Emerging technologies to support indirect procurement: two case studies from the petroleum industry

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This paper discusses the use of emerging Internet technologies to support indirect (non-production oriented) procurement processes. We provide an overview of objectives and available technologies and outline some of the critical success factors and key decision points. Two case studies from the Petroleum Industry help demonstrate the concepts.

Keywords: electronic commerce, procurement, outsourcing, internet, petroleum industry, case studies

1. Introduction

The Internet and Internet-based technologies are impacting businesses in many ways. New technologies are promising to save costs, to improve customer and supplier relationships, business processes, and performance, and to open new business opportunities. They allow firms to respond better to existing challenges and improve the anticipation of future developments. As has been the case with earlier innovations, rich multi-facetted interactions are occurring between developments in the marketplace, global business environment, work environments, and technical innovation [10].

One area that has recently gained attention is Business-to-Business procurement which encompasses the purchasing of goods and services as well as higher-level management tasks and logistics. While traditional use of information technology (IT) has been complex back-end applications supporting production-oriented procurement and supply-chains of large companies (the traditional area of EDI-systems), a recent tend is focusing on user-friendly front-end applications supporting non-production-oriented procurement by non-purchasing experts. A variety of systems has emerged that promised significant benefits to buying firms, such as streamlining purchasing processes, increasing contract buying and improving the leverage of corporate buying power as well as spending information and control.

A closer look at the market of available solutions, however, reveals a certain immaturity as well as rapid evolution. Vendor strategies are often poorly defined and constantly changing. The number of operational customer implementations is limited, albeit growing. Individual attempts to connect inter-organizational business processes

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and to interchange information are often undertaken independently from each other, and, due to a lack of commonly accepted standards, lead to incompatible results.

This paper addresses the use of electronic commerce technologies to support indirect (non production-oriented) procurement processes. We discuss the implications of emerging e-procurement systems on internal purchasing processes and external relationships, and outline some of the critical success factors and key decision points that firms have to consider in order to utilize the technologies in an optimal way. Two examples from the petroleum industry are used as showcases to clarify the concepts. By presenting results from case and field study research, we address researchers as well as business managers who want to understand how emerging technologies are affecting purchasing practices. The paper provides a basis for further conceptual research efforts as well as quantitative studies.

The next section presents a general overview of the technologies used to support procurement processes and highlights some of the benefits that early adopters are trying to achieve. This provides the basis to identify a number of critical decision points that need to be considered in the context of designing and implementing an e-procurement strategy. In section 4, we present two case studies from the Oil & Gas Industry that help point out the impacts of emerging e-procurement systems on purchasing processes and organizational structures. Section 5 outlines some of the limits of currently available systems and provides an outlook.

2. Emerging technologies to support procurement – objectives and technology overview

Based on the purpose of the acquired goods, procurement activities are often divided into direct, production-related procurement and indirect, non-production-related procurement [40]. Table 1 summarizes the characteristics of items usually associated with direct vs. indirect procurement.

Direct procurement occurs in manufacturing settings only, and it encompasses all items that are part of finished products, such as raw material, components and parts. Concepts and practices such as material resource planning (MRP), supply chain

Table 1
Direct vs. indirect procurement items – adapted from [18,25].

Direct, production-related materials	Indirect, non-production related items and services
Scheduled	Not scheduled
Production items	Miscellaneous items
Usually no shelf items	Usually shelf items
Inventory accounts	Expense and asset accounts
Buyers' desktops only	Everybody's desktops
No approvals	Approvals required
Bill of materials	Aggregated catalogs

management and Computer Integrated Manufacturing gained much attention, in particular during the 1980s and as a response to the leadership of Japanese manufacturers over their U.S. and European competitors. Significant efforts in research and management practices resulted in the emergence of innovative methods in logistics, capacity planning, and inventory management as well as sophisticated IT systems to span organizational boundaries supporting replenishment and logistics [13,25]. They helped firms become flexible enough to respond to constantly changing customer requirements, while still allowing them to stay cost effective, and, thus, to remain competitive in increasingly open markets.

Indirect procurement activities concern all items and services that are not directly part of a finished product. Compared to production-oriented procurement, the picture of indirect is usually much more diverse. Purchasing is often done by non-purchasing experts, as well as by the central purchasing unit. Purchases include a broad variety of items, ranging from "simple" office products to parts for maintenance, repair, and operations (MRO), such as lubricants or spare parts, to complex construction-related items and to various services. Purchases usually occur on an infrequent basis and demand is difficult, if not impossible, to predict.

In order to keep control of the complex matter, non-supply chain related purchasing processes tend to be organized in a particularly complex and inefficiently fashion, and until recently, IT support has played a minor role.

2.1. Re-organizing indirect procurement – the objectives

In recent years, firms have been discovering the potential of indirect purchasing as an area that can help achieve cost cutting goals and improve competitiveness. In particular, since the early 1990s, business process analysts propagated a change from a purchasing function that is mainly clerical and transaction-oriented to a more strategic one [9,24,26]. It was not until recently, however, that supporting technologies became available that could help make this shift feasible and economically worthwhile on a broader basis.

Case examples as well as industry surveys show a number of common objectives, and business practices that are frequently implemented in the context of re-organizing indirect purchasing processes [10,25,33,34,37]. They are partly interrelated:

- The *decentralization of day-to-day purchasing operations* can help eliminate the purchasing department as the "middleman" between end users in need of a particular item or service, and suppliers. In the process, end users are being empowered to select items and services and to follow requisitions through the approval process. By allowing them to generate requisitions and purchase orders as well as to handle receiving and payment, process time and administrative overhead can be saved. As a result, the availability of goods is improved, which, again, allows lower inventories and, thus, might hold additional cost savings.
- Through the institutionalization of end user purchasing, companies also hope to *increase contracted buying.* Centrally stored multi-vendor catalogs can help guide

end users toward a set of pre-contracted items and prevent them from "buying from their friends down the street". Cost savings occur from the discounts that are often reflected in pre-negotiated arrangements.

● Increasing the use of supplier contracts throughout a company bears potential to increase the *leverage of corporate purchasing power*. Large, decentralized buying companies tend to rate this point as key and expect most significant savings from re-negotiating long-term contracts with their suppliers as a result.

● In many companies, indirect buying is not very well documented. Consequently, there is only poor information about spending patterns and little process trans- parency. Similarly, supplier performance cannot be assessed. *Monitoring buying patterns* as well as *improving supplier management* through better performance in- formation can help identify additional areas for cost savings as well as enable fast reactions to changing business requirements.

● Finally, many examples show firms trying to decrease their, often enormous, sup- plier base and try to *tighten the links with a small number of preferred suppliers*. In exchange for the promise to provide a supplier with an ongoing relationship and with a significant amount of business, price reductions and/or improved service lev- els are expected, as well as the willingness to participate in electronic procurement solutions. At the same time, and especially when getting online, buying companies value the possibility of being able to *switch suppliers* easily.

The next section presents an overview of new web-based technologies designed to change the picture of complex and inefficient purchasing processes and to achieve the goal of a "strategic purchasing department".

2.2. Technology overview

Although the use of information technology (IT) has quite some tradition in purchasing, it has often been limited to the support or automation of transactional operations within the purchasing department like CD-ROM based catalogs or electronic forms. Electronic Data Interchange (EDI) systems support communication beyond organizational boundaries and automate the exchange of structured messages between independent computer applications, often over private networks (VANS) [35].

The advent of the Internet and World Wide Web opened up many new opportu- nities for the support of procurement [7,22,23,27].

● *Internet-based online stores* have been popular since the early days of commercial Internet-use. The so-called merchant servers address mainly the sell-side (providing support for sellers) and help businesses set up store on the Internet, including online catalogs and ordering functionality [1]. Although, most applications, such as Amazon.com, 1-800-Flowers, or OpenMarket focus on retail selling between business and end-consumers, the general concept also applies within the business- to-business context.

- *Internet and Web based electronic market places* are extending the idea of online stores and try to build communities, often in vertical markets. In addition to supplier directories they offer industry news and other information of interest to participants, including buyers and suppliers. The directories of different suppliers, however, are usually not integrated with each other, displaying a yellow pages-type structure, which means that buyers have to search through a number of catalogs in order to do comparison-shopping. After early large-scale efforts failed (Industry.Net), more focused environments have been initiated. So far, they proved somewhat more successful with the electronics industry being one of the forerunners: Asian Sources, Manufacturing.Net, Digital Market, Chemdex. OilOnline provides information and news for the petroleum industry. Occidental Chemical recently announced an online procurement project together with six other petrochemical companies and manufacturers that will support collaboration with materials suppliers [39].

- Several companies specialize in *multi-supplier online catalog* services. Examples are EDI-provider Harbinger and Thomas Register that is publishing its paper and CD-ROM based supplier catalogs on the Web. Besides supplier directories, it also offers customized catalogs and helps suppliers get online and upload their data. In this context, the management of catalog content is one of the most critical issues. It includes the categorization of products and suppliers and the elimination of duplicates in efficient ways. Although there are no uniform schemas today, a number of standards enjoy relatively widespread use. Among the most important are Dun and Bradstreet, Universal Product Code, and Thomas Register. CommerceNet is currently administering a major project with the goal of developing a standard for interoperable catalogs [11].

The practical use of online stores, electronic market places, and online catalogs is currently limited within business-to-business procurement settings for several reasons. First, their paradigm basically consists of one seller interacting with multiple buyers. It does not truly support the interaction between one buyer and its multiple suppliers – a common need, especially among large buying companies. In addition, support for internal business processes is usually not included, and catalog content is mostly generic and not customized to the individual buying company. Finally, the Internet access cannot be considered a given, yet it is mandatory to access the systems; in fact, some companies insist on intranet-based solutions for security reasons.

In recent years, a *new generation of purchasing systems* has been introduced that applies a different paradigm. Systems by companies such as Ariba Technologies and Commerce One are specifically designed to enable end user requisitioners to order supplies directly from a multi-vendor catalog and, thus, support the self-service [34]. Compliance with corporate purchasing rules is ensured with the help of, in some cases quite sophisticated and flexible, workflow systems to support approval routing. Integration with backend systems facilitates reporting and allows to track purchasing and spending patterns. While purchasing operations are performed by end users, central purchasing is usually responsible for setting up and maintaining the systems, for in-

corporating suppliers into the network, and for negotiating blanket order agreements and long-term contracts.

Taking this concept one step further, new forms of IT also support *procurement outsourcing* in various forms. Company such as IBM Global Services, EDS, or Corpro 2000 takes responsibility for procurement activities in the area of non-production purchasing and/or provide the IT applications to realize their automation [38]. In particular for smaller market players, outsourcing agreements promise a highly welcome way to participate in Internet commerce. They are offered the opportunity to get online at reasonable cost and set up and maintain customized multi-vendor catalogs. Larger firms value savings in administrative overhead, especially in the context of non-strategic procurement that full-service providers are offering.

Finally, emerging technologies start to offer support for an area, which has not yet seen much automation: negotiations [30,32]. Online auctions – a very simple mechanism of negotiation confined to price alone – achieved much attention, especially in the business-to-consumer area (Onsale.com), as well in the consumer-to-consumer market (Ebay.com). Companies, however, are still hesitant to adopt auctions as a way to do purchasing [5]. To date, more complex negotiation processes are rarely supported by new technologies and innovative, dynamic pricing schemes are evolving very slowly [4,6,12]. Pittsburgh-based FreeMarket Online, Inc. is among the small number of firms that offer electronically supported Requests for Quotes (RFQs) [21]. While utilizing the Internet and related technologies, the process still involves much "manual" work by the service provider.

3.   Choosing an electronic procurement solution

In the preceding section, we introduced a number of IT solutions to support and automate indirect procurement. In order to utilize the new technologies and realize the benefits to full extent, however, a number of decisions need to be made. The following section sketches out a number of decision points.

After identifying the objectives of the project (see section 2), the scope of the e-procurement project needs to be determined, regarding the products and services as well as the processes that are affected. Other points include vendor selection and choosing a business model for catalog content and supplier management as well as the degree of integration with ERP and other systems.

3.1. Scope

Two main dimensions determine the scope of an electronic procurement solution: the range of products and services that it covers and the functionality it provides.

Not every category of goods and services is equally suited to be supported by electronic procurement solutions. As an example, goods and services can be divided according to their level of complexity (risk) and their strategic importance for the firm (profitability) [28]. Variables to be considered include delivery terms, number of

available suppliers, pace of technological change, and complexity of logistics. "Low hanging fruit" includes standardized items that do not require much information and explanation, that allow for digital handling, and involve high transaction volume and high degree of distribution, and for which the transparency of the supplier market is low.

Similarly, a decision has to be made as to which parts of a purchasing transaction should be covered by the system. Each buying activity consists of several steps including an information phase, negotiation, and settlement including payment and after-sales activities. Upon the design of an electronic purchasing solution decisions have to be made as to which steps to include and to support or automate. In addition to automating processes as-is, new process designs might become feasible, including the shift of activities between central purchasing and end user requisitioners, and the introduction of innovative forms of negotiations, pricing structures or payment methods.

3.2. Vendor selection

Similar to the decision process regarding the scope of a project, the vendor selection process has several dimensions. Best-of-breed solutions by vendors, dedicated to a small range of products, compete with established market players offering a broad range of products. Outsourcers provide alternatives to in-house solutions for procurement applications and services.

Since the mid 1990s, a number of new companies (Ariba, Commerce One, Elekom, Netscape, Concur) started to explore the market for self-service oriented tools and services to support indirect procurement and tapped into niches left open by established market players. Not much later, broader focused enterprise resource and planning (ERP) providers (Oracle, SAP), for example, began to view the procurement front-ends as a natural extension of their products and started to offer similar modules.

As a result, two basic options are available both of which have advantages and disadvantages.

In addition to their software solutions, many vendors also feature additional services that are often provided in collaboration with strategic partners. Examples are catalog content management and support for suppliers to get online, or implementation services. The scope and intensity of its business partnerships can support the vendor selection process to the extent that it reflects some sort of quality assurance.

The outsourcing of IT systems as well as procurement tasks has long provided an alternative to retaining responsibilities in-house. Traditional forms of outsourcing tend to focus either on IT functions or procurement activities, such as sourcing and vendor managed inventory concepts. In the context of emerging technologies new forms are being facilitated combining both approaches, e.g. application and catalog hosting [34].

3.3. Catalog content and supplier management: Internal vs. external solutions

Multi-vendor catalogs, displaying items and services of different supplier companies, are central to electronic procurement systems. Blending data from different

Table 2
Vendor selection: Best-of-breed vs. comprehensive solutions.

Feature	Best-of-breed/sole solution providers	Established vendors of comprehensive solutions (ERP)
Focus vs. Vision	Focus on limited range of products – concentration on core competencies No constraints by previously defined IT architectures and underlying business models	Need to support broad range of products and large number of installations can limit ability to focus Integration of applications into a larger whole – helps realize a broader vision
Flexibility vs. Experience	Small customer base allows flexibility and responsiveness to customer needs	Robust software development concepts, experience
User friendliness	Friendly user-interfaces as major success factor	Took time to match requirements regarding ease of use and intuition
Brand name	Uncertain future – early stages of financing, tight competition expected	Established brand names, large customer bases, market power
Implementation efforts and real-time integration	Stand alone solutions not always available – need to install backend systems and databases and establish additional links and interfaces Real-time integration not always available	Backend systems and front end applications from one source. Number of additional links limited

suppliers into a comprehensive catalog is critical to the success of most projects. Again, companies face a range of options reaching from the do-it-yourself approach to complete outsourcing. Decisions have to be made with regards to where the catalog data will be hosted (and controlled) and regarding the question of who is put in charge of content management and data integration. Again, each solution has advantages and disadvantages [17].

- *Do-it-yourself.* Many large buying companies prefer to control the multi-vendor catalog. They chose the option of hosting the catalog on their systems, sometimes shielded from their core internal functions by a single firewall. This solution guarantees maximum control over the data including customized views on products, suppliers, and prices. It also provides a flexible basis for reporting on spending

patterns and supplier performance. On the other hand, this solution requires significant efforts, such as setting up and maintaining electronic links with suppliers, integrating data of different data formats into a single meta structure (or convincing suppliers that they have to comply to a certain standard) and creating a number of views on the catalog data for different users.

- *Catalog management services.* Many companies decide to use a third party service provider for catalog data management and supplier ramp-up. The services of companies such as Harbinger or TPN Register range from setting up electronic links to suppliers and vendors, to complete data management services, to establishing initial contact with suppliers. Third party vendors are usually able to handle data in many formats ranging from simple flat files to real-time links between ERP-systems. Pricing structures vary according to individual requirements. In some cases, buying companies subsidize suppliers in order to help them get online. Some catalog providers are specializing in certain industries, such as the petroleum or the manufacturing industry. This means that new customers can take advantage of an existing online supplier base.

Security issues play a role in addition to the cost of the different solutions, especially in cases where payment and other sensitive information are sent over the Internet. Not all companies are comfortable with using the Internet, some insist on intranet-solutions which can be shielded from the public Internet, and let third parties handle the connections with the suppliers. In other cases they let suppliers upload their data via ftp onto specially assigned servers.

3.4. Integration with other applications

Several factors need to be considered in order to answer the question of how tightly electronic procurement solutions should be integrated with existing ERP applications: the existing IT environment plays a role as well as available IT capabilities. Not all of the small vendors offer real-time links between their systems and major ERP systems. On the other hand, not all user companies require such tight links: in some cases, availability checks are considered unnecessary since supplier agreements are guaranteeing 48 to 72-hour deliveries.

Real-time integration between systems can pose a performance problem on the overall system if the IT architecture is not built up to it, especially as soon as the number of end users reaches beyond pilot stage figures.

3.5. Critical success factors

Electronic procurement solutions should not be viewed as stand-alone applications, but rather as part of a larger environment. Not only do they have to be integrated with other applications inside the firm, they also need to provide some interaction with the outside world. Upon system design, user companies need to be aware of the current status of the market and monitor its developments. We have identified seven factors

that can help choose a vendor and that might ultimately determine the success of a vendor.

1. *Content management* – the ability to manage content in an efficient way.

2. *Supplier connectivity* – the ability to attract a significant number of suppliers, necessary to create a critical mass.

3. *Scalability* – the ability to scale systems beyond pilot stage, including large numbers of users and line items.

4. *Security* – the ability to handle security issues efficiently and effectively.

5. *Meeting functional requirements and responsiveness* – the ability to respond quickly to customer requirements, in addition to providing a broad functional scope.

6. *Development skills* – the ability to build robust systems using innovative methods and technologies.

7. *Strategic alliances* – the ability to partner with key market players.

The market of electronic procurement systems shows signs of immaturity. After a number of small players have been trying to position themselves and to establish their ideas, major software vendors are now starting to enter the market, inducing changes to the market dynamics. In the area of content management in particular, no standards have emerged yet and effective leadership has not yet been established [36].

4.   Two case studies from the petroleum industry

In order to reorganize procurement with the help of innovative technologies and to optimize the benefits that they can provide, the specific situation of a firm needs to be taken into account. In the following, we use two examples from the petroleum industry to demonstrate the use and the impacts of electronic procurement systems.

4.1. Market overview

The business in the petroleum industry is divided into two main types of activities: upstream activities include exploration, production, and procurement of crude oil; downstream activities include refining, transportation, and sales of petrochemical products such as motor gasoline, jet fuel, industrial oils, or lubricants. Both types are currently facing particular challenges.

On the upstream side crude oil prices are falling steadily, especially since late 1997, and the trend is expected to continue [14,29]. The reason is that many producers in the Middle East and elsewhere need the revenues from oil for short term reasons, preventing a significant reduction in supply. Impacts of global competition are quickly becoming common place, making cuts in operating costs imperative. One of the results has been a reduction of employment in U.S. petroleum businesses of more than

400,000 jobs since the early 1980s – about a quarter of 1997's workforce of 1.5 million workers [2,19]. In some cases, job losses in North America are being compensated by new jobs overseas.

At the same time, exploration and production processes are becoming increasingly complex and capital intensive. Advancements in technology help exploit oil fields more efficiently than in the past and have led to the discovery of more proven oil reserves than ever before. These achievements, however, do not come cheaply and require complex research methods, sophisticated exploration setups, and expensive production facilities. Technology is fast becoming one of the primary success factors of the industry. Companies offering seismic, sensing, and well-management services are on the rise. They are becoming as integral part of the oil industry as Intel and Microsoft are of the computer industry.

A major part of the upstream business of U.S. oil companies is being conducted in less developed countries such as the former Soviet Union, South America (Venezuela), Africa (Nigeria, Angola), and China, often with unstable political situations and poor infrastructure. Transfer of technology know-how is usually mandatory and contracts require extensive and complicated negotiations up front. Alliances are becoming common place, as are multi-billion dollar joint ventures ranging over several tens of years. In 1993, Chevron, number three in the U.S. American oil industry, started a $20 billion, 40-year joint venture with the Republic of Kazakhstan. At the time, the project was the largest joint venture with a single western corporation in the former Soviet Union.

In summary, while crude oil prices are falling, oil production becomes increasingly complex and requires significant research efforts. Often, intense negotiations precede a long-term contract.

The situation at the downstream side of the business is similarly complex and tight, as gasoline prices, especially, tend to reflect price changes of crude oil. Overall growth rates are low compared to other industries. In its 1996 International Energy Outlook, the U.S. Department of Energy estimated that the demand for oil would grow at a rate of 2% worldwide over the next 15 to 20 years. Given that this figure includes fast growing developing countries and was estimated prior to the recent economic turmoil in South East Asia, it might even have to be considered as too high. For the U.S., an increase of 1.2% in the demand for oil is expected over the next 10 years [20].

Throughout the petroleum industry, complex regulations require substantial efforts to assure quality and compliance. As in many low growth industries, competition and margins are tight. In order to maintain or even gain market share, industry players constantly have to develop new products or improve quality standards; in addition, marketing expenses are often substantial.

To complicate matters, companies often face environmental concerns that can even lead to open rejection and boycott demands. This happened to Exxon with the Exxon Valdez oil spill off the Alaskan coast in 1989 or to Shell in 1995 as it faced a fierce debate over the disposal of one of its redundant offshore petroleum installations.

The consequences are costly, again, as companies are spending quite significant dollar amounts on public relations[1] including environmental or social programs.

Finally, strategic alliances have to be considered a critical issue. In 1998, a "round" of market consolidation was kicked off with the merger of British Petroleum and U.S. based Amoco, and followed by the acquisition of Mobil Oil by Exxon (the two largest U.S. based petroleum companies), and the buy-out of Belgian-based Petrofina by the French Total. These developments will sharpen the picture of an industry that already includes some of the world's largest companies [15]. With $8.46 billion of profits in 1997 and $120 billion in revenues, U.S. Exxon Corp. ranked number one globally. With $128 billion of sales in 1997, Royal Dutch/Shell is currently Europe's largest company and ranks 3rd on a global basis, while British Petroleum, the second largest British company ranks 26th globally in terms of market value (at $70 billion in revenues). Further mergers are expected in the near future. Potential candidates are second tier players, which are currently lacking large companies' economies of scale.

Given their size, many players in the oil industry are enjoying massive buying power, although they are not always making use of it. Instead, purchasing is often organized either in a very centralized way with the result of complex processes and enormous administrative overhead. In other cases, a rather decentralized structure fails to reap the benefits from consolidated corporate buying power.

4.2. Direct vs. indirect procurement

In the petroleum industry, direct procurement consists of crude oil and natural gas and is usually not handled by Central Purchasing, but by specialized departments. It accounts for a significant share of the overall business in an otherwise very capital-intensive industry, i.e., 30 to 40% of revenues. Like other commodities, crude resources are traded in future markets, where prices are highly volatile and time sensitive. Price determination involves macroeconomic variables such as economic growth, weather, specifics of demand and supply, and, very importantly, geopolitical factors. In many ways, the market for oil and gas resembles the markets for foreign exchange or gold with interventions by public institutions and companies deciding on their inventories not only according to demand expectations but also based on expected price developments. Trades involve the physical presence of brokers, speculation, options and hedging mechanisms, contracts, and bids [31,40]. In many cases, prices are finalized only at the time when the oil leaves the harbor or according to similar variables.

With direct procurement of oil and other natural resources being handled by special departments, the purchasing department handles indirect procurement (material and services). Procurement under the supervision of the purchasing department accounts for 14 to 16% of revenues [8,31]. On one hand it concerns relatively simple items in the area of maintenance, repair, and operations (MRO), such as valves, pipes, and

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[1] See for example the extensive Web sites that have been established by both companies to cover the events and to provide a platform for discussion: http://www.oilspill.state.ak.us/exxon.html and http://www.shellexpro.brentspar.com/shell/brentspar/respectively.

fittings, office supplies, and computer equipment. On the other hand, it includes complex equipment, e.g., for exploration, drilling, and refining, and, in particular, services such as pumping, drilling, and maintenance services [16].

Given the size and organizational structure of many companies in the oil industry, sourcing, ordering, supplier management, as well as the monitoring of purchasing patterns tend to be difficult tasks, especially in the case of service procurement. Contracts are usually complex and nationally and internationally dispersed. Poorly integrated IT infrastructures inhibit efficient communication processes, especially across operating companies, and make a free flow of information difficult. As a result, companies report problems in leveraging their purchasing power through mechanisms like contract buying or blanket orders, especially in the area of service procurement. Overall, procurement processes tend to be cumbersome, slow and expensive – a benchmarking study by CAPS estimates purchasing costs of 32 cents for each dollar of goods and services for the petroleum industry [8].

4.3. Emerging technologies to support procurement in the oil industry

As was pointed out in the preceding discussion, many players in the oil and gas industry are very large companies. This means that electronic commerce applications are usually in place for the communication of purchase orders, invoices, or payment. Frequently used inter-organizational IT applications include EDI, EFT (electronic funds transfer), bar code receiving, and evaluated receipt settlement [8]. The applicability of these links, however, is limited in several ways.

EDI, for example, is expensive and setup costs of $100,000 per business partner are not uncommon. As a result, EDI links are only justifiable for pre-defined situations and processes and for high transaction volumes. Especially small and medium businesses are hesitant to adopt EDI systems and in many cases only do so when forced by their (mostly larger) business partners. In addition, EDI technology is not very well suited for the communication of structured messages with the need for immediate interaction. Traditionally, EDI has been done over dedicated lines or using the services of VAN (value added network) providers. While this solution allows for high security and reliability standards, it also adds significantly to the cost of EDI and makes it a non-flexible solution.

CAPS' 1998 benchmark study identified a number of ways petroleum companies utilize emerging technologies, including the Internet and intranet applications, ranging from industry, supplier, and market research, support for purchasing operations and statistics, to asset recovery, external benchmarking, and Web pages displaying agreements.

In the following, we use two case studies to outline how procurement processes can be changed with the help of Internet technology combined with sound management methods. While BPXA chose an outsourcing approach to lower its MRO supply costs, Chevron is installing a web-based desktop purchasing system in the context of a major

overhaul of its indirect procurement function. The case studies demonstrate much of what has been outlined above.

4.4. Case 1: British Petroleum Exploration (Alaska)

In 1995, British Petroleum's Exploration branch in Alaska (BPXA) started an outsourcing project with the objective of reducing the costs for maintenance, repair, and operation (MRO) supplies [3]. BPXA, which explores and develops oil and gas reserves in Alaska and manages the company's interest in the Trans-Alaska pipeline, is the largest of BP's international group of companies based on reserves. During the project, BPXA handed over responsibility for MRO supplier management and MRO purchasing operations to Fairmont Supply (http://www.fairmontsupply.com), a distributor of MRO supplies with an annual sales volume of $256 million (1998). The outsourcing agreement includes all steps from requisition to payables as well as warehouse operation.

As a result of the new arrangement, the company is expecting cost savings of as much as $5.5 million annually from process improvements and lower prices. Inventory reductions might account for another $11 million. As a share of BPXA's overall annual MRO procurement of $35 million these savings are quite significant. Although the figures are still small compared to BPXA's total spend of $740 million (see table 3), the case could become an example for other business areas.

Procurement at BPXA used to focus primarily on securing low prices from a large number of suppliers, not unlike other big organizations. Emphasis is now put on the elimination of redundancies, process management via performance metrics, and process improvement through integrated supply. Fairmont Supply administers and executes agreements of BPXA with a small group of MRO local suppliers. Since the beginning of the outsourcing agreement, the integrator has helped reduce BPXA's

Table 3
Annual spend at BPXA – source [3].

Type of items and services		Annual spend (Million dollars)
Drilling, maintenance, and engineering		640
Equipment and services, bought from OEMs	Drilling and well services	40
	Chemicals and fuels	17
	Compressors, turbines, and pumps	8
Maintenance, repair, operating (MRO) supplies	Building supplies, industrial hardware, instrumentation, mobile equipment, pipe and fittings, telecommunications, valves, office supplies	35
Total		740

supplier base from more than 1000 MRO suppliers located all over the U.S. to less than 30, all of which are located in Alaska. As a result, transportation cost decreased, which, in the past, could add up to as much as 12% of total MRO expenditures.

The small network of core suppliers has been expanded to the second level, including another 250 vendors. The local character of BPXA's network helps strengthen the links between the companies involved and further insures synergies.

In addition to supplier management, BPXA's outsourcing partner handles procurement operations and in that context helped unify the process which used to be done in six different ways. Although being one of the objectives of the re-organization project, not all suppliers are EDI capable as of yet. Of the 24 core suppliers, only three are fully EDI enabled; twelve receive orders via fax, some are even unsure what EDI is all about. In order to reach its goal, BPXA actively helps smaller suppliers get online. Apart from EDI and other electronic commerce systems this may also regard other, more general systems, e.g., for maintenance management. In addition to EDI, EFT and bar-coding systems are introduced, as well as systems interfacing with logistics programs.

As an outcome of the project, BPXA's procurement division can now concentrate on more strategic activities such as planning, innovation, and continuous process improvement. For example, BPXA's buying team selects strategic suppliers and negotiates agreements, which are then used by the outsourcer distributor. The efforts promise to result in lower costs for both partners, with purchasing and its internal customers receiving improved service, and the distributor getting a greater share of BPXA's business.

MRO was chosen as an area for improvement because it was especially transaction intensive and therefore costly. Besides pure cost reductions, the new arrangement also helps suppliers and BPXA's buyers get closer and intensify information exchange.

Savings are expected from product standardization, application improvement, buying power leverage, supplier consolidation, and suppliers focusing on core competencies. In addition, an inbound logistics program helps gain additional savings.

The performance of the procurement integrator is measured in several different terms. Measures for internal customers of procurement include delivery dates versus promised dates, fill and error rates of orders, and price via a market basket. Meaningful measures for managers include cost of goods, cost to buy, and inventory. BPXA's purchasing group is developing performance standards that help secure project success and identify areas for future improvements. Suppliers are actually rewarded a percentage of the savings that BPXA incurs. The same is true for Fairmont Supply.

4.5. Case 2: Chevron

With a total of $40 billion in revenues, San Francisco-based Chevron is currently the U.S. third largest Petroleum Company (second after soon-to-be-merged Exxon and Mobil). Operating in roughly 100 countries the company of close to 40,000 employees reported a net income of $3.2 billion in 1997. Chevron's purchasing budget amounts

to $9.9 billion per year (excluding raw materials, such as crude oil). Two thirds of the budget is spent for services, including pumping and construction services and oilrig leases, one third for materials and other supplies. Commodities such as valves, pipes, and fittings account for the biggest shares in MRO purchases [34].

In 1994, Chevron started a major effort to overhaul its corporate procurement function. In order to improve the balance between centralized and decentralized supply chain management purchasing was realigned by moving more than 400 buyers out to the operating companies which are dispersed nationally as well as internationally. With this move, decentralized order placement was facilitated as well as decentralized coordination of local contracts and alliances, local planning and forecasting. Central purchasing was put in charge of more general functions such as alliance contracts, identification and implementation of best practices, training and development as well as systems implementation, support, and maintenance.

In the same context, Chevron also started to consolidate its supplier base, which included almost 60,000 suppliers in 1994. Three years later the number was reduced to 38,000. Two hundred of these suppliers are considered alliance partners accounting for as much as 27% ($2.7 billion) of Chevron's annual spend. Although the percentage of contracted buying has already more than tripled between 1994 and 1997, which allowed Chevron to realize savings of $400 million, the project is still far from its medium-term goal of 60%. Especially in the service area, contract spending is still very low.

During the past years Chevron has been implementing several best purchasing practices including:

- alliances and supplier management initiatives;
- purchasing cards for low dollar transactions;
- asset redeployment initiatives;
- electronic commerce applications (EDI, autofax, Internet);
- small business program.

Information technology has been identified as a key factor to help glue the different efforts together. Since 1993, Chevron started to implement ERP systems from SAP and J.D. Edwards for accounting, material and inventory management. Later, an Intranet was deployed to help MRO buyers keep track of preferred suppliers, alliance information, purchasing best practices, and sourcing information.

However, when buying functions needed to be made accessible to the occasional user in addition to the purchasing experts, both systems, SAP and J.D. Edwards turned out to be too difficult to handle. User interfaces were too complex and the processes of finding materials and issuing purchase orders were so cumbersome that users started to invent workarounds in order to make their lives easier.

Soon, it became clear that the targeted increase in expenditures under alliance contracts was not achievable with the current ERP-based purchasing solution. In 1997, the project team decided to implement an additional procurement front-end specifically

designed to help end users perform purchasing activities and channel them to alliance suppliers. The system included the following elements:

- central database with information about materials, services, vendors, and contracts;
- customized electronic catalogs, fully priced and accessible throughout the corporation;
- electronic forms and electronic commerce such as EDI and EFT to support the submission of purchase orders, invoices, price updates, and evaluated receipt settlement, i.e., payment upon receipt.

The project promised immediate cost savings in two ways through reduced administrative overhead and processing time and discounts from alliance buys compared to off-contract buys. Future savings were expected from renewed contract negotiations, where Chevron would be able to leverage its corporate purchasing power to fuller extent.

The electronic procurement solution had to meet several requirements:

- ease of use, especially for the occasional user;
- integration with existing and projected enterprise resource planning systems;
- compliance with Chevron's individual purchasing needs, particularly regarding services and complex items.

In 1998, Chevron started to pilot a desktop purchasing system. While first aimed at handling Chevron's business with contracted suppliers, the system will eventually be enlarged to cover all of the company's procurement. Plans are that during the first stages, 400–450 users will be given access to the system, mainly buyers of the departments. The next stage will include all buyers (about 2000 people), and eventually the system will reach all end users with purchasing authority. After implementation throughout the U.S., international sites will also be included. Figure 1, depicts the scope and the stepwise approach. Figure 2 shows the functional architecture.

The system allows employees to source multiple supplier catalogs; to fill in a requisition form and have it routed through the approval process; and to issue a purchase order. Apart from information about products, services, and contracts, the system also gives access to compliance data of suppliers and other attributes.

Chevron chose a two-fold solution involving software and services from Ariba Technologies and Harbinger (formerly Acquion), a provider of EDI and electronic catalog services. While Ariba's Operating Resources Management (ORM) system is used as a Web-based front end and user interface for catalog search and purchase order and requisition creation, Harbinger facilitates the interaction with the suppliers. It manages catalog content and takes care of the current customer base and supplier ramp-up. The procurement system will be integrated tightly with Chevron's two ERP systems, SAP and J.D. Edwards.

Ariba's ORM system was chosen in part for its intuitive interface that makes it easy to use for the occasional non-professional buyer. The system is flexible enough to
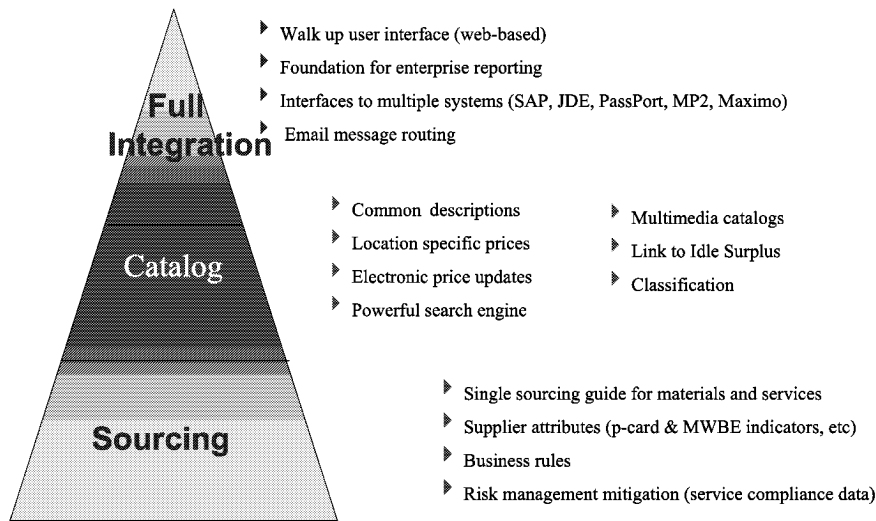
*e*Procurement Scope

Figure 1. Scope of Chevron's eProcurement Project.

display a large number of different items, including services and third party catalogs. The latter is important as Chevron plans to integrate the new procurement solution with other applications such as its excess inventory management system, FasTrack.

After the pilot phase, Chevron started to roll out system in early 1999. In the initial phase, three operation companies were included: an upstream production company located in Bakersfield, Houston-based Overseas Petroleum, and the IT department located in San Francisco. The initial group of 30 users is scheduled to reach more than 200 by June of 1999 and 3000 by the end of 1999 upon full rollout. Additional supplier catalogs will be added as required by the individual operating company; an estimated 20 suppliers per month. This will be done in cooperation with Harbinger, which already has a significant portion of Chevron's suppliers as customers.

Chevron estimates a total of $10–13 million in tangible savings per year, to be achieved through simplified sourcing and procurement ($3 million), more effective catalog management ($0.5 million), improved data accuracy, reconciliation, and reporting ($2 million), and increased alliance utilization ($5–6 million). The costs for the procurement and catalog front-end were estimated at $6–8 million. Chevron essentially considered the project an "incremental investment on a huge investment", i.e., an add-on to the three-digit million dollar ERP implementations to achieve the expected benefits. It chose two sole-solution suppliers, mainly because the ERP vendors were unwilling and unable to provide them with the required functionality.

In addition to the IT system itself, the new system also led to a number of organizational and cultural changes. The project team identified the following issues as particularly important:
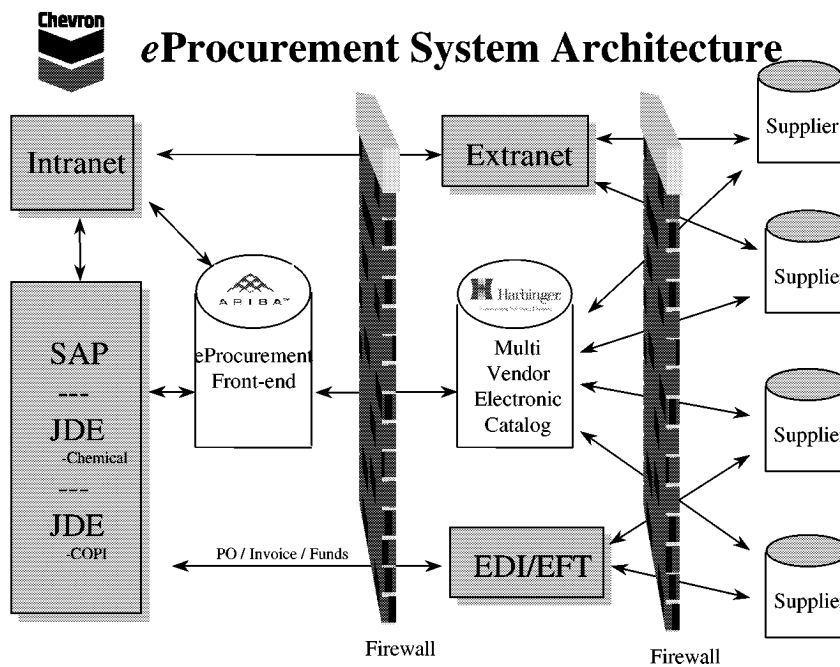
Figure 2. System architecture.

- central ownership and control of catalog data and price updates;
- maintenance of business rules for managing views of catalog data;
- re-alignment of roles and responsibilities in the context of master data maintenance;
- introduce accountability for using the new system including rewards for users.

Regarding the use of innovative technologies in procurement, Chevron is an early mover. Systems available at the time of the project design were limited in terms of scope and scale. After reaping the "low-hanging fruit", support for the procurement of sophisticated technical equipment, for complex service agreements, and for large-scale projects will become key in order to reach the initial vision. So far, the vendors responded well to Chevron's specific needs, e.g., by developing a module to support service procurement. Additional functions still need to be implemented such as real-time integration with back-end systems.

5. Summary and outlook

In this paper, we provided an overview of how emerging technologies can impact indirect procurement processes and pointed to the key decision points in the context of their use. Two case studies from the petroleum industry served as showcases to illustrate the issues.

The petroleum industry is characterized by relatively low growth rates, tight cost structures, and increasing competition. The industry is shifting from a commodity market towards a high tech industry where the access to technologies, knowledge, and services is key. Companies are internationally dispersed and, as a result, often not leveraging their full corporate power. This is especially true for procurement.

Emerging technologies can help automate procurement operations and enable end users to satisfy their needs without having to go through central purchasing. The systems can also help enforce corporate purchasing policies and monitor purchasing patterns centrally. This, in turn, enables tighter relationships with suppliers as well as better leverage of corporate buying power.

Currently available systems do not yet include all the functionality that is needed by oil companies. In particular, support for the procurement of services has not yet been addressed extensively. Other areas include support for the management of excess material (within and between companies), as well as support for the management of large projects. With the industry becoming more high-tech oriented, increasing specialization is already visible. Collaboration between otherwise independent players will become commonplace and not be feasible without adequate IT support.

Particularly in the area of desktop purchasing systems, developments are still in an early stage. Startup companies such as Ariba Technologies and Commerce One dominate the scene, while the numbers of adopters are still very small. ERP vendors, such as SAP and Oracle started to enter the market, tightening the competition. New niches are opening up, such as content or supplier management. Similarly, plug and play solutions for small market players (buyers and suppliers) are still missing, as are sophisticated tools to support negotiation and bidding processes.

Like in other industries, consolidation trends as well as the availability of electronic commerce systems point to an increase in power on the buyer side. On the supplier side, mergers and acquisitions might become the necessary answer in order to match the counterparts in power and size. Other possibilities include alliances, which can well be supported by emerging technologies (virtual organizations) and ventures into new business areas like MRO distributor W.W. Grainger that is offering purchasing outsourcing services. More research on the current trends is necessary to comprehend the implications to their full extent.

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