Integrating Organizations in a Supply Chain with Electronic Contracts

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Abstract

Agreements between trading partners can be used to regulate the cooperation of organizations in a supply chain. They are typically written in a natural language which leaves room for interpretation and makes them hard to implement and enforce. Moreover they are often rudimentary so that many details have to be worked out during operation. It is therefore desirable to have a method that helps in designing more formal agreements, electronic contracts, that can improve the cooperation between partners. We suggest an approach to solve this problem based on a business-action model of the interaction between organizations in a supply chain.

1. Introduction

The economic activities within and between organizations in a supply chain can be coordinated in two different ways: via hierarchies (i.e. internal coordination) and via markets (i.e. external coordination). There are likewise two major theories that claim to explain why a particular way is preferred in a given situation: Agency Theory [1, 20, 34, 39] and Transaction Cost Economics [6, 23, 36-38]. Based on these theories the internal and external coordination costs can be determined [16]. High external costs favour centralization, high internal costs promote decentralization. It is assumed that organizations in a supply chain choose their organizational structure and network of trading partners in such a way that the sum of both costs is minimized.

The impact of information technology (IT) on this choice has been debated for quite some time and different hypotheses were advanced. Early work by [29] suggested that IT will lower transaction costs and therefore, ceteris paribus, lead to an increase in market coordination. Later work posited that organizations will "move to the middle", i.e. to "more outsourcing, but from a reduced set of stable partnerships" [5] if non-contractible issues (e.g. quality and trust) play an important role. Empirical evidence [19] shows that companies often operate in a "mixed mode" blending aspects from both markets and hierarchies.

As a result organizations in a supply chain are trying to extend their internal hierarchy to cover also their suppliers to some degree. So instead of buying from an anonymous market they prefer to engage into closer cooperation with fewer suppliers to exert more control over them and to ensure the tight coordination required for the provision of increasingly complex products and services. Such a relationship is not necessarily stable over a longer period of time, though, and after its termination a new (potential) supply-chain partner is acquired via the market for the start of a new relationship. Hence relationships of that type have a project character. The supply chain is constantly transforming.

The extended use of hierarchy-like coordination between organizations in a supply chain on the operational level requires that the partners integrate their business processes more closely than in a market scenario. Through a detailed analysis of the interactions between the partners we can determine the prerequisites for this integration and help with the design of an appropriate electronic contract that corresponds to the conventional trading partner agreement and that regulates the cooperation. This analysis is performed with the help of a particular modeling language for business processes called DEMO that represents a certain perspective on organizations, namely the business-action perspective. The next section motivates the choice of this particular perspective for modeling interactions between (and within) organizations.

The remaining sections of the paper are structured as follows. First we give an overview of the business-action perspective on organizations. We motivate the use of that specific perspective for modeling business processes and we show why modeling of organizations in a supply chain in particular can profit from it. The focus is on interactions between partners in a supply chain and relevant organizational units. For this purpose we introduce the interaction model of a methodology called DEMO. Based on this model we develop transaction models which represent a more detailed account of the interaction. In the section "Electronic Contracts" we proceed by giving an outline of the structure of such agreements. We take a closer look at two of their components, business rules and collaboration model, and show how they can be derived from the detailed description of the interaction between the organizations in a supply chain. Fig . 1 depicts the overall process.

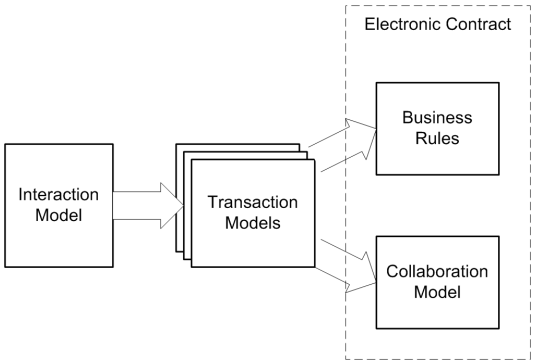

Fig. 1: The design of an electronic contract

All examples and figures used in this paper are excerpts from the real models we designed in the course of a consulting project where we tested the feasibility of our approach. The section "A Case Study" gives further details on this project. Last but not least we conclude this paper by summarizing the main arguments and specifying directions for further work.

2. A Business-Action Perspective

At the core of the business-action perspective is Business Action Theory (BAT) [11-13]. It represents a general framework for business interaction that has undergone considerable empirical validation [3, 4, 14, 18, 21, 22, 25, 27, 31, 32]. It can therefore be considered a stable foundation for the analysis of business processes. Its origins are in Speech Act Theory [2, 35] and the Theory of Communicative Action [17] but in addition to social aspects BAT also considers material (i.e. physical) aspects. In BAT a process is divided along two dimensions into phases and layers, respectively.

The main phases are proposals, commitments, fulfilments and assessments which are complemented by pre- and post-transactional activities. The layers are transaction group, business transaction, exchange, action pair and business act. We extend this classification scheme by a third dimension: regularity, which consists of regular behaviour and exceptional behaviour.We show that a process model to support interorganizational workflows has to be on the business-act level. But such a model would be to large to form a part of the framework contract. We therefore suggest to split this model into regular and exceptional behaviour, where the former is covered by an collaboration model (in the form of a diagram) and the latter by business rules (in tabular, textual form). We also relate how we used this approach in the context of a project that involved a logistics provider and a retail chain. All the examples throughout the paper are taken from this case. Fig. 2 shows the components of a business transaction in this framework.

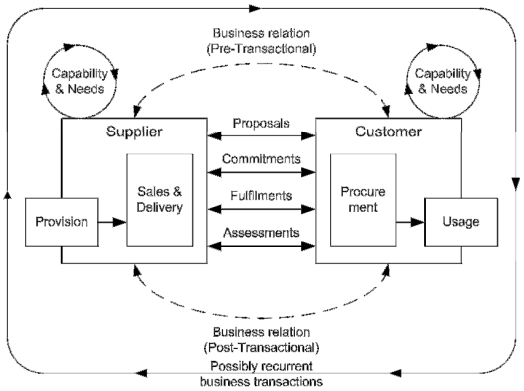

Fig. 2: A business transaction in BAT (Lind and Goldkuhl, 2005)

Some business modeling methodologies provide their own modeling languages, e.g. Action Workflow [7, 30], Conversation-for-Action [40], Action-Based Modeling [24], and Dynamic Essential Modeling of Organization [8, 9, 28]. In contrast to such approaches BAT does not come with its own language. Instead its proponents suggest to use the language of SIMM (Situation adaptable work and Information systems Modelling Method) [10, 11, 13, 15]. Lind and Goldkuhl [25] recognize that the weak coupling between method and language is a problem but they defend this approach nevertheless.

The deficiencies of SIMM are particularly problematic when we intend to develop electronic contracts. Here we need a language that provides two features that SIMM lacks: business-action patterns and transaction layers. Business-action patterns elaborate the phases of BAT by structuring the interaction between partners in a supply chain and they guide us in defining a contract. Transaction layers have been introduced into BAT by Lind and Goldkuhl [26] but they were not incorporated into SIMM.

DEMO, on the other hand, provides both action patterns and transaction layers. It implements many of the central ideas of BAT and is therefore a suitable language for modeling interaction between partners in a supply chain. In addition to that DEMO is formalized to a larger extent than SIMM which facilitates the design of electronic contracts, i.e. formal representations of the business interaction. DEMO has also roots in language action.

This communicative aspect is important in an inter-organizational context where we cannot rely on a common structure when coordinating activities that cross the boundaries between organizations. This raises a demand for additional communication, particularly in two areas. Firstly a contract has to be negotiated that regulates the relation between the cooperating parties, and secondly there is also an increased need for communication between members of different organizations in the daily routine work. This is due to the fact that a member of organization A typically has a limited knowledge about organization B and also little access to internal information of B. This can partly be compensated by introducing Inter-Organizational Systems (IOS), which formalize to a certain extent the otherwise more spontaneous, ad-hoc communication.

The central concept in DEMO is that of a transaction. In it two roles are engaged: the initiator and the executor. Each transaction is assumed to follow a certain action pattern which consists of 3 sequential phases each of which is made up of business acts. The phases are: order (O), execute (E) and result (R). This leads to the following layers: transaction, phase and business act. In the order phase the contract is negotiated. This involves typically a request being made by the initiator and a promise by the executor

to carry out the request. In the execution phase the contracted business action is executed. Finally, in the result phase the executor states that the agreed result has been achieved and the initiator accepts this fact. If anything goes wrong the participants can decide to move to the discussion or discourse level [33].

The following section describes one of DEMO's models, the interaction model, which will serve as a basis for deriving the transaction models, which in turn lead us to the business rules and the collaboration model.

The Interaction Model shows actors and transactions. The actors are roles that are enacted by a person, an organizational unit or a whole organization. Fig. 3 shows the Interaction Model of our case. The main actors are the Logistics Provider, the Headquarters of the retailer and the Shop.

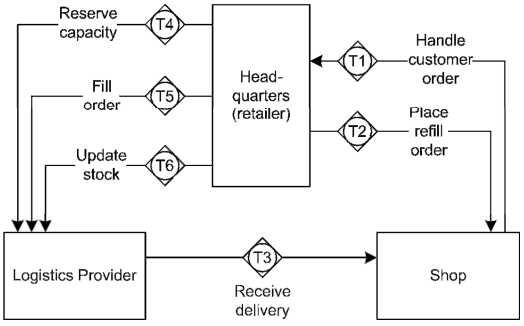

Fig. 3: Interaction model

A transaction is represented by a diamond with an enscribed circle that contains the number of the transaction. An undirected arc connects it with the initiator, an arrow points from it to the executor. In fig. 3 we have added the name of the transaction, which coincides with that of the contracted action, to enhance readability. Fig. 3 describes the process of capacity reservation and order handling among these organizations. It starts when Headquarters reserve capacity for handling a certain amount of ordered items in advance of the actual order (T4). The Logisitics Provider (LogPro) allocates staff and space so that the reserved capacity can be provided at the time the respective order arrives. But the capacity required by the order might actually be higher or lower than the one that was reserved.

The product assortment consists of basic-range products and seasonal products. The latter are distributed according to turnover quota and are not part of the order process. Orders for basic-range products can be initiated either by Headquarters or by the Shop. The former happens when the Shop is running low on certain products. Headquarters will in such a case suggest to to the Shop to place a refill order (T2). For this purpose they send an order proposal containing the products in question which, after possible changes and/or additions is returned. If customers ask for specific products, the Shop can also place a so-called customer order (T1). Headquarters will forward both types of orders to LogPro (T5). The delivery to the Shop will then be performed by LogPro which includes picking items, packing them and handing them over to the carrier. Finally the Shop receives the delivery (T3). This consists of the arrival of the goods and a confirmation. The confirmation can be accompanied by a complaint if items are missing or wrong ones have been sent.

Periodically Headquarters will also ask for an update of the stock (T6). This is necessary because they run their own warehouse management system which is not integrated with that of LogPro. The next section describes how the transaction models can be derived from the Interaction Model. This is an intermediate step towards the two parts that make up the electronic contract, i.e. the business rules and the collaboration model.

Transaction Models

Much of the detailed behavior that constitutes a business process is hidden inside each transaction. For the specification of the electronic contract this has to be brought to light because it constitutes the content of the Business Rules and the Collaboration Model. A transaction in DEMO is made up of a number of business acts.

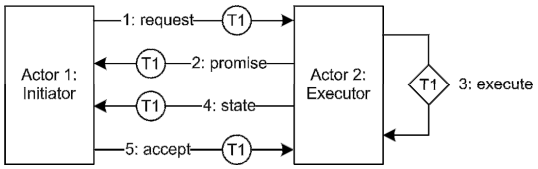

Fig. 4: Transaction model of T1

The order phase has at least two elements: a request and a promise (see fig. 4) but longer negotiations (including a failure) are possible. If an agreement was reached in the order phase, the contracted action (E phase) is executed and the result phase is entered. As a minimum this can consist of the business acts state and accept. Fig. 4 summarizes these steps which are performed in the order that is indicated by the leading numbers. For the actors we use the same notation as in the interaction model. A business act is represented by a circle containing the number of the respective transaction. An arrow goes from the performer via the circle to the addressee. The arrow is annotated by the name of the business act which can be preceded by a sequence number. The contracted action is represented by a diamond containing the number of the respective transition. The arrow starts and ends at the executor. A model that contains only actors, business acts and contracted actions is called a business-act model. A

business-act model that contains only actions and actors belonging to one transaction is called a transaction model.

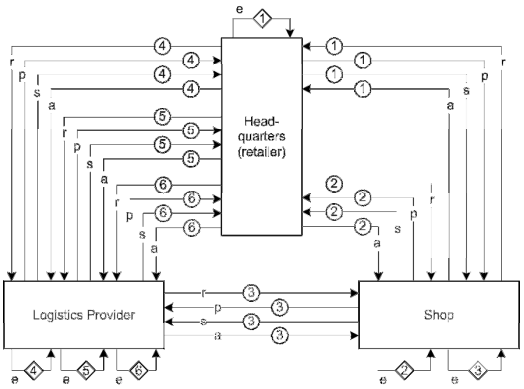

Fig. 5: Complete business-act model of the case

Fig. 5 shows the complete, minimum business-act model of the case in fig. 3. As business-act models can be very complex for realistic cases we will usually refer to a set of transaction models instead. The following section shows how these can support the development of electronic contracts in general and the business rules and collaboration models in particular.

3. Electronic Contracts

An electronic contract is a formal representation of the cooperation between a number of organizations. It consists of a static and a dynamic part. In the static part we find product or service specifications, prices and general conditions. The dynamic part defines the roles that each party to the contract plays and the activities they perform in the context of the cooperation. It is this dynamic part that we focus on. In principle we could claim that the business-act model already contains most of the information necessary for this part but this approach is not sufficient for at least two reasons. Firstly this model is typically very complex for realistic cases as the example of fig. 5 (which contains only a small part of the overall model) indicates.

It is therefore unsuitable for communicating knowledge about the obligations implied by this process structure to the respective parties. But one of the most important requirements of a good contract is that the parties signing it should be fully aware of its implications. Secondly the business-act model is hard to implement. It does not give us any directions as to which of its activities are supported by information systems integration and which not. Both issues can be addressed by dividing the behavioral model into two components: Business rules and collaboration model. The latter is a detailed workflow-like model of the cooperation. It is structurally very similar to the business-act model but it contains only a fraction of the actions. It shows only standard, routine behavior that can be performed or largely supported by information systems integration. This facilitates the enforcement of the contract.

The business rules then cover exceptional or non-routine behaviour. This kind of behavior does not occur often enough to economically justify an integration of the involved information systems. Such behaviour would also crowd the collaboration model too much. It can be better represented in a separate table. The next section describes the development and the use of the collaboration model and the business rules in detail.

Collaboration Model and Business Rules

When developing the electronic contract we look at each transaction in turn. We first create a business-act model of the respective transaction as described in the section "Transaction Models". The result is a very detailed model with all the steps that have to be performed in the course of the transaction. Fig. 6 shows as an example the business-act model that corresponds to transaction T5.

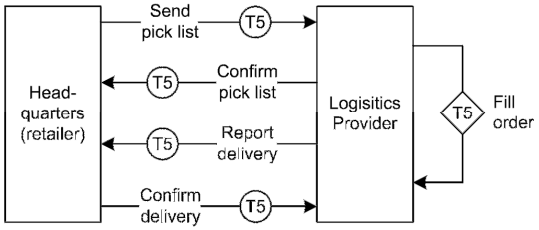

Fig. 6: Business-act model of transaction T5

The aim of that transaction is to fill the order, i.e. to deliver the items contained in the order. It starts when Headquarters send a so-called pick list to LogPro. This list names the products to be picked (and delivered) and their quantities. The associated activity is a routine activity and the information is important for controling the process of filling the order. It will therefore be entered into the collaboration model (see fig. 7). The information systems of Headquarters and LogPro are integrated in such a way that the list is sent electronically as a "pick file".

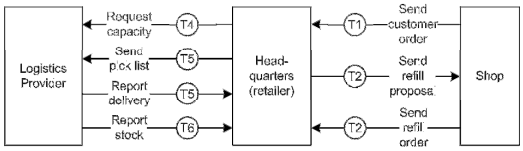

Fig. 7: Collaboration model

The next step in transaction T5 is that LogPro confirms the receipt of the pick list. As the warehouse management system of Headquarters mirrors that of LogPro an out-of-stock situation

cannot occur. LogPro only has to confirm that enough resources are available (staff, shelf space) to handle the order. As the reserved capacity (T4) is usually sufficient an explicit confirmation is not required but is per default assumed. The respective speech act does therefore not appear in the collaboration model. Instead we create a business rule that is activated in the case of an exception, i.e. if the required capacity does exceed the reserved one by more than the specified percentage value (see table 1, T5, promise).

Table 1: Business rules

Tn	Phase	Business Rule
T1	promise	A request to deliver items is per default granted and hence not confirmed. In case of out-of-stock a respective notification is sent.
	state, accept	covered by transition T3
T2	state, accept	covered by transition T3
T3	request, promise	covered by transition T1 or T2
	accept	If 'confirm receipt' was O.K. no further message is sent. Otherwise the claim is processed (return/resend).
T4	promise	A request for a capacity (forecast of required capacity) is always accepted and hence not confirmed.
	state, accept	The provision of the requested capacity is guaranteed. Hence no confirmation is required.
T5	promise	The pick list is accepted per default, no confirmation is sent. If the amount of items to be picked exceeds the limit specified in the general terms and conditions of this agreement (in relation to the reserved capacity), a special arrangement is made (rescheduling of warehouse staff / higher unit price).
	accept	This is implied by the receipt of the delivery. If items are missing or wrong ones have been sent a respective complaint is sent to LogPro and wrong items are returned to LogPro.
T6	request, promise	The updating of the retailer's warehouse system is done via an automatic, daily file transmission containing a stock report. Request and promise are therefore obsolete.
	accept	The receipt of the stock report is assumed. If transmission fails, manual troubleshooting will be invoked.

As a special arrangement has to be made for solving this problem in each specific case this activity cannot be supported by information systems integration. The logistics managers at both companies have to negotiate this solution.

The contracted action "Fill order" is not considered in the electronic contract because it concerns only internal behavior of LogPro. The next step in transaction T5 is that LogPro reports the delivery. This is a routine activity and Headquarters needs this information for billing purposes. It is therefore a part of the collaboration model. The final step, confirm delivery, is implied by the receipt of the delivery (T3). The exceptional case of a wrong delivery is handled by the business rule T5, accept (see table1).

The same is done for the remaining transactions T1 - T4 and T6. This leads to the complete collaboration model in fig. 5 and the complete list of business rules in table 1.

4. A Case Study

The approach we have described so far was tested in a project that we carried out with representatives from both the Logistics Provider and their customer, a retail chain. One of the aims of that project was to improve the existing agreement. Our approach helped us to develop a proposal for a new contract based on a thorough analysis of the interorganizational business process. The old contract was vague which led to a series of problems:

1. Indistinct communication structures: It was often unclear who communicates with whom regarding which issue.

2. Lack of trust: Different interpretations of the contract by the parties led to expectations that were not fulfilled.

3. Lack of information: LogPro was not provided with the information they need for a reliable capacity planning, This had not been specified clearly in the old agreement.

4. Excessive communication: A significant amount of personal interorganizational communication was spent on handling everyday work. This was only necessary because of insufficient specification of routine procedures in the existing agreement.

5. High transaction costs: Ad-hoc solutions to exceptional problems increased transaction costs.

Using the approach introduced in the previous sections we developed a proposal for a new, electronic contract that addressed the issues 1, 2, 4 and 5. The new agreement specified more precisely the obligations of each party concerning the behavior at the interface between the organizations. This

reduces the room for interpreation of the contract which leads to more realistic expectations and ultimately to increased trust (issue 2). The collaboration model clearly states who interacts with whom regarding which issue. This clarifies the communication structures (issue 1) and reduces the amount of "unnecessary" communication (issue 4). Business rules specify the behavior in exceptional situations eliminating the need for developing ad-hoc solutions. This reduces transaction costs (issue 5).

5. Conclusions

A business-action model of the interactions between organizations can contribute towards the design of electronic contracts. In particular the interaction model of DEMO allows us to develop first the transaction models, detailed business-act models of each transaction, and ultimately the dynamic constituents of the contract: Collaboration model and business rules. The former represents routine behavior that is typically supported or performed by an integration of the respective information systems and it is formally a reduced version of the complete busines-act model that provides the same level of precision. The latter complements the former and describes the exceptional and/or situational behavior in form of a table.

An electronic contract that is developed in this way is less ambiguous which facilitates the implementation of the procedures and the enforcement of the rules and conditions. This can reduce transaction costs, the need for extraneous communication and the reliability of commitments. Ultimately this leads to an increased level of service quality and improves the mutual trust among the participants in the cooperation.

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