephone- or paper-based).

Exhibit A.2-4: Interview contact protocol, completion rates and non-response reasons

		DE	ES	FR	IT	PL	UK
1	**Sample (gross)**	**2301**	**2171**	**828**	**1001**	**847**	**943**
1.1	Telephone number not valid	251	0	41	51	40	114
1.2	Not a company (e.g. private household)	23	52	4	6	22	12
1.3	Fax machine / modem	4	0	5	1	0	1
1.4	Quota completed → address not used	438	557	0	37	0	0
1.5	No target person in company	217	34	155	41	68	72
1.6	Language problems	1	0	0	0	15	0
1.7	No answer on no. of employees → not used	1	3	0	1	1	0
1.8	Company does not use computers	0	9	0	1	0	0
1.9	Company <10 employees	38	152	10	5	15	24
	Sum 1.1 – 1.10	**973**	**807**	**215**	**143**	**161**	**223**
2	**Sample (net)**	**1328**	**1364**	**613**	**858**	**686**	**720**
2.1	Nobody picks up phone / answering machine	97	169	57	0	39	143
2.2	Line busy, engaged	0	0	0	0	5	0
2.4	Contact person refuses	504	721	322	561	287	236
2.5	Target person refuses	383	197	62	92	34	173
2.6	no appointment during fieldwork possible	1	0	7	15	58	28
2.7	open appointment	151	128	72	80	119	72
2.8	target person is ill / cannot follow the interview	1	0	0	0	0	0
2.9	Interview abandoned	11	24	6	9	26	4
2.10	Interview error (→ interview cannot be used)	0	0	1	0	11	0
	Sum 2.1 – 2.10	**1148**	**1239**	**527**	**757**	**579**	**656**
3	**Successful interviews**	**180**	**125**	**86**	**101**	**107**	**64**
	Completion rate (= [3]/[2])	**14%**	**9%**	**14%**	**12%**	**16%**	**9%**
	Average interview time (min:sec)	**14:23**	**15:57**	**15:06**	**16:57**	**17:24**	**14:54**

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 in 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 (http://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, not allowing any reasonable presentation of results. Thus, weighting is required so that results adequately 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: weighting by employment and by the number of enterprises.[138]

[138] 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.

- Results weighted 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 that there are many more micro-enterprises than any other firms. If the weights did not take into account the economic importance of businesses of different sizes in some way, the results would be dominated by the percentages observed in the smallest size-band.
- Results weighted by the number of enterprises: Values that are reported as "x% of enterprises" show the share of firms (as legal units) that use a certain technology or activity, irrespective of their size, i.e. a small company and a large company 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.

The results for filtered questions can be computed on the base of not only those enterprises that were actually asked the question (e.g. "in % of enterprises buying supplies online"), but also on the base of "all companies". In the study, both methods are used, depending on the variable and the issue to be analysed. The base (as specified in footnotes of tables and charts) is therefore not necessarily identical to the set of companies that were actually asked the underlying 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 A.2-5 gives some indication about the level of accuracy that can be expected for industry totals (based on all respondents) and for specific break-downs, depending on the weighting scheme applied. The confidence intervals[139] differ depending on the break-down and the respective value. On average, it is 3-5 percentage points (+/-, and in both weighting schemes) for the sector total. Confidence intervals are higher for sub-sectors and specific break-downs: about 5 points for the cement industry, and up to 10 percentage points (+/-) for the glass and the ceramics industries.

The calculation of confidence intervals is based on the assumption of (quasi-)infinite population universes. In practice, however, in some countries the complete population of businesses consists of only several hundred or even a few dozen enterprises. 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 borne in mind when comparing the confidence intervals of e-Business Watch surveys to those commonly found in general population surveys.

[139] A confidence interval indicates how likely a specified interval is to contain the given parameter. This is determined by the (i) confidence level and (ii) the selected confidence coefficient. For example, in the survey, the result might be that 40% of enterprises use a certain software application. A "90% confidence interval" for the proportion in the whole population of enterprises using the same technology might be "37% to 43%", which means that the actual adoption value will be within this interval with a likeliness of 90%. In Exhibit A.2-5, the 90% confidence intervals have been calculated for specific percentage values and segments of the sample.

Exhibit A.2-5: Confidence intervals

	Survey result	Confidence interval								
		if weighted as "% of firms"			if weighted by employment			Unweighted		
GCC total	**10%**	**7.8%**	**-**	**12.8%**	**7.5%**	**-**	**13.2%**	**8.3%**	**-**	**12.1%**
NACE 23.1 (Glass)	10%	5.9%	-	16.4%	5.6%	-	17.2%	6.7%	-	14.6%
NACE 23.2-4 (Ceramics)	10%	5.9%	-	16.3%	5.5%	-	17.6%	6.7%	-	14.7%
NACE 23.5-6 (Cement)	10%	7.1%	-	13.9%	6.8%	-	14.6%	7.7%	-	12.9%
GCC total	**30%**	**26.4%**	**-**	**33.9%**	**25.9%**	**-**	**34.5%**	**27.2%**	**-**	**33.0%**
NACE 23.1 (Glass)	30%	22.8%	-	38.4%	22.0%	-	39.4%	24.4%	-	36.3%
NACE 23.2-4 (Ceramics)	30%	22.8%	-	38.3%	21.8%	-	39.7%	24.3%	-	36.4%
NACE 23.5-6 (Cement)	30%	25.1%	-	35.4%	24.4%	-	36.2%	26.2%	-	34.1%
GCC total	**50%**	**45.9%**	**-**	**54.1%**	**45.3%**	**-**	**54.7%**	**46.8%**	**-**	**53.2%**
NACE 23.1 (Glass)	50%	41.5%	-	58.5%	40.6%	-	59.4%	43.5%	-	56.5%
NACE 23.2-4 (Ceramics)	50%	41.5%	-	58.5%	40.3%	-	59.7%	43.4%	-	56.6%
NACE 23.5-6 (Cement)	50%	44.4%	-	55.6%	43.6%	-	56.4%	45.7%	-	54.3%
GCC total	**70%**	**66.1%**	**-**	**73.6%**	**65.5%**	**-**	**74.1%**	**67.0%**	**-**	**72.8%**
NACE 23.1 (Glass)	70%	61.6%	-	77.2%	60.6%	-	78.0%	63.7%	-	75.6%
NACE 23.2-4 (Ceramics)	70%	61.7%	-	77.2%	60.3%	-	78.2%	63.6%	-	75.7%
NACE 23.5-6 (Cement)	70%	64.6%	-	74.9%	63.8%	-	75.6%	65.9%	-	73.8%
GCC total	**90%**	**87.2%**	**-**	**92.2%**	**86.8%**	**-**	**92.5%**	**87.9%**	**-**	**91.7%**
NACE 23.1 (Glass)	90%	83.6%	-	94.1%	82.8%	-	94.4%	85.4%	-	93.3%
NACE 23.2-4 (Ceramics)	90%	83.7%	-	94.1%	82.4%	-	94.5%	85.3%	-	93.3%
NACE 23.5-6 (Cement)	90%	86.1%	-	92.9%	85.4%	-	93.2%	87.1%	-	92.3%

confidence intervals at α=.90