Facilitating the Integration of SMEs to Supply Networks with Lean IT Solutions

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Abstract: Being able to control logistics on the network level demands transparency to inventory and deliveries in the whole supply network. However, the information technology (IT) solutions enabling network transparency are expensive and heavy to install and, thus, small and medium sized enterprises (SMEs) often find them infeasible. This paper brings forth the difficulties small and medium sized enterprises (SMEs) experience with the prevalent solutions for supply network transparency and discusses the applicability of different solutions for SMEs. Further, the paper presents a lean, agent based approach that enables integrating SMEs in multi-company supply networks without considerable investments, and experiences from two industrial cases.

1 Introduction

A decreasing tendency for vertical integration has made multi-company networks the prevalent business structure in most advanced economies. Advances in supply chain management theory and practice have proposed that controlling these multi-company networks integrally can provide significant benefits. [1-7]. Being able to control logistics on the network level demands transparency to inventories and deliveries in the whole supply network. However, the information technology (IT) solutions enabling network transparency are expensive and heavy to install and, thus, small and medium sized enterprises (SMEs) often find them infeasible. They have two bad choices: To fall back on the developments in supply network management, or to invest in IT solutions with long payback time. Both of these alternatives can compromise the competitiveness of SMEs in the long run. This is a notable shortcoming as SMEs contribute considerably to all economic activities in the industrial countries. An important question for industrialised economies is thus: “How to build supply network transparency solutions that are also feasible for SMEs?”

The aim of this paper is to bring forth the difficulties small and medium sized enterprises (SMEs) experience with the currently prevalent solutions for building transparency in multi-company supply networks and discuss the applicability of different solutions to SMEs. Furthermore, the paper presents a lean, agent based approach that can help SMEs join multi-company supply networks without considerable investments.

2 Criteria for SME friendly solutions

Most current information technology solutions for building transparency in multi-company networks demand considerable investments. The motivation for the solutions is that the long-term savings potential offered by the solution will outweigh the investments needed for a tighter integration of the supply networks. However, the volume of business transactions between an SME and its business partner often falls short of justifying the IT investments aimed at facilitating that relationship. Therefore SMEs need solutions that do
not demand significant initial investment, as the potential future savings are much smaller than those of larger companies, and the financial leverage is often not sufficient for expensive solutions.

SMEs often have limited IT resources, and thus the maintenance that many solutions require makes them infeasible. Therefore SME-friendly solutions should consume as little as possible information technology oriented resources.

Further, SMEs lack the potential of dictating their solution to be used by their business partners. Instead, more often than not they have to comply with the requirements of several large enterprises. This has led to difficulties when companies with the fewest resources are forced to cope with several different IT solutions.

As a summary, solutions that best suit SMEs have the following characteristics:
- Easiness of set-up, to minimise investment requirements
- Leanness of use, to minimise operating and maintenance costs
- Scalability, to maximise the applicability of the investment

3 How do different transparency solutions fit SMEs

In this section we examine several different solution approaches regarding their potential to serve as the tool to incorporate SMEs in business networks. We look at both the suitability of each approach to provide network transparency and the feasibility of the solution for SMEs.

3.1 Centralised databases

The early utilisation of information technology in companies resulted in information exchange between functional databases by physical or electronic messaging. This led to errors and time lags in information processing. Company internal processes were developed in huge leaps after the emergence of central company databases [8]. These predecessors of current packaged Enterprise Resource Planning (ERP) systems enabled the same set of data to be used in all functions of the process. Amendments and appends were made to the same information, ensuring correct and up to date information for the whole process, which increased the productivity of inter-enterprise processes substantially [8]. It can be stated that within the company boundaries tight integration has enabled building Information Technology (IT) solutions that successfully support company operations [9]. Centralised database solutions operating in real-time provide the best possible transparency, as all inventory and material movement information is available at a single source. Therefore all the parties needing the information have access to up to date information.

For multi-company networks, a solution similar to intra-company information management is not feasible. A kind of “Mega ERP” or a “Virtual Enterprise Resource Planning (VERP)” – an integrated database of all the companies in a supply network would be analogous to ERP in an individual company. But, the centralised approach in multi-company networks has noteworthy challenges. Firstly, companies in multi-company supply networks are independent entities, and it is, thus, difficult to convince them to hand over their information to be managed by an external party [10]. Secondly, building a central database for the supply networks is a very complicated task, and integrating all the companies involved to the database consumes a lot of resources. This problem is multiplied by the flexible nature of the networks. And thirdly, most companies are members of several supply networks, which makes central supply network databases undesirable for them. For example, it is not feasible for a components supplier to integrate with the databases of several Original Equipment Manufacturers (OEM’s). [11]. However, there is a risk that SMEs are forced to invest in the solutions of several large business partners, as supply chain management is full of examples where the stronger company reaps benefits at the
expense of the weaker party [12]. Therefore a single integrated database can be considered a risky solution for SMEs in multi-company networks.

3.2 Business to business application integration

Business to business (B2B) application integration stands for the direct integration of company specific information systems. It is a less binding method than a “VERP”, but offers good functionality for network transparency due to the possibility of real-time information transfer and reliable access to the updated information. [13, 14]. There are many possible approaches for B2B application integration, such as: Data-oriented, application interface oriented, method-oriented, and process integration-oriented application integration. Almost all B2B application integration techniques enable real-time data transfer, and the linking of different information entities together. [14]. These qualities make them suitable for supply network management, and less resources are needed during the use of B2B application integration than in the centralised approach.

However, B2B application integration has also some downsides that make it infeasible to be used by most SMEs in multi-company supply networks. As is the case with the VERP-approach, B2B application integration also demands a lot of resources during the implementation, which makes it economically feasible only for supply chain partners having continuous high volume business. As the number of partners increases, either from the same supply network or other networks, B2B application integration becomes infeasible as a comprehensive transparency solution, due to its poor scalability. B2B application integration is consequently most suitable for stable networks with a limited number of partners, but it does not suit many SMEs due to their limited business volume.

3.3 Message transactions

Another option for communicating movements of inventory in a supply network is using transactional messages. In the beginning of development these messages were often manually entered to the information systems of the company in question. A big increase in information processing productivity was gained when automatic system-to-system messaging, i.e. Electronic Data Interchange (EDI), was introduced. Even though in theory EDI stands for all direct system-to-system communication, the term in practice is mostly used to represent batch oriented information exchange utilising standard messages (EDIFACT and ODETTE being the most popular EDI standards), which is usually organised in point-to-point connections between companies [13].

The problem with EDIFACT, from the SME point of view, is that even though standard message formats have been developed, the standards are so broad that establishing a new point-to-point connection demands considerable amounts of integration work. Value added network (VAN) providers alleviate the integration work, but when utilising VAN’s transaction fees are incurred for each EDI message sent. Although these costs are not a significant downside when automating business transactions (such as purchase orders and bills) it is questionable whether it is feasible to use them when recording material movements, which is needed for building supply network transparency. For example, in shipment tracking applications several EDI-messages are sent concerning the movements of a single consignment. Another downfall of EDI as a technology for supply network management is that most often EDI applications send information in batches [13], which creates difficulties in a fast paced environment as there are often severe problems in matching the received information to a physical delivery, and in temporally synchronising material and information flows [15].

New message-based solutions are emerging with the growing popularity of XML-applications. The most notable of the development efforts is ebXML, which is an XML-
specification suite sponsored by UN/CEFACT and OASIS and is building on the experience of existing EDI knowledge. From the SME viewpoint this development is desirable, as the target is to create an open, consistent, and globally standardised messaging structure [16]. Should the efforts prove successful, SMEs would benefit greatly by having a single standard to invest in, with which they could gain the ability to communicate in all the business networks in which they participate.

There are also industry specific standardisation efforts for message-based integration, for example RosettaNet that utilises the ebXML-framework. RosettaNet is a collaborating network of more than 400 companies representing Electronic Components, Information Technology, and Semiconductor Manufacturing industries. Their goal is to develop not only messaging standards but e-business processes including order status transparency. [17]. However, RosettaNet is only targeted at the electronics industry, and applying it elsewhere requires extra effort, and it does not directly provide a solution for gathering information on inventory levels on the supply network.

3.4 Portals

Portals form one special instance of B2B application integration. Portals can represent information from various different systems in a single place, through a browser. Portals are easier to establish than other kinds of B2B application integration, because the applications are not directly integrated. However this leads them to having limited functionality, as information can be accessed and manually altered at the portal, but system-to-system functionality, messaging and reactions are not possible. [14].

4 Agent-based approach for supply chain transparency

From the review in the previous section, it can be concluded that the integration of databases or application integration are not a viable information management solution for many SMEs due to the need for heavy investment in setting up the network and maintaining it. Further, transactional messaging solutions do not in themselves solve all the challenges associated with building transparency in SME-networks. Thus, we have been trying to develop a leaner approach that would also be attractive to SMEs.

4.1 Basic principles of the approach

When seeking a solution for building transparency in multi company networks including SME’s, we found that agent-based solutions offer a natural way of dealing in network environments. Software agents can be defined as atomic software entities operating through autonomous actions on behalf of machines, systems or humans without constant human intervention [18]. One problem with the concept of software agent is that many kinds of software products that are not agents are being marketed under that term [18]. The problem can be noted from the research literature, as systems that simply exchange information on events happening in the supply chain [19], and system controlling operations through a complex negotiation and co-ordination process [20, 21] are both referred to as agent based systems.

The proposed agent-based approach for solving the challenges in SME-networks is currently of the simpler information transfer and management type, but problem-solving capabilities can be added to the system. The two basics building blocks of the system are simple: It consists of easily installable check-point clients that are used to track the movements of material and inventory statuses in a supply network, and servers that receive information from the clients and pass it to business applications [11].
An important feature of the approach is the coding it uses for shipments. The coding encompasses two pieces of information: The identity of the shipment, and the address of the recipient of the information. One possibility is to present the identity following a notation ID@URI [22]. In this notation the ID stands for an identity code of the consignment, and URI stands for the Internet address of the computer to which the information should be sent. The functionality of the system is illustrated in Figure 1.

![Figure 1 The functionality of the agent based tracking system](image)

This system set-up enables visibility to the location of a certain delivery, and the aggregate information provides transparency to the supply chain as the inventory residing in the supply network is easily mapped.

As mentioned earlier, the system can be updated into a control system quite straightforwardly. The globally unique identity of the individual shipments is used to store information related to their content and delivery terms, the system also provides means to communicate the information to other companies in the network as it currently opens a bi-directional connection between the client and the server. Therefore the shipment’s identity can be used to control its route in the supply network, and its delivery schedule can also be linked to other deliveries in the network. As the identity of a shipment or a product is the central controller in this way of operating we call it "product centric control" [11, 23].

### 4.2 Use cases of the agent based approach

In this section we present two use cases of the agent-based solution to illustrate the benefits it offers for SMEs in multi-company networks. First we will look at the application in a tracking context, i.e. the aim is to gather and retain information on the whereabouts of a certain shipment/product, and second we will review it from a supply network transparency viewpoint, i.e. the focus is on gathering information on inventories in the supply network.

The tracking approach was tested in project deliveries of a company in mechanical engineering industry. Project deliveries were a natural first application area because they are time critical and several companies participate on processing them [23]. The approach was tested in an industrial pilot installation, which contained an original equipment manufacturer (OEM) company and one of its subcontractors. The subcontractor is an SME. The pilot validated the operational feasibility of the approach, and revealed some major advantages from the SMEs point of view. The most important effect of the tracking approach for the subcontractors is that it provides a lean, low cost way of integrating with the OEM’s system. It is much easier and cost efficient for the subcontractor to establish a checkpoint of the tracking system to its premises than to engage in an application integration task consuming large amounts of resources.

By participating in the tracking efforts with the OEM the subcontractors gain a better visibility to their own delivery performance and thus may be able to enhance the service
level to all their customers. A study performed with a wholesaler of MRO equipment has also revealed that the proposed approach can be taken into use easier than EDIFACT-messaging based approaches, and provides savings in information transfer costs [24]. The functionality of the tracking system is illustrated in Figure 2. An important issue is that besides enabling the installation of lean checkpoints to SMEs premises, direct application integration with partners possessing more IT resources is not inhibited.

![Figure 2 The tracking functionality of the agent-based system](image)

We are currently conducting a feasibility study of the approach used in the furniture industry. This study aims to assess the potential of the system for building inventory transparency for supply networks containing SMEs. The study is performed with a group of companies consisting of a large furniture retailer and five small or medium sized furniture manufacturers. The agent based supply network transparency tool is illustrated in Figure 3.

![Figure 3 The agent based supply network transparency tool](image)

The work up to now has revealed that the approach can offer transparency to a supply network at installation costs easily achievable to SMEs. The lowest requirements for SME partners are one computer with Internet access and two bar code readers. The study is still
ongoing, but current results indicate the approach to be appealing from both the manufacturer and retailer point of view. The easiness and cheapness of implementation of the checkpoints makes the system desirable for SMEs because network transparency can be built with little SME investment. Thus, the retailer has the possibility to include also the smaller suppliers to its supply network management practices, which was infeasible with traditional approaches.

The cases proved that supply chain transparency, i.e. the ability to locate individual shipments/products, and to gather and communicate information on inventories in the supply network, can be established with limited functionality and lean IT infrastructure. The lean approach has been appreciated by the SMEs involved in the cases as they can comply with the requirements of their partners, and enjoy the operational benefits of increased transparency with minimum costs. The larger companies have also found the approach attractive as it enables extending supply network management to their SME partners.

5 Conclusions

Currently available solutions for supply chain transparency do not well suit SMEs. A fundamental problem with the solutions is that they are often built to maximise business efficiency, not to minimise expenses, and thus demand heavy integration and maintenance efforts. However, the functionality needed for building supply network transparency is minimal and, thus, leaner solutions can provide sufficient support for successful supply network management. We can conclude that there are available benefits for both SMEs and larger companies with lean transparency solutions. It begs the question, therefore, why are there no existing wide-scale applications?

Even though supply chain management theory strongly indicates that increased transparency to supply chain inventory and sell through enable remarkable increases in operational efficiency, the benefits have been hard to capture in real life cases [25]. Therefore companies have curtailed investments aiming solely at increasing supply chain transparency, and have focused on larger initiatives aiming also at automating business transactions as the investment needed for any IT development has been considered substantial, regardless of the functionality of the applications. However recent studies have proved that transparency can enable more efficient processes in manufacturing as well as in retail, but it requires that companies adjust their operations accordingly [25].

References