INFORMATION INTERFACE CLASSIFICATION OF ACTORS IN SUPPLY CHAINS

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Abstract

Internet technology with its standards of exchange has been regarded as a method to reduce the amount of communication interfaces among the partners in supply chains. Since enterprises have a huge amount of relationships to partners fulfilling various tasks and business processes, the usage of the internet and its standards can hardly be considered to be the same interface for each actor. In fact, information in the supply chain is transferred via internet technology but depending on position and objective of each actor. Therefore different kinds of data transfers are required and the formats of exchange also have to vary. In this context we propose an interface classification using the internet in supply chain networks. As a result we are able to classify the actor's interface and to depict the exchange of information in supply chain using the internet. This will allow a smooth initiation and execution of the informational exchange between the actors in the supply chain.

Methodology

First of all we view the kernel of the supply chain, along with the actors and their relations. In detail we describe the information flow using the internet and the upcoming necessity of carefully regarding and distinguishing the interface 'internet'. Doing this we define classes of information exchange in the supply chain and assign appropriate technologies and formats used. Within this classification we can depict the interfaces of actors in the supply chain concerning the usage of the internet and further formats.

Emerging Supply Chain Relationships and Actors

Supply Chain Activities in Internet-Based Markets

The industrial age has been an age of large corporations that doing most of the value adding and supplying activities like product creation, distribution and sales. With the upcoming information technology and new organization principles the established monolithic model changed towards a network of various actors, putting together what each subject can do best. The immanence of modern information- and communication technology and constructive relations of exchange shape the form of these value chains and contractor partnerships.

Value creating networks based on the internet are called internet business models (Rayport 1999; Timmers 1998; Rappa 2001; Scheer/Loos 2002), economic webs (Hagel 1996) or business webs (Tapscott et al. 1999). Timmers describes the general structure as "an architecture for the product, service and information flows, including a description of the various business actors and their roles" (Timmers 1998, p. 4). Focusing the idea of a network Hagel defines "clusters of companies that collaborate on a particular technology" in order to "deliver independent elements of an overall value proposition that grows stronger as more companies join" (Hagel 1996, p. 71-72). Tapscott et al. add that the actors "conduct business communications and transactions on the internet and other electronic media in order to produce value for end-customers and for one another" (Tapscott et al. 1999, p. 198). Without doubt, internet technology and its services are the base of value and supply chain relationships (Österle 2000, p. 36-40; Rayport 1999).

Relationships Between the Actors in the Supply Chain

Relationships in a supply chain consist of two or more legal entities as separated actors being linked by goods, information and financial flows (Stadtler 2000, p. 7; Alt et al. 2001, p. 6; Akkermans et al. 1999, p. 4-5). The goods consist of products and/or services (in the following abbreviated with the term output) and can be either digital or physical. Information and financial transactions can always be handled digitally. While material products and services imply exchange relations in a physical environment, digitalized exchange relations, like digital products and services, financial transactions and information itself, can be treated by information technology, in particular the internet. Figure 1 shows the relationships between two actors in the supply chain.

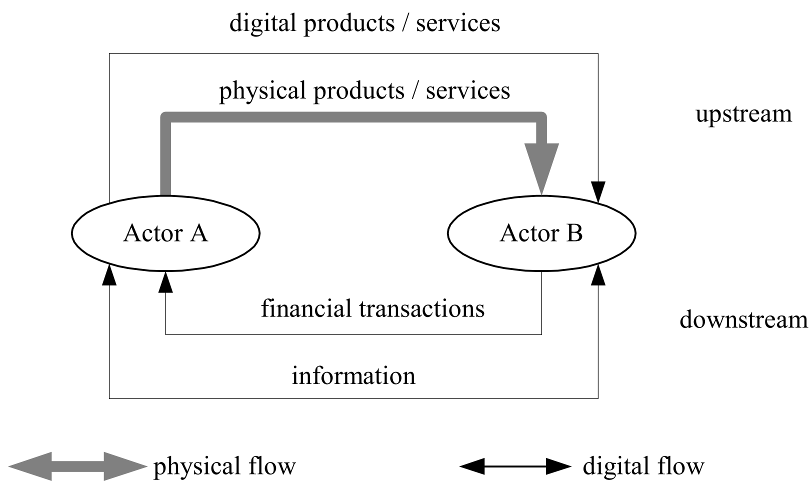


Figure 1. Physical and Digital Flows in the Supply Chain Between Two Actors

Within a supply chain, the actors face each other in different processes and activities in order to provide the succeeding actor with the products and services required. Christopher describes the supply chain as a "network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer" (Christopher 1998, p. 15). The relations of exchange between the customer and the supplier run upstream on one side: the supplier provides the customer with digital and physical products as well as with services. For initiation and execution of the exchange, information is flowing down-stream among the actors who realize the transaction. The supplier then receives monetary compensation through payment transactions from the customer.

Classification of Actors in the Supply Chain

Some classes of market participants are discussed in literature. A common approach distinguishes between businesses, employees, public administration and consumers. These classes can be assigned to a meta level, which can be applied to all business practices (for the used meaning of the term "meta" see the work of Stachowiak, e.g. Stachowiak 1973)

Carried forward to the internet based business activities, many different actors and their roles are differentiated in literature, which are aligned with each other within a value chain and supply chain relationship (Scheer/Loos 2002, Chapter 4). These statements can be assigned - based on their special focus on electronic markets - within the described meta level in order to describe potential actors within an electronic-based supply chain.

Besides the amount of classifications of potential actors within a supply chain relation in the e-business (Rappa 2001; Wagner 1999; European Commission 1998; Sarkar et al. 1995; Tapscott et al. 1999; Kalakota/Robinson 2000; Akkermans et al. 1999), we look at the approach of Wigand and Benjamin, who provide us with an extensive classification.

Wigand and Benjamin pick up the idea of meta levels of potential actors and subdivide the class of businesses into the following sub-classes: producer of informational outputs, producer of physical outputs, intermediaries in an electronic market, information network distributor and physical distributor providing physical transport services (Wigand/Benjamin 1995, Chapter 4 and 5). A similar approach is given by Österle, Leist and Winter who focus on the financial sector (Österle 2000, p. 19-51; Leist/Winter 2000, p. 154-156). Furthermore we distinguish between business customers and (private) consumers in order to depict the different objectives in business and private space. As a result we are able to describe the potential actors in the supply within the following classification (cf. Figure 2).

Actors in meta-relationship	Actors in e-business relationships
Business	Producer of physical products and services
	Producer of informational products and services
	Intermediary in electronic market
	Physical Distributor
	Information Network Distributor
	Business Customer
Employee	
Public Administration	
Consumer	

Figure 2. Classification of Actors in E-Business Relationships

Businesses can be divided into suppliers of physical and digital products and services. Business activities based on physical output require the existence of material structures, whereas digital output can completely be managed via information- and communication systems because of their immaterialness. Therefore producer of physical output supply their products and services within an adequate environment, while producer of information goods (software, music, media, financial transactions) can wind off their transactions without physical restrictions in an information and technology based surrounding. Physical distributors such as conveyances and information network distributors (e.g. internet service provider) offer services for the transport of either physical or digital products and services. Intermediaries perform mediating tasks in electronic markets (e.g. broker, portals). Sarkar calls them Cybermediaries (Sarkar et al. 1995, Chapter 1). Within the class of business we also look at business customers which purchase products and services in the view of a company. The demands of a business customer are different from these of a private customer (consumer). A business customer has regular requirements of material and uses computer systems to plan his requirements. In order to refine his own plans he needs to integrate the seller-side systems into his own systems (e.g. e-procurement). A consumer only uses the shop-system of a supplier to satisfy his own private demand. He does not need any integration into his private computer systems.

Employees are bound by work contracts to a certain company or public institution and support services in their working environment which is stamped by information- and communication technology.

Public administration and institutions contain social, national or religious facilities, which exercise mandatory tasks in statutorily boundaries. Leist and Winter point to the necessary existence of these facilities within the value chain, that offer products and services with a special amount of credibility and trust (e.g. notarizations) (Leist/Winter 2000, p. 4).

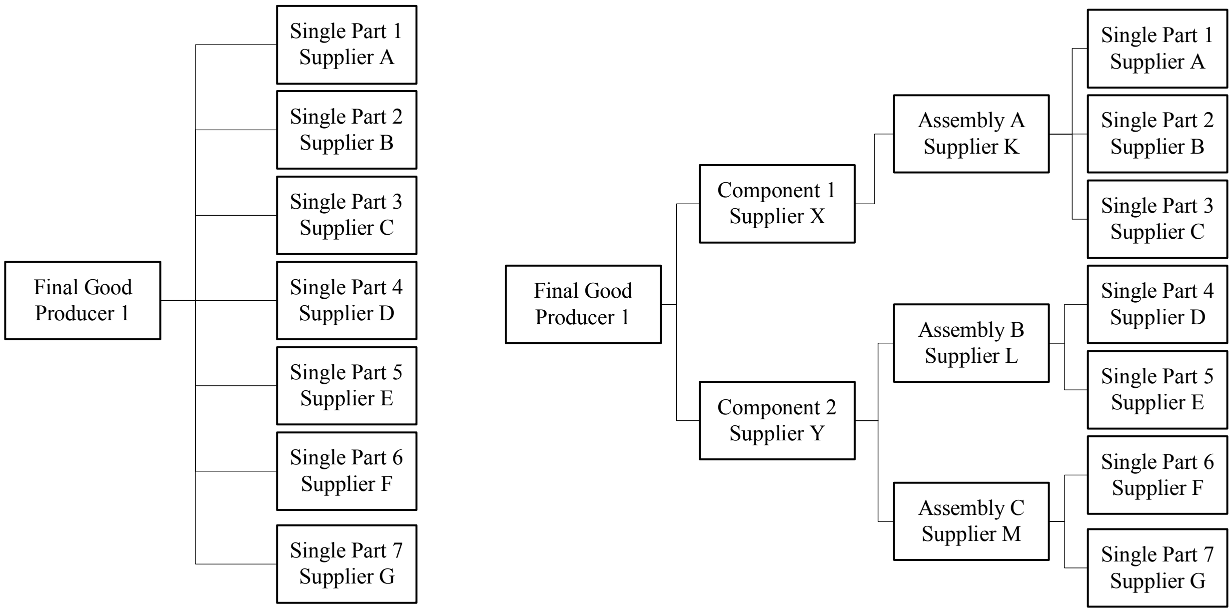
In literature, the **consumer** is considered to be an essential part of the supply chain. He or she is familiar with modern information- and communication technology and therefore is a so-called "Homo Informaticus". The consumer seeks an appropriate service for his needs and additionally desires a spatial and temporarily detached interaction with the supplier side, reduction of complexity, aggregation of information, more efficient time management, high degree of comfort as well as maximum flexibility (Fey et al. 2000, p. 260).

Information Flow in the Supply Chain Based on the Internet

The basic exchange relations (chapter 2.2) among the different actors within an increasingly extensive supply chain (chapter 2.3) lead to a wide variety of exchange relationships. Modular Sourcing which describes the increasing modularization of tasks in the supply chain, further supports this effect. The desired reduction in production depth of the individual enterprise leads to a reduction of active interfaces, as only suppliers of system components need to be connected. Considering the chain as a whole, a variety of interfaces emerge among the different actors (cf. Figure 3)

Scenario 1:
Producer 1 manufactores with single parts

Scenario 2:
Producer 1 manufactores using modular sourcing strategy



Consequence:
7 customer-supplier-relations

Consequence:
2 customer-supplier-relations on top-level,
overall 12 customer-supplier relations

Figure 3. Amount of Interfaces Between Enterprises

The increasing number of sub-contractual relations can cause a so-called bullwhip or whiplash effect, if the production plans have not been harmonized with each other, especially with partners that are the foremost supplier within the chain. (Forrester 1972, p. 21-42) The mentioned effects are caused by fluctuations in sales prognoses or future supply predictions. The effects get worse, the more distant the supplier and the customer are from each other. This causes 2nd- or 3rd-tier-suppliers to suffer from heavier demand fluctuations as 1st-tier suppliers or even the manufacturer or retailer. (Stadtler 2000, p. 21-25; Lee et al. 1997) The workload of the capacities is driven by the same effect: Partially the cumulated demand needs to be absorbed by extra work hours in high times, whereas in other situations the suppliers cannot operate at full capacity. (Reese 1998)

Information transparency throughout the supply chain can reduce these negative consequences raised by the high amount of exchange relations. Transparency, however, can only be applied by using a consistent design and electronic back-end for the interfaces of the informational exchange. This will replace bilateral negotiations about the communication standards of actors. The objective therefore has to be the exchange via information technology and standardized data exchange formats. "a key driver of supply chain management is the availability of cost-effective information technologies." "Significant investments are required to allow information to be shared across entities so that the activities and decisions throughout the supply chain can be coordinated." (Lee/Whang 1998, p. 1) "The key ingredient for success in managing a supply chain is fast, accurate information from a wide range of operating areas" (Lancioni et al. 2000, p. 54)

Lee and Whang's arrive at the conclusion that the extent of information sharing in a supply chain expands (Lee/Whang 1998, p. 10). The information flow contains inventory information, sales data, order status for tracking and tracing, sales forecast data, production and delivery schedule as well as performance metrics and capacity information. In order to institutionalize this flow of information, they suggest three models:

- Information transfer model
- Third party model
- Information hub model

According to the information transfer model the actors transfer information to an specific actor in supply chain who maintains the database and the IT-System for supply chain information. The third-party model involves a third party whose main function is to collect information and maintain it in a database for the supply chain. The information hub model is similar to the third-party model except that the third party is replaced by an distributed information system. Each actor implements individual functional modules of the information system and is connected by information sharing technology like CORBA (Common Object Request Broker Architecture). (Lee/Whang 1998, p. 2-15)

Internet technology volunteers to be the basis for institutionalization of the information flow (Lancioni et al. 2000) which calls for unified data exchange and standardized formats. It should not be omitted that internet technology offers an integrated information interface including lots of standardized exchange formats for all actors within the supply chain. Several issues amplify the fact that the interfaces of the actors differ in consistency and amount. First of all each of the actors require a different kind of interface regarding the formats of exchange due to their field of work and their relations to other parties. Adding to this concern is the fact, that internet technology points to implementing pursuing standards, such as SCOR. These standards are not useful to every actor. Eventually, internet creates exchange relations in an m:n-way which leads to a high amount of relationships and different interfaces between the actors.

We can conclude that the actors in the supply chain have different requirements concerning the information interface due to their task in the chain. The internet technology in a boarder sense can not be used by each actor in the same consistency of basic and pursuing standards.

To specify the information interface for a single actor and his relations we present a classification of information interfaces. It classifies technologies and formats in the supply chain concerning the intensity, with which the actors are connected. As a result we are able to assign the actor's interface to classes in the classification and to depict the relationships using the internet and further formats. This will allow a smooth initiation and execution of the informational exchange in the supply chain.

Classification Model of the Information Interface

A classification of information interfaces in the supply chain network can help to depict all interfaces needed in the flow of information between the actors. The information interface describes the type of data which is exchanged between the participants of the supply chain network independent from the physical exchange of outputs between them.

In order to create a classification model of the information interface in the supply chain, we need to review relevant data exchange formats used by individual actors. Based on the TCP/IP technology, which enables different services for the exchange of information like electronic mail, hypertext or file transfer (Kurbel et al. 1999), a bundle of pursuing exchange formats and models can be used in the supply chain, including exchange standards like EDIFACT (Electronic Data Interchange for Administration, Commerce and Transport) or XML (Extensible Markup Language), data formats like UN/SPSC (United Nations Standard Products and Services Code System), EAN (European Article Number) or XML-based branch standards and process models like SCOR (Supply Chain Operations Reference), RosettaNet (RosettaNet 2002) and CPFR (Collaborative Planning, Forecasting and Replenishment) (CPFR-Committee 2002). (Grünauer 2001, p. 97-99, 116-119)

First of all we build up our classification by describing the information flow at the level of the TCP/IP protocol. This is the standard basis for communication within the internet (Tanenbaum 1997) and is at least necessary to exchange any kind of data between the participants of the supply chain network within the internet. In order to simplify the classification model it is useful to arrange services into this layer, which allow an exchange of unstructured and semi-structured data via the internet from one actor to another. In this context "unstructured and semi-structured data" means any information to be exchanged does not contain any fix scheme or cannot be interpreted semantically except for addresses or other protocol-dependent data. (Steffens 1995) Typical services in this layer are e-mail and www (See also: Kurbel et al. 1999).

To exchange structured data in a universal way it is necessary to define unique data exchange formats. Because these formats (not to be mistaken with ASCII or Unicode) are not defined in the TCP/IP-Model a new layer has to be created, which describes different exchange formats. This new layer uses the TCP/IP-protocol as communication basis. So the data exchange format layer has to be implemented above the TCP/IP-Model.

As an example the established exchange format for interorganizational communication EDIFACT is described. This is especially used for the exchange of business documents among companies. (UNECE 2002) The handling of EDI-Systems is regarded to be complex because of various parameters and settings. As a consequence these EDI-Systems are only suitable for linking up customers or suppliers with a large amount of transactions and a high quality of the documents to be exchanged. Also initial investments have to be considered high. Because small and medium enterprises have only a moderate amount of transactions, the use of EDI-Systems is not profitably for them. EDIFACT is also questionable, if control checks and improvements of the transferred documents are necessary on a regular basis.

Another example of data exchange formats is XML as a document description language for the internet (Grünauer 2001, p. 113-119). It turned out to become the standard meta language for electronic catalogs and business documents. In the field of electronic catalogs, several different XML instances like cXML (Commerce XML) or xCBL (XML-based Common Business Library) have been established. (cXML Organization 2002; xCBL Users Group 2002) To reduce the number of interfaces within a supply chain network, it is necessary to establish a common XML instance within the entire supply chain and to keep the amount of arbitrary field definitions as small as possible.

If companies in the supply chain network do not only want to exchange business documents but like to optimize their common processes, the above described layer of data exchange formats is not sufficient. In this case process models have to be used, such as SCOR, RosettaNet or CPFR-Guidelines. They have to define a common language for processes and procedures for all companies participating in the supply chain network. These models also have to be independent from the used data exchange format as well as from the used TCP/IP-protocol. Therefore they are located as a new layer above the TCP/IP and the data exchange formats.

As an example the SCOR-Model is described: It represents activities within a comprehensive value chain among a number of companies. This process reference model defines a standardized language for company internal as well as spanned communication with the supply chain partners. SCOR spans all customer interactions from order entry through paid invoice, all product [...] transactions […] and all market interactions, from the understanding of aggregate demand to the fulfillment of each order. The SCOR model defines five main processes “plan”, “source”, “make”, “deliver” and “return”. On the Configuration Level these can be further described by Process Types such as “Planning”, “Execution” and “Enable”. At this level 30 process categories are available. The next level of the SCOR-model presents detailed process element information for each process category. Each element is defined, its performance is measured and best practices are given. (Supply Chain Council 2002; Meyr et al. 2000)

Figure 4 shows the compiled classification of the information interfaces in the supply chain network.

Class	**Name**	**Exchange formats and models**
D	Exchange of process data	SCOR, CPFR, RosettaNet
C	Exchange of structured data	XML inclusive different instances, EDIFACT
B	Exchange of unstructured data	TCP/IP reference model and basic internet services
A	No exchange	No exchange between the actors

Figure 4. Different Classes of the Information Interface in the Supply Chain

Finally the positioning of the above derived layers build the classification model of the information interfaces (cf. Figure 4). This model can be used to classify the information interface between the actors of the supply chain network. Because some actors do not exchange any information within the supply chain the class “A” is built. Class “B” contains the TCP/IP model together with the standard internet services like www and e-mail. Based on this layer the next classification “C” implies the structured data exchange formats. This layer is used to dispatch business documents between the actors of the supply chain network. At last the level “D” defines a common speech to describe processes and procedures.

Illustration of the Information Interface of Each Actor

In this chapter the communication between the different actors of the supply chain is depicted. Figure 5 shows the classification of the information interface which is necessary for an efficient communication between the actors. For each actor different interfaces can be identified, dependent on the other participant of the supply chain network he has to communicate with.

	Consumer	Public administration	Employee	Business customer	Information network distributor	Physical distributor	Intermediary in electronic market	Producer of informational products and services	Producer of physical products and services
Producer of physical products and services	B	C	B	D	B	D	D	D	D
Producer of informational products and services	B	C	B	D	B	A	D	D	
Intermediary in electronic market	B	C	B	D	B	D	D		
Physical distributor	B	C	B	D	B	D			
Information network distributor	B	C	B	B	B				
Business customer	A	C	B	A					
Employee	B	B	B						
Public administration	C	C							
Consumer	A								

Figure 5. Information Interface of Each Actor in the Supply Chain

The figure shows, that almost each actor in the supply chain has to handle different classes of information interfaces. Dependent on whom he communicates with it might be necessary to exchange data about processes and procedures (class "D") as e.g. producers of physical and informational goods among each other. Only if the definition of common processes is unique and common targets are defined and communicated, the flow of the whole supply chain can be improved.

The higher communication class especially within producers is caused by greater efforts to be made for the planning of a production process, and also by a higher logistical coordination, as far as physical goods are concerned, which is necessary to move the goods from one actor to another. In that case it is essential not only to exchange fix-formatted data beneath the supply chain network, but to communicate and transpose information about defined processes. Therefore the supply chain interface is “D” if both actors are either producer of goods, intermediary or physical distributor. To allow an optimum of communication, common processes and procedures between the actors have to be defined, e.g. based on the SCOR-model.

It is identifiable that the information interface becomes the less complex the less the actor is involved in logistical processes of the supply chain network. Except for public administration, which should offer an interface to exchange structured data, actors like the consumer or the employee only provide a TCP/IP based interface with basic services like www and e-mail. Also the information network distributor only provides the TCP/IP basis. He is not directly involved in the supply chain in form of producing or value adding processes.

Information interfaces classified as “A” depict absence of communication between the actors of the supply chain network. This is e.g. between business customers and consumers (as long as the business customers do not offer their final products to consumers), consumers among each others or business customers among each others (as long as they have no customer-supplier-relation). At last the communication between producers of information goods and physical distributors is to mention. Because these goods are not transported physically but via internet there is also no communication needed between these actors.

Conclusion and Further Research

It has been shown that actors in the supply chain network need to implement different information interfaces. Dependent on the type of data to be exchanged and dependent on the degree of interorganizational process integration it is necessary to define an information interface for structured data, e.g. to exchange business documents, or even to define common processes and exchange process-relevant information. This is especially necessary if producers of physical goods communicate with their suppliers within a complex supply chain network. Without exchanging process relevant information the modular sourcing strategy will not have any benefit for all participants of the supply chain and the associated bullwhip-effect will not be avoided. Dependent on the type of exchanged data different investments into the information interface have to be made.

As a next step the roles of the actors should be defined closer and the classification model of information interfaces should be refined. Therefore also complex relationships between business customers or even between private consumers (e.g. buyer aggregator and buying communities) should be taken into consideration.

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