Application Service Providing as Part of Intelligent Decision Support for Supply Chain Management

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Abstract

A prominent trend in the software industry in the late 1990s was the development of the application service providing business model. Application service providers (ASP)[1] offer their customers access to software applications via a network instead of installing them on the customer's in-house computer system. ASPs host and manage applications from a central location and charge a fee for their services. Nevertheless, there are currently serious reservations and myths about what ASP can mean for companies and whether it can be applied in the context of business networks. In this paper we investigate the impact of this business model on decision support technologies in the supply chain management field. Furthermore, we provide a survey of some ASP issues regarding supply chain management software.

1. Introduction

The term *supply chain management* (SCM) gained popularity in the last decade because an increased competition and a trend in global sourcing have forced companies to improve the coordination of business functions across partners within the supply chain. Since problems in SCM encompass a large variety of decisions regarding logistics network configuration, inventory planning and control, transportation analysis, etc., a SCM system integrates several functions or tools that are important for the management of supply chains [25, 32]. Information technology and its facets are vital components and important enablers for supply chains and networks as they allow to manage material, information, and financial flows more efficiently. The abundance of data and the savings that arise due to sophisticated analysis of these data are factors that have initiated the current interest in SCM.

Since many problems in SCM are too complex to be handled by humans but not so well defined that they could be entirely performed by computers, *decision support systems* (DSS) are designed to assist the human decision maker. These systems implement, e.g., analytical tools using methods of operations research, simulation, and flow analysis. Respective decision problems are usually very complex and, therefore, the deployment of sophisticated DSS is connected with very high – for many companies even prohibitive high – investments.

A fierce competition and a globalization of SCM have forced companies to develop more effective ways to coordinate their flow of materials, information, as well as financial transactions. After reducing the manufacturing costs by deploying new manufacturing technologies in the 1980s, companies were looking for ways to reduce their huge costs in the supply chain due to inefficient practices such as redundant stock, transportation strategies and discovered SCM as a next step to increase profit and market share.

In the literature a large number of definitions for SCM can be found. For instance, in [19] a supply chain is defined as "a set of three or more companies directly linked by one or more of the upstream and downstream flows of products, services, finances, and information from a source to a customer." The primary decisions made within the supply chain include sourcing (quality of product, choosing suppliers, etc.), production (location of production, make vs. buy decisions, quality of product, etc.), inventory (e.g., how much inventory to hold, how much to order, and when to order), and logistics (e.g., transportation type, mode of transport, shipment size). Furthermore, companies within the supply chain may have to agree to use the same software for integration or at least upon certain protocols for electronic data interchange. Since relationships are not always between equal partners, larger customers may dictate the type of software that will be used. Therefore, suppliers are sometimes even forced to use several different SCM solutions.

[1] We shall use the acronym ASP for both the task of application service providing as well as the application service provider, i.e., the company.

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According to other definitions, SCM can be seen as the general integration of functions throughout the supply chain. Supply chain applications, therefore, include several functions such as order processing, inventory control, materials requirements planning, traffic routing and scheduling, and purchasing [25, 32]. Several ASPs are offering SCM software packages with varying tools. However, many companies might need to customize or even modify these packages to fulfill their special requirements. In this paper we survey ideas on which the ASP business model is based. Furthermore, we elaborate on some of the benefits as well as current deficiencies of the ASP model and incorporate a discussion on service level agreements (SLA). Occasionally, we refer to market surveys conducted by popular market research companies when no other firm research results are available.

2. The ASP Business Model

The history of remote delivery of software applications began in the 1960s. Several businesses shared mainframe computer resources by remotely accessing their services on an as-needed basis. In the 1980s, the development of networked desktop computing placed software applications on the personal computer and upgrading and maintaining software grew to costly tasks. As client/server computing spread during the 1990s these tasks were shifted to a more centralized place at the server level. Usually, only data was shared on a central server. Software was still installed on every machine in the network due to missing/inappropriate software distribution methods. The pervasiveness of the Internet combined with cheaper bandwidth in the late 1990s has reasserted the idea of network-based computing where the information is mostly processed and stored in central network locations. Users can access the network from an ordinary PC or from a simple terminal, a so-called "thin-client" only equipped with basic desktop software applications and a Web browser. ASPs made use of this development, and the first ASPs entered the market in the late 1990s.

2.1. Fundamentals of ASP

The term ASP has been defined by several organizations from different points of views. The *ASP Industry Consortium* (ASPIC) and the *Information Technology Association of America* (ITAA) built a relationship to support the ASP industry. They agreed to the following definition: "An Application Service Provider, or ASP, is any company that delivers and manages applications and computer services to subscribers/clients remotely via the Internet or a private network." All definitions emphasize that an ASP delivers and centrally manages applications to clients via a network. The client accesses remote, centralized computer servers hosting the application via a regular Internet connection, a virtual private network, and/or dedicated lines. The type of service is consent in a rental agreement, even if it is not specified in full details. It allows the user to rent a software component or a suite of applications from a range of vendors from a Web site rather than buying and maintaining it in-house. The customer pays a monthly fee for the software use, hosting, and management services. Furthermore, ASPs usually charge a one-time set-up or installation fee. The emphasis is on the use, not the ownership of the application.

In theory, a broad range of applications might be available through the ASP model. Sometimes ASPs are called "Enterprise ASPs", "Collaborative ASPs", or "Personal ASPs" according to the offered application. The applications might be Web-native or Web-enabled and some ASPs provide client/server applications. Several ASPs focus on a horizontal market, i.e., they specialize in one type of application and provide it for a broad range of industries or they focus on a vertical market which means they offer a broad range of applications to one industry.
ASPs deliver software services including the deployment, integration, access, training, management, and support of applications at guaranteed service levels. From a customer's perspective he purchases a single service from a single point of contact: the ASP. Behind the scenes, however, a complex ASP supply chain exists to deliver a variety of competencies in different areas such as services, networking, and applications. Supply chain members are service firms (system integration, consulting), network providers, and application vendors [11].

2.2. ASP Benefits

Usually, ASPs are seen as faster, more cost-effective, and reliable than in-house resources. Especially specialized and experienced ASPs are able to meet these expectations. They developed rapid-deployment strategies that shortened the implementation time and – due to leveraging economies of scale – ASPs can reduce costs, especially labor costs, for implementation and maintenance. Furthermore, to ensure good references, ASPs are usually anxious to deliver their best-effort services to meet their customers' expectations and the binding agreement for service delivery (*service level agreements*, SLAs).

Companies of all sizes may benefit from this business model as they share the need to manage costs and quality of computing resources across their organizations. In the beginning ASPs focused on small and medium-sized enterprises (SME) as one supposed that ASPs would enable especially SMEs to use business software that they otherwise could not afford. But, according to a study conducted by PMP Research in 2001, larger businesses are more likely to buy ASP services. Over 40% of the 3,000 interviewed companies recorded as ASP users have turnovers in excess of US$100 million and 44% employ more

than 500 people [21]. The reasons for this trend are diverse and depend on the particular company. In general, most large companies already have so-called outsourcing contracts and are, therefore, more familiar with the idea of outsourcing than smaller companies [6, 24, 31].

In the following, we present some possible benefits companies may have turning over from an in-house application deployment to ASPs [4, 7, 28].

Rapid Deployment. Since a company benefits from ASP implementation expertise and a deep understanding of the applications, the implementation time for new applications and upgrades can be reduced, and thus a faster time to market can be realized. This expectation is, in particular for SME and start-ups, still one a major driving force for the acceptance of the ASP model. However, as rapid implementation technologies rely heavily on the fact that the solutions are pre-configured, sometimes companies have to forgo much of the customization that would otherwise tailor the application to their needs.

Lower Cost of Entry for Applications. Cost savings were the primary reason for companies to outsource applications or business processes in the early 1990's. In light of the economic slowdown that has occurred in the high tech sector over the past twelve months, cost reduction has once again become a primary business benefit that ASPs offer. By mandating ASPs, companies may reduce overall costs of application lifecycles considerably [18]. Particularly labor costs, which usually are the largest IT costs, can be reduced, since installation and ongoing maintenance of applications are performed by ASPs. Popular estimates reveal that as a result of these reduced costs, the total cost of ownership (TCO) for enterprise applications can be as little as 70 to 50% of a non-ASP purchase cost [9]. Less optimistic estimates see the TCO, over a five-year period, at 10-40% lower than for a purchased application [34]. Obviously, the business value ASP provides varies according to the market segment and the functional needs.

Raise Return on Investment (ROI). ROI is the most commonly used metric by which organizations assess investment opportunities. IDC fielded a study to measure the ROI realized by organizations that have successfully implemented and utilized ASP-delivered services. ASP implementations yielded an average five-year ROI of 404% and almost half of the companies had payback within six month. 56% of the organizations included in the study experienced an ROI greater than 100%, while 12% reported ROI returns of more than 1,000%. The average payback for an ASP-outsourced solution was 1.33 years on an average total investment of $4.2 million. The average initial investment was around $400,000. Further, powerful solutions also establish solid competitive advantages in their respective markets [13].

Primary Business Focus. As competitive pressures are increasing, businesses focus on their core competencies. In most enterprises, IT enables critical business activities, but is not a core function itself. The ASP model allows a business to focus time and resources on its core competencies and to offload functions that are difficult to manage. IT administrators might shift their free internal resources from maintenance and support roles to more strategic functions to focus on core business issues and thus improve the efficiency of internal IT staff.[2]

Affordable Access to High-end. Companies may be enabled to access the latest applications and the ASP's IT expertise to level the competitive playing field. Even though the technology change can be very rapid, the ASP model may allow businesses to gain a much higher technology level without the need of high investments.

The ITAA interviewed 118 current ASP customers and 532 non-ASP customers that planned to adopt ASP [15]. The latter companies consider, besides the access to high-end applications (62%), the reduced initial capital outlay (62%), and lower IT costs over time to be the main benefits. Companies currently using an ASP also name the access to high-end applications as the main benefit. However, only about 52% determine reduced initial capital outlay and lower IT costs over time as benefits. This may lead to the question, whether the assumptions about cost-savings are too optimistic and ASP users already noticed that the cost benefits are not that high or maybe even less important than benefits such as cost predictability, access to high-end applications, and reduced implementation times.

Predictable Costs. Since organizations pay only a predetermined (e.g., monthly) fee instead of huge upfront expenditures, they are able to predict IT support costs more accurately. According to InformationWeek research, more than 90% of all respondents mentioned that the cost predictability was one reason for the company to rent the application from a third-party provider [33].

3. Categories of ASP SLAs

A SLA is a binding agreement with the intent to outline the nature of a relationship between parties. It identifies and describes the roles and responsibilities of the service provider and the customer. It describes the service offering which will be guaranteed via the SLA, standards of quality, service level criteria, and possible remedies.

The SLA contents and design hinges on the client's expectations, the type of business, and the involved ap-

[2] Examples in this respect are widespread. Early ideas in this spirit include the joint operation of a computing center (as, e.g., performed by IBM, Continental, and Gesis in Lower Saxony, Germany, for more than a decade). In this respect even universities become customers of ASP as intended, e.g., by the recent SAP Education Alliance for Universities.

plications. Internal needs, capacities, and goals should be determined in advance to assure a realistic contract.

The ASPIC and the ITAA have published guidelines for SLAs, which include contractual elements to be considered [2, 14]. To address the ASP value chain consisting of software supplier, network provider, service provider etc., they distinguish between four SLA groups: network, hosting, application, and customer care/help desk. In the following some service level elements of each of these categories are sketched.

3.1 Network SLA

The ASP model implies that services are delivered across a network from the service provider's data center to the customer's premises. The network SLA covers the network connection between the customer and the ASP and identifies the network performance that the provider will offer. In the following, the most important components of the network SLA are discussed.

Network Availability. The network availability is measured in percentage uptime and is the amount of time that a network is operational and available for the customer. A reasonable guaranteed uptime depends on the kind of application and the type of business. Companies usually offer at least 99% guaranteed uptime and according to *International Data Corporation* (IDC) the industry average is 99.4% guaranteed network uptime. This percentage seems to be very high, but 99% uptime means that the customer must tolerate 86 hours failure per year (about 99 minutes per week). Customers must pay attention if the term "network uptime" also includes "application uptime". Some vendors consider a service as available if the network is operating. In case of a software crash he meets his obligation even though the application itself is not available [20].

Network Throughput. The network throughput is the amount of bandwidth available and determines the likelihood of delays and traffic conflicts in the system. Usually the capacity of the network is expressed by the size of the backbone that makes up the network core. Network throughput is a major issue since an under-provisioned core affects the service performance dramatically.

Network Security. The network security is an important issue for ASP customers and relates to maintaining the security of client data. The SLA must define which security mechanism such as firewalls, encryption, tunneling, and other security related aspects will be implemented. As particularly encryption affects the performance, consideration about the impact on throughput and quality of service must be made.

Data Loss. When an IP network becomes overloaded, data packets might get lost or delayed. This is especially critical for real-time applications and can in the worst case interrupt business. This issue will become critical if more users adopt the model and more critical applications are hosted. However, only few ASPs articulate data loss in their SLAs. Those who do, mostly guarantee 99% packet delivery even though real-time applications need less than 1% loss rates.

Latency. Data delay can be highly disruptive to time-sensitive applications such as video and audio and is an important issue for customers. Latency might become a critical aspect with an increasing number of time-sensitive hosted applications.

3.2 Hosting SLA

The ASP model implies that infrastructure and application hardware is hosted with a hosting provider. Regardless whether the ASP uses hosting services from a third-party or provides them itself, the hosting service components given below must be identified and described in the end-to-end SLA.

Server Availability. This category addresses the issue of server uptime (including hardware and operating system), which is measured in percentage uptime. Benchmarks range from 99-100% based on the type of server management services. The server availability is of highest importance for ASPs and customers and should be examined according to the type of application and the business needs.

Backup and Rotation. Since operational und customer data are important resources data backups are very important. Industry standards require that backup tapes rotate once a week and are stored in a secure location (e.g., a fire retardant safe outside the main computer room) for 60 days. As the importance of backups differs depending on the application, provider and customer can negotiate about the implemented approach.

Physical Server Security. The physical security of the data center can be provided by restricted access to the data center to named stuff, security cameras, lockable cabinets, security breach alarms, etc. The ASPIC even suggests that the ASP or the customer should conduct an inspection of all data centers to verify that security issues are being adequately addressed.

3.3. Application SLA

The application SLA addresses the measurement of the application performance. The ASP delineates the domain of its responsibility, performance parameters including performance metrics and penalties for failure to meet agreed service levels.

Application Availability. The application availability is defined as establishing a connection through a demarcation point to the hosting site and using the desired application. Outages can have different reasons and are usually caused by a combination of network, server, or application failures. Availability of each application is

measured separately and may be represented by total hours of availability, hours or minutes of outage, mean time to repair, etc. It should refer to the availability from the perspective of the user and take an end-to-end view and not a component-by-component perspective.

Application Performance. Application performance is significantly more difficult to measure than availability. Usually, performance has a speed dimension. Speed may be represented by response time, data transfer rate, or other measures. Especially for online systems, the SLA should always include a metric for response time. Another common performance characteristic is volume. Volume may be reflected, e.g., in the amount of data transferred or the number of transactions processed.

Application Security. The ASP should build security features (e.g., firewalls, SSL technology, virus management, and authentication) into its network design to avoid security breaches.

Software Upgrades. The SLA should define which versions of an application will be supported and commit to delivery of the latest upgrades within a specified time.

3.4. Customer Care/Help Desk SLA

As ASPs usually provide technical (help desk) and non-technical (customer care) support for end users, these services are identified in the respective SLA. SLAs are defined for customer care and help desk in three categories availability, responsiveness, and customer satisfaction.

Availability. Availability SLAs consist of agreements that stipulate, e.g., the ability to contact the help desk (hours of coverage), the average speed of answer. In some cases it also includes an agreement concerning the abandonment rate (total number of customers who hang up while waiting to reach a help desk or customer care employee).

Problem Resolution Time. Depending on the type of application, short problem resolution times can be vital for the customer's business. However, many ASPs state in their SLAs the problem response time which usually varies depending on the contact method (phone call, e-mail, or Web requests), the priority of the problem, and the source of the problem (e.g., network problem, application issue) and not the problem resolution time which is obviously much more important than short response times.

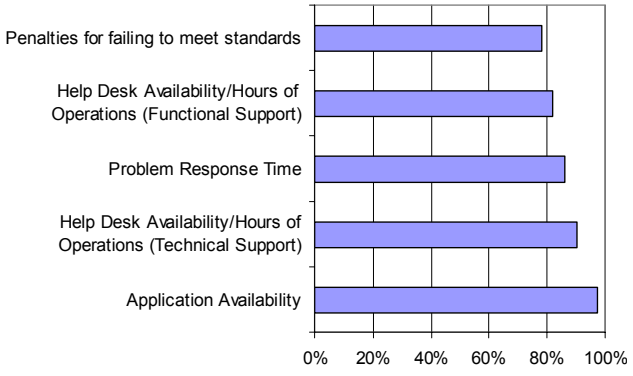

Figure 1. Importance of SLA features
(Source: IDC [30])

Customer Satisfaction. Customer satisfaction depends on the quality of service offered by the customer service and help desk employees (e.g., right information, quick response, courtesy, and friendliness).

3.5. Additional SLA Categories

Most common SLA components surveyed by IDC include the customer-facing aspects of the service such as application availability and help desk availability (see also Figure 1). Other critical components such as time to repair and application performance are not guaranteed as frequently. However, even if these aspects are included, they are sometimes difficult to control. If an ASP depends on partners for network connectivity or other services, it may monitor but it cannot control the end-to-end performance of the application service chain. The ASP might try to tailor the SLA according to its SLA with his suppliers, or even try to exclude outsourced services such as network, server, or system availability.

The following provides additional clauses customers and ASPs can include to their SLA to ensure further confidence in the solution (see, e.g., [7, 10, 22, 28]):

- Escalation procedures for problem resolution, which define the process and persons to handle types of service problems, should be specified in the SLA. It might be needful to specify a process for resolving disputes that may include designated third-party mediators and SLA audit procedures. In case of unsuccessful mediation, the SLA should establish which jurisdiction's law will apply for disputes.
- The SLA should include a clause that stipulates that any data placed on an ASP's server will remain the property of the customer.
- A SLA may include a written transfer plan with an exit or cooperation clause, to provide continuous service in case the customer must transfer its application to another provider because of an ASP business failure. This includes format agreements such as a data exchange format to ensure the unrestricted usability of all data after contract end.
- Termination clauses that define the ability of the ASP and the customer to terminate the agreement prior to the planned contract end should be part of the SLA. Furthermore, clear guidelines regarding the events for termination and any payment obligations should be established to protect both parties.
- Even if the provider maintains the system regularly, failures might occur. Breaches of service levels are usually remedied with service credits. For more se-

vere breaches, the SLA should include financial penalties to compensate the direct costs that have been caused by failure to deliver.

- Since the contract period is usually one to three years, it is likely that the scope of a customer's service could change. Both parties should review the SLA regularly in preferably frequent intervals (e.g., once a year or more frequently).

An important question is how to monitor the SLA compliance. According to [28], ASPs supporting a simplified boilerplate SLA offer a monthly management report, supplemented by an SLA monitoring tool.

Unfortunately, during an economic downturn, ASPs may tend to agree to SLAs with unrealistic service guarantees in order to gain new customers. This behavior is very dangerous for both participants since ASPs have to commit to high technology investments to comply with the SLA. Those ASPs run the risk of being not profitable since the costs may exceed the revenues over a long period of time. The results could be observed in the US in 2001 when several ASPs had to close down their businesses in many cases due to high investments that could not be fully compensated by their turnover. ASPs must perform a cost-benefit analysis that considers the metric being measured and the business process supported by the offered application. This may include benchmark testing to determine the current application performance levels before the ASPs host the application.

Since the design of the SLA depends on the customer's expectations and the type of application it is not possible to set up one model SLA for every ASP. For critical and complex applications so-called boilerplate SLAs would leave too many issues unaddressed whereas negotiated agreements offer greater flexibility. However, it seems almost impossible to consider every possible aspect that might affect the service delivery. Therefore, the SLA can be seen as an important contract that outlines the rights and obligations of both parties but it may not be able to prevent disputes completely.

4. Impact of ASPs in SCM

In particular supply chains may benefit from ASP because all partners can access the application without the need to install them in-house especially since the supply chain is not a static but a dynamic formation where members change from time to time. On the other hand, the efforts for contractual agreements will increase since every new partner needs to negotiate the SLAs with the ASP. The Internet enables companies to change the way in which supply chains are planned and managed. A tight coordination between business partners, which means that all the information, transactions, and decisions will flow through the Web, allows the implementation of synchronized supply chains [1].

In the following we discuss three key functions within SCM and the possible impact of ASPs on them.

4.1. Forecasting in Supply Chain Management

Even if the demand for a specific product is fairly constant, the variability in orders placed by a retailer may be higher than the variability of the demand. Since wholesaler usually do not have access to the customer's demand data, they may use historical order data to perform forecasts. Therefore, the wholesaler might be forced to keep a higher capacity than the retailer in order to be able to deliver the products whenever the retailer orders them. This effect can also be observed at the distributors and factory side and results in an increased variability in the supply chain and, therefore, in higher inventory levels and higher costs [25] (unless so-called vendor managed inventory functionality is installed).

Simulations have documented how forecasting techniques and inventory policies can influence the degree of demand variability in the supply chain. They have shown that if all companies in the supply chain would use the same demand data and the same forecasting techniques the demand and inventory fluctuation (the so-called bullwhip effect) could be reduced. On the other hand, problems tend to escalate in supply chains where communication is low between supply nodes and where forecasting techniques depend on estimations of parameters to address factors such as trends and seasonality [26]. In-house SCM systems usually consider the supply chain as a linear formation and the information exchange is mostly limited to the direct predecessors in the chain.

Appropriate ASPs may transform the linear supply chain in an adaptive supply chain network that enables all partners to share information, plan, and coordinate. Adaptive supply chain networks are designed to enable dynamic collaboration throughout several processes including forecasting demand.

SCM and supply chain planning heavily rely on sharing, e.g., customer demand data. The sales forecasts derived from those data can help plan operations more efficiently. Information technology allows access to real-time sales and forecasting information for each chain member and improves control and management. Instead of building private connections with trading partners, companies could rather use Web-enabled forecasting applications through an ASP where every company can log into the ASP's system.

4.2. Transportation in the Supply Chain

During the 1970s and 1980s a significant shift towards third-party logistics providers (3PLs) such as transportation and warehousing firms could be observed

as companies tried to reduce their inventories. Today companies ask for value-added services that go far beyond these traditional services such as specific productivity goals like a percentage of on-time delivery. Therefore, carriers must develop information management skills that enable them to fulfill these requirements [8, 12, 31].

Initially, the relationship between 3PLs and shippers was based on transaction processing with telephones and fax machines. Today, the Internet replaces these forms of communication and information exchange and 3PLs are embracing an entirely new role in the transportation industry. Nevertheless, in the complex business supply chain, in which each movement of freight can involve up to 50 discrete transactions, intermediaries remain a critical factor and even though the support through technology becomes more sophisticated, human intervention and the expertise of professionals cannot be replaced [3].

Logistics is a scalable market and shippers follow fundamentally similar tendering, dispatching, and billing practices. These are some of the reasons why ASPs that provide hosted online applications for the transportation industry have managed to survive and even thrive in the last year in spite of the economic downturn. Companies' logistics needs are similar across different industry types, and ASPs may be able to achieve the scale they need to survive [23]. However, even the success of some transportation ASPs such as Descartes, 3PLex, and Logistics.com cannot guarantee their long-term viability since large transportation players launched their own ASP spin-offs and therefore competition is becoming fierce. The promise of transportation ASPs is to automate all essential back office tasks, improve business communications, and enable 3PLs to differentiate themselves competitively by providing better information and enhanced value-added services to their customers.

4.3. Decision Support Systems for SCM

DSS are designed to assist and support the human decision maker in their decision-making process. They provide support for decision makers ranging from top executives to line managers mainly in semi-structured and unstructured problems by bringing together human judgment and computerized information. DSS are usually computer-based information systems that combine several models and data, but even a simple spreadsheet can be a helpful decision support instrument [29, 31].

DSS are used to address key issues in SCM, which range from strategic through tactical through operational level. A typical problem at the strategic level is, e.g., the logistics network design and at the tactical level, e.g., the development of inventory policies. In SCM DSS are often called advanced planning and scheduling (APS) systems and they typically cover the areas demand planning, supply planning, and manufacturing planning and scheduling. A DSS including one or more so-called artificial intelligence components (such as expert systems, intelligent agents, neural networks) are sometimes called *intelligent DSS* [25]. They are developed for complex problems that require expertise for their solution in addition to regular DSS. Expert systems or other intelligent systems may enhance the operation of the DSS by providing the required knowledge for solving some aspects of the problem. This knowledge component may consist of one or more intelligent systems.

According to [29], the DSS software market continues to develop and mature. We can observe that supply chain software provider embed expert systems and other intelligent systems in DSS and in traditional software to provide additional capabilities. Furthermore, new decision support development systems are mostly Web-enabled which allows users to develop a DSS. However, these solutions are often of poor quality and, therefore, many DSS are integrated in software suites.[3] Since companies need DSS for a specific set of problems application developer need to provide focused versions which are usually quite expensive. Therefore, a Web-enabled DSS provided by an ASP focusing on a specific industry might be a solution for many companies searching for appropriate and affordable SCM software.

5. ASP Issues Regarding SCM

The stated concerns about the ASP model vary mainly depending on the type of customer and the type of application. First of all, customers worried mainly about security and availability of the application and data. Meanwhile, concerns about the long-term viability of the ASP, possible integration problems, and customization issues become important, too. The concerns regarding ASP are frequently not SCM-specific but apply to different types of applications. Therefore, we discuss some of the most commonly investigated ASP issues.

5.1. Data Security

Security and privacy of sensitive corporate data is an obvious concern when applications are hosted remotely at a provider's data center and accessed over the Internet (see Figure 2). Especially virus and distributed denial of service attacks are examples of potential security problems. A Computer Security Institute study [5] revealed that 186 organizations reported more than US$377 billion in financial losses as a result of computer-oriented crime in 2000. In contrast, in 1999 the reported losses from 249 respondents totaled about US$265 billion. Ac-

[3] See, e.g., the *mySAP* components including the Advanced Planner and Optimizer (APO) intended especially at SCM problems. That this is not a trivial undertaking can be deduced from respective modeling issues; see, e.g., [32].

cording to the same survey 85% of respondents detected computer security breaches in 2001. This development results in security concerns, and according to IDC companies will spend by 2002 more than US$10 billion in security software and services.

Due to these issues, many companies hesitate to adopt the ASP model for applications that are mission-critical for daily business operations. Especially supply chain partners want to protect their data so that other partners only have access to relevant data. Leading ASPs use a number of security measures to address these concerns and to safeguard customer data. On the other hand it is questionable if the customer demands on data security to an ASP are as high as they are within their own companies as many companies do not look after security within their enterprise as well as they expect the ASP to do. Due to possibility to leverage its economies of scale and scope, an ASP may be able to build a more sophisticated security architecture compared to those of its customers [7].

Many companies do not realize that not only hackers or unauthorized users are potential risks, but also careless or inappropriate use of information within the enterprise. Companies usually have policies and procedures but if employees do not obey them, security issues emerge and data security cannot be guaranteed [27]. ASPs try to enhance access control by performing personnel screenings, installing biometric access systems and video surveillance systems to reduce the risk of unauthorized access.

5.2. Application Availability and Performance

As shown in Figure 2, service reliability is an important criterion in selecting an ASP. Reliability encompasses availability and performance, both of which should be spelled out in a SLA between the ASP and the customer (see also references on SLA [2, 14]). However, in the mid-market the network is often the limiting factor as bandwidth outside of the LAN is very costly. ASPs are forced to use computing architectures such as Web-based applications, thin-client server, and Java-based applications that require less bandwidth than, e.g., conventional client/server applications.

ASPs address the performance issue by, e.g., deploying load balancing systems and dynamic failover solutions and by constantly monitoring their infrastructure, applications, and databases. However, ASPs are not able to influence the reliability and performance of the customers' Internet or Infrastructure Service Provider, they can try to reduce the bandwidth needed to reduce the risk of performance bottlenecks.

5.3. Application Integration

In SCM companies usually do not only use one application but desire integrated data shared by multiple applications (commonly used over the chain/network), e.g., applications offered by the ASP and existing applications customers want to keep and integrate [17]. Therefore, it is necessary to provide data exchange options between applications within the legacy systems. For example, data collected in enterprise resource planning systems should be accessible for DSSs (back-end integration). Therefore, ASPs need to seamlessly integrate and deliver applications that are managed and supported internally with those provisioned externally. Naturally, we assume provision of modern forms of electronic data interchange.

The integration with client's legacy systems can be very troublesome and requires good knowledge about different systems. Especially smaller ASPs may not have the staff and expertise to integrate their customer's legacy solutions with their own application. Therefore, ASPs often team with system integrators or value added resellers to enable various types of integration. Companies such as Jamcracker offer a platform that enables customers and partners to deploy, integrate, manage, and support web applications from different sources. The platform serves as an access point for web-enabled applications within and outside a company's firewall.

We can observe that some ASPs try to increase customer retention by providing additional services and by expanding their application portfolio by offering applications that cover the entire enterprise. For instance, SAP announced that it continues to improve business processes with integration between mySAP customer relationship management and mySAP SCM (cf. the APO module). The integration aims at improving productivity and efficiency by helping companies respond to market conditions, maximize revenue opportunities, minimize costs, and improve customer service. To successfully create and manage such a diverse set of applications and objectives is difficult and thus ASPs will weigh up ease of integration, market share, and available skills vs. 'best-of-breed'. Whether these promised functionalities are really provided is still open to debate.

5.4. Vendor's Stability / Longevity

Due to the fact that especially in 2001 many ASPs had

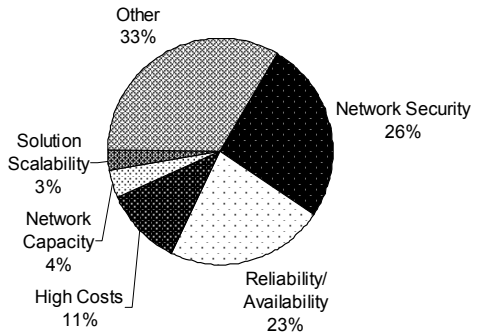

Figure 2. Concerns about outsourcing applications (Source: Datamonitor [34])

to close down their businesses, worries about the long-term viability are common. Many ASPs went bankrupt because revenues were not high enough to cover their costs. Furthermore, venture capitalists were more reluctant to invest in ASPs, as most of the ASP customers were struggling dotcom companies whose financial situation was not promising either.

For a long time, ASPs were simply expanding revenues at any costs in order to achieve higher market shares rather than focus on achieving profitability. Internet-native Web service vendors may have better chances to reach long-term profitability. At least the willingness of venture capital groups to invest money into their business model is obviously higher than to invest in third-party ASP.

Many of the companies ranked in IDC's top 15 ASPs had revenues of US$20 million or below, and measured by revenue accounted for only 48% of the market overall. Accordingly, many ASPs have only small revenues which illustrates that the ASP market is still in its infancy. ASPs need to offer unique value-added elements to their offerings to maintain their customer base. Customers will also evaluate the provider's financial model as well as the companies that are backing the ASP. They suppose that the risk of a sudden closure is mitigated when the ASP is financially backed by a solid company.

However, even though prospective ASP customers can try to get detailed information about their ASP, e.g., seek for information about business model, financial situation, partners, etc. or by meeting customers to get some feedback regarding their satisfaction with the services, uncertainties about the viability of the ASP will remain.

5.5. Customization

As the ASP model is based on the one-to-many idea, ASPs offer the same application to many customers. Thus, any customization efforts, i.e., the adaptation of application software to customer-specific needs which is often accomplished in coding and/or configuration, challenge this model and reduce ASP's profitability. Nevertheless, customers will require application customization, and especially for non-standard software customization is inevitable. ASPs face this problem by specializing on a specific software type (*horizontal ASPs*) or on industry specific applications (*vertical ASPs*). However, since some companies have special software needs, they will develop their own systems or modify existing systems.

In SCM the key performance metrics vary, e.g., in retail the most important metric is inventory-carrying costs, in a distribution company it is the transportation costs. To meet the individual needs in a specific industry, SCM software must be highly customizable, which raises the cost and complexity of these software applications. According to IDC, consultants can cost as much as five times the initial investment in the software, but even customizing it in-house doubles SCM's cost.

5.6. Bound by Contract

In the way customers want to tie the provider to its service agreements, they must also enter in a commitment. According to [16], companies are bound by a contract whose average period time is about three years. Sometimes customers are discouraged to leave early, as the SLA may include contractual commitments that invoke penalties for a premature contract exit.

6. Conclusions

In this paper we have discussed the impact and issues of application service providing regarding supply chain management. We have shown that ASPs represent a viable alternative to the in-house deployment of software applications. Especially companies that do not have sufficiently skilled personnel at their disposal to implement enterprise application software or companies that try to reduce the burdens of their IT department may take ASPs into consideration when planning to introduce new application software. Even though large companies are the early adopters of the ASP model, the benefits for small and mid-sized enterprises are likewise strong. So far, small and medium-sized companies usually do not apply sophisticated SCM software, since they usually have only small IT departments – if any – and their investment budget is rather small. Especially for smaller companies with low budgets ASPs are expected to become an important alternative for information technology.

However, the ASP development in 2001 was not very promising for most U.S. companies, and especially some bigger or even publicly traded ASPs went out of business or filed for Chapter 11 bankruptcy protection. The main reason for this development was that ASPs evolved during the boom days of the Internet and many of their customers were newly established start-ups. During the economic downturn, many dotcoms got into financial trouble and ASPs were strongly affected by this development because they were closely related to the Internet and often dependent on dotcoms as their main customers. When revenues decreased and venture capitalists judged more skeptical about Internet related firms in general and ASPs in particular, companies were no longer able to cover the high expenses especially for technology investments and had to close down their businesses.

Nevertheless, the perspectives for the future might be more promising, since the market predictions for ASPs as well as the estimations stating an increased usage of decision support systems for SCM are encouraging. Furthermore, a strong interest to utilize the huge amount of collected data to gain a competitive advantage by reduc-

ing supply chain costs and improving services can be observed. The ASP model offers an affordable and predictable subscription-based fee model, whereby customers can avoid upfront capital investments for hardware, software, end-user licenses, etc. and may profit from significantly shorter implementation cycles.

To summarize, we have provided a brief overview over ASP and possible impacts on SCM and respective decision support systems. Information systems research has to provide more scientifically founded material, e.g., regarding well accepted measures for ASP especially for Internet enabled organizations.

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