Information Systems Frontiers 4:3, 285–302, 2002

Electronic Markets for Architects—The Architecture of Electronic Markets

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Abstract. *In recent years there has been a move towards more cooperation in the construction industry. While the traditional practice is that the architect chooses the trades, provides the construction plan, and tells the trades what to do, a new initiative has been formed to create cooperative construction teams. Here the architect will discuss details of the construction plan with the trades concerned and all parties work cooperatively on the construction project. This means that there will be many coordination tasks and that communication plays a pivotal role. The paper presents a framework for and an implementation of an electronic marketplace to support such cooperative construction teams. It will be argued that there must be a co-design of the business system (i.e. cooperative construction teams) and the IT system (i.e. the marketplace including the search, negotiation, and fulfilment phases) for efficiently supporting small and medium-sized companies participating in cooperative teams and interacting on electronic marketplaces.*

Key Words. *electronic marketplace, negotiation support, communication system, cooperation, communication modelling, language-action perspective, architecture*

1. Introduction

Electronic Commerce (EC) has turned from a research vision into reality. Nowadays, many companies interact electronically and many EC frameworks such as Intershop (www.intershop.com) or CommerceOne (www.commerceone.com) and applications such as auctions sites (Bichler, 2001; van Heck and Ribbers, 1999) have been developed.

Electronic marketplaces provide a forum for bringing together buyers and sellers with the aim of enabling and supporting trade (Schmitt and Schneider, 2001; Schoop et al., 2001). In recent years we have seen different implementations of the concept of an e-marketplace. For example, some portal approaches (such as www.baunetz.de) concentrate on providing facilities for finding new partners. Interactions leading to a business deal and fulfilling the related contract are not supported and thus need to take place outside the portal. Other approaches (such as www.chemunity.com) automate the interactions. No search for potential business partners is possible but a request is directly sent to approved suppliers in an auction-like manner.

One of the advantages of business-to-business electronic commerce (BtB EC) is the electronic integration of negotiation and ordering processes with the rest of the business process. The integration can help to reduce costs and is expected to speed up the buying or selling process. However, such an integration has yet only taken place in large enterprises, for example in the automobile industry. A large enterprise can set requirements for its smaller suppliers to adhere to a certain standard, e.g. following certain procedures using pre-defined protocols, installing certain software for electronic data interchange (EDI) etc. Interactions between large companies are usually long-term relations based on frame contracts. A small or medium-sized enterprise (SME) usually conducts business with various companies, has more flexible business structures, and operates on a smaller scale. SMEs could benefit from EC approaches but they require different support than large companies (Quix and Schoop, 2000).

In the present paper, we will present an EC approach for SMEs in the construction sector. In particular, the co-design of new business systems (namely of cooperative construction teams) and of IT systems supporting the new business structures will be discussed. In the following section, the context of the present work will be introduced before the detailed research aim and the related research methodology will be discussed

(Section 3). Results from field work in the construction sector led to the development of a framework for efficient communication support in electronic marketplace that is based on established theories of communication and grounded in the Language-Action Perspective. The theoretical foundations will be presented in Section 4. The co-design described above will be introduced in Sections 5 and 6. In Section 5, we will discuss the architecture of an electronic marketplace for SMEs before the design of such a marketplace for architects initiating cooperative construction teams will be presented in Section 6. Final remarks and an outlook to future work will conclude the paper (Section 7).

2. The Context: Cooperative Approaches to Construction Projects

The construction industry is characterised by the interaction of professionals from different disciplines. For example, an architect acts on behalf of the building owner, negotiates with different tradesmen such as roofers or bricklayers who purchase goods from wholesalers who in turn interact with manufacturers of, for example, roof tiles. Traditionally, there was a clear hierarchy: The architect initiates the business interactions with the tradesmen once the complete construction plans have been finalised. There is no discussion about the plans; the tradesmen have to work according to the plans and do not discuss them with the architect. Moreover, the architect does not ask for the tradesmen's opinions even if the details of the plans concern their area of expertise. Interaction between the trades is neither encouraged nor discouraged; it usually takes place on the building site in an ad-hoc matter if at all.

In recent years, there has been a move towards more cooperation especially among SMEs. It has been recognised that cooperation is essential to ensure smooth interactions during a construction project. Such a project is itself a highly cooperative process. Professionals from different disciplines need to work together efficiently in order to ensure that the construction project is finished on time and with the required quality. Furthermore, it has been found that the different professionals need to interact during their interwoven tasks and that the different tradesmen can contribute to a better construction plan. If the architect is willing to discuss the construction plan for which he was solely responsible, then it is possible to detect potential problems or conflicts before the final plan is drawn up. The preliminary plan can be assessed by the trades separately or in joint interactions. Such a pre-check can save costs and avoid re-drawing of the plan. On a more interpersonal level, such a cooperative approach to the shared work plan shows that the architect values the tradesmen's contributions which, on the side of the tradesmen, can in turn lead to a higher identification with the project and thus to increased efficiency (Schoop, 1998).

A construction project executed in the above way will be called a *cooperative construction project* in this paper. *Cooperative construction teams* engage in a cooperative construction project and jointly decide beforehand on costs, margins, and other shared details.

The business model of cooperative construction teams is that SMEs can only compete against large-scale building companies by joining forces. The teams have a higher flexibility and can offer more individual solutions while offering a competitive price and being able to react quickly on customers' demands. This requires a network of trusted business partners that have all agreed on the cooperative processes beforehand.

3. Research Aim and Outline

Having set the scene by introducing the context of the present work, namely cooperative construction teams engaging in cooperative construction projects, we will now discuss the research aim and outline the present work.

3.1. Research aim

The general aim is to introduce electronic marketplaces to the construction industry and in particular to small and medium-sized architectural practices. Our research aim is to support such companies in their electronic interactions efficiently and to exploit the potential of information technology (IT) to create new and better opportunities for business compared to the existing traditional forms of business. In interviews with architects we found out that one of the most fruitful application areas of electronic business would be to support cooperative construction teams in their complex interactions on electronic marketplaces. This will be the focus for the remainder of the present paper.

3.2. Research outline

To achieve the research aim, the following two goals were identified.

On the one hand, the business systems of cooperative construction teams need to be supported. The initiative has just started and much needs to be done to establish such cooperative approaches:

- New business structures need to be developed. A new workflow structure of a cooperative construction project needs to be created. The new workflow differs significantly from the old one. For example, the construction plan will have to be approved/assessed by the partners before it is finalised; teams might decide to work together continuously; tradesmen get new obligations (such as commenting on the construction plans, liaising with their colleagues before going out on the building cite) and so on.
- New ways of doing business need to be established. While the traditional form of doing business in the construction industry was for the architect to send out calls for tenders, followed by offers made by the relevant trade companies, an efficient cooperative approach can only work if there are efficient mechanisms for support. In general, information technology will be used to create new ways of doing business since it offers the required technology for cooperative support. For example, time is a critical factor for construction teams. Both architect and tradesmen are often on the construction site and thus cannot be reached at all times for synchronous interactions. Asynchronous work is vital and IT can provide the required mechanisms to support asynchronous work efficiently. This means that tradesmen and architects need to get to know and use information technology.
- New business patterns will develop. Cooperating in construction projects in the way discussed before will lead to the development of new patterns of cooperation, communication, and business interaction. For example, the strict hierarchy (architect acting for the project client issuing orders to the tradesmen telling them what to do) is dissolved. A tradesman now has the opportunity to enter into vertical discussions with the architect (e.g. about the construction plans) and into horizontal discussions with the other companies involved. Furthermore, the model of "one face to the customer" will be used; the cooperative construction team will jointly deliver the service of realising the construction project. This means that coordination and trust among the participants is vital since all are mutually dependent.

On the other hand, efficient IT systems have to be created to support the new business models efficiently. The cooperative teams need IT for their complex and highly interactive exchanges. As mentioned before, asynchronous work can be supported efficiently by IT systems. Furthermore, some of the routine interactions can be automated, e.g. the cost calculations, some parts of the workflows etc. Moreover, information technology offers models such as marketplaces that deal with the interaction of different professionals while retaining the possibility for the architect (or the client of the construction project) to choose among competitors. Parallel exchanges and mass communication are supported. As will become clear later, the issue of electronic negotiations plays a central role for cooperative construction teams. Information technology is required to support human negotiators in their complex tasks of interacting electronically (Schoop and Quix, 2001). For example, contract management can be integrated into structured message exchange for electronic negotiations; obligations can automatically be deduced and checked for satisfiability; interactions can be automated using auction settings and so on.

Both goals, i.e. the establishment of new business systems and the development of IT systems for the new business systems, are interwoven. The business system is the basis for the IT system to be developed. The need for cooperation must exist before the IT support can be of use. On the other hand, IT can help to further the cooperative approaches. IT opens up new possibilities (such as electronic negotiations, asynchronous written exchanges, efficient partly automated workflows etc.) which in turn will lead to further refinements of business systems. Therefore, the co-design of business and IT systems is required. Otherwise, IT systems will not be used (as has been discussed, for example, in Forsythe (1992)) and new business systems will not work due to media restrictions.

3.3. Research methodology

The research is multidisciplinary in character, that is it combines ideas from philosophy, linguistics, sociology, computer science, and mathematical logic. Therefore, multiple methodologies are used and briefly discussed in the following paragraphs.

3.3.1. Ethnographic investigations. In order to develop the foundations for efficient IT support of cooperative construction teams engaging in cooperative construction projects, field research was necessary to analyse the real requirements for such support. The method of qualitative research employed was

ethnography (Burgess, 1984; Hammersley and Atkinson, 1995) which aims to be free of the researcher's own presuppositions and to provide accounts from the participants' point of view. Furthermore, ethnographic investigations are relatively unobtrusive and cause little disruption to the setting observed. The ethnographic methods used for the present work will be discussed in the following sections.

3.3.1.1. Participant observation. Participant observation is the ethnographic method that involves observing people in a natural setting over a prolonged period of time, and talking and listening to them. In the present context, participant observation was employed in three settings.

Firstly, the face-to-face negotiations between architects and tradesmen were observed. The aim was to find out which information is necessary for each professional group in the context of a (cooperative) construction project, which information is exchanged during the negotiations, which items are negotiable and which will not be discussed etc. The negotiation scenarios were used because they were the manifestations of interactions between architects and tradesmen and thus showed both viewpoints.

Secondly, the discussions between the client and the architect were observed. They showed particular terminology in use and the general patterns of interaction.

Thirdly, a cooperative construction team was observed. The aim was to find out the motivation of each participant, the method of set up, the costs involved, and the interactions in general.

3.3.1.2. Document analysis. Four types of documents were analysed in the course of the field work. Firstly, the construction plans are the basis for interactions between architects and the different trades. Apart from the specific requests made by the architect, the plans play an important (non-verbal) information medium. Secondly, the calls for tenders were analysed. In them, the architect specified the products and/or services required by the different trades. Usually, these specifications are based on established norms and catalogues of trade services. Thirdly, the replies from the trades, i.e. their offers, were analysed. The offers were of no standard format and were often difficult to compare. Both the calls for tenders and the subsequent offers are the most important forms of coordination and direct interaction. A call for tenders specifies the basis for the business interaction while the related offers show how the trades involved are willing to negotiate, how their offers differ, and what their requirements for a structured process are. Fourthly, subsequent documents exchanged between the partners involved such as letters, reminders, counter-offers etc. were analysed.

3.3.1.3. Interviews. Once familiar with the work practices, less time was spent observing and informally talking to the participants and more time was spent carrying out interviews. The types of interview used were unstructured and semi-structured interviews (Burgess, 1984). Unstructured interviews were used at first to find out about the participants' views on the (cooperative) building process and in particular on the negotiation phase. Secondly, semi-structured interviews were conducted with the architects specifically to find out about the possibility of conducting the negotiation process electronically, and on the potential and existing problems in traditional negotiation processes.

3.3.2. Theoretical foundations. The choice of a solid theoretical framework as the basis for our approach was influenced by the findings of the ethnographic work. It was found that communication plays a central role in interactions between architects and other professionals. Therefore, established theories of communication were used to analyse existing problems and to develop a framework for communication support in the present context (see Section 4).

3.3.3. System development. The third methodological strand is the prototypical realisation of our approach. A prototype of a marketplace for SMEs in the construction sector was built and empirical evaluations were carried out with an architectural practice.

3.4. Summary

The aim of the present work is to provide IT support for cooperative construction teams interacting on electronic marketplaces. To achieve this aim, co-design of new business systems, namely cooperative construction teams engaging in cooperative construction projects, and IT systems of efficient marketplaces to support such structures is required.

Since the interactions among the members of cooperative construction teams are characterised by a high level of communication in order to negotiate, cooperate, and coordinate, the idea was to look at established theories of communication to find help in analysing

existing problems and to provide the basis for IT support that can help to avoid and overcome many of these problems. The next section will present the two communication theories that were found to be the most relevant ones.

4. Theoretical Foundations: The Language-Action Perspective

The ethnographic studies showed that the exchanges between architects and tradesmen are highly interactive and involve a large amount of communication. Calls for tenders and offers are types of written communication. The negotiation phase is characterised by exchanges of communication acts in various forms such as face-to-face discussions, telephone conversations, letters, fax messages etc. In electronic forms of negotiations, the communication acts take place via a written (electronic) medium.

It has been reported that fundamental communication problems exist in written communication (Schoop, 1998; Schoop and Quix, 2000). Problems that can be solved easily in face-to-face interactions, can lead to serious problems when the communication is written. If these problems remain unsolved, they can lead to complete breakdowns in communication which in turn can lead to cooperation breakdowns. Therefore, potential problems need to be anticipated. It was decided to look at established theories of communication to find out whether they can provide help for the analysis and classification of communication problems and for developing a framework for IT support avoiding (most of) these problems.

Two obvious candidates of communication theories were Searle's Theory of Speech Acts and Habermas' Theory of Communicative Action. Both have been influential in the area of information systems. Both theories were found to be intuitively understandable and useful for the present context. The theories are located within the so-called Language-Action Perspective which forms the theoretical foundation of this work. First the relevant elements of the two theories of communication will be introduced.

4.1. The theory of speech acts

John Searle published the Theory of Speech Acts in 1969 (Searle, 1969). His aim was to show that "speaking a language is performing speech acts ... in accordance with certain rules for the use of linguistic elements" (Searle, 1969, p. 16) and to formulate these rules (Searle and Vanderveken, 1985).

Searle argues that the minimal unit of an utterance is not a word or a sentence but a speech act. There are two distinct components of a speech act: a *propositional content* and an *illocutionary force*. The propositional content describes what an utterance is about whereas the illocutionary force describes the way it is uttered. Taken together, both components provide the meaning of the utterance and both have to be known to understand the speech act. Each act has got a "point" which characterises that particular type of speech act. For example, an assertion is about informing other people, a request is about getting the recipient to perform an action etc. This purpose of the act is called the illocutionary point. Searle classifies utterances according to the illocutionary point and proposes the following five classes of speech act:

Assertives represent facts of the world of utterance or common experiences, e.g. reports or statements.

Directives represent the author's attempt to get the recipient to perform the action indicated in the propositional content, e.g. requests.

Commissives represent the author's intention to perform the action indicated in the propositional content, e.g. promises.

Expressives say something about the author's feelings or psychological attitudes regarding the state of affairs represented by the propositional content, e.g. apologies.

Declaratives change the world through the utterance of the speech act. The author brings about the state of affairs represented by the propositional content solely by uttering the speech act, e.g. sentencing a prisoner or performing a marriage.

Searle argues that the illocutionary force imposes certain conditions on the propositional content of an utterance, in other words what an utterance can be about. These conditions are called *propositional content conditions*. For example, a report can only be about present or past events.

Preparatory conditions express an author's presuppositions when uttering a certain speech act. They have to be fulfilled for a non-defective performance of the speech act. For example, an author using any directive force presupposes that the recipient is capable of carrying out the requested action. Preparatory conditions can also be related to the propositional content. Most utterances presuppose the truth of certain propositions. For

example, if an architect asks a company to make an offer for the roof work of a construction project, the architect presupposes that the company is a roofer company.

Each illocutionary act implies a *commitment* for either author or recipient. An assertive speech act commits the author to the belief in the statement, an expressive statement commits the author to the psychological state expressed, a declarative statement commits the recipient to both belief in the statement and intention to bring about the change. The most important forms of commitment occur in commissive and directive speech acts because these types of act deal directly with the coordination of actions and utterances between communication partners. Directives commit the recipient to carry out the action represented in the propositional content whereas commissives create a commitment for the author to carry out the action.

4.2. The theory of communicative action

Jürgen Habermas published his Theory of Communicative Action in 1981 (Habermas, 1981). He takes Searle's theory as a starting point for his own theory reflecting his concerns with pragmatic aspects of language. Like Searle he argues that a speech act is the elementary unit of linguistic communication and that each speech act consists of an illocutionary force and a propositional content. The illocutionary force establishes the mode of communication between author and recipient and thus the pragmatic situation of the content of the utterance. The propositional content establishes the relation between the utterance and the outside world.

A central argument in Habermas' theory is that "we understand a speech act when we know what makes it acceptable" (Habermas, 1984, p. 297). So what makes a speech act acceptable? It must satisfy conditions that enable a recipient to say "yes" to the speech act. These conditions are not specific to certain author-recipient pairs but are general for all possible actors uttering and hearing similar speech acts. Through the utterance of a speech act, an author makes an offer to the recipient to accept the speech act and enter into a rationally grounded relationship. The basis for such relationship are rational agreements that can be negotiated, criticised, changed etc. No force or threats are used, everything is out in the open. Habermas concentrates on those conditions that motivate the recipient to accept the speech act offer, presupposing that the utterance is grammatically correct and that conditions for this particular type of speech act are fulfilled. Thus, Habermas implicitly presupposes that the preparatory and propositional content conditions (using Searle's terminology) are satisfied and introduces further conditions of his own (Schoop, 1998). A speech act can only be successful if the recipient says "yes" to certain *validity claims* raised by the author which are determined by the illocutionary force of the utterance.

From the viewpoint of a recipient, there are three levels of reacting to a speech act:

- the recipient understands the utterance, i.e. (s)he grasps the meaning of what is being said;
- the recipient says yes or no to claims raised through the utterance of the speech act, i.e. (s)he accepts or rejects the speech act offer;
- following an agreement, the recipient accepts obligations and commitments arising from the speech act that are determined by social conventions for this utterance.

Habermas argues that an author making an utterance makes four implicit validity claims:

- that the utterance is *comprehensible* so that the recipient can understand the author;
- that the utterance is *true*, i.e. it represents a fact or a common experience, so that the recipient can share the author's knowledge;
- that the utterance is *truthful*, i.e. the author's intentions are expressed in a sincere way, so that the recipient can trust the author;
- that the utterance is *appropriate* in relation to a given normative context, values, or standards so that the recipient can agree with the author in these values.

The four validity claims can be seen as four areas where communication can break down and require reparative action: If the utterance is incomprehensible then the author must rephrase, explain, or translate it. If the truth of an utterance is challenged then the author must justify the utterance, for example by explaining it, supplying more information, pointing to common experiences etc. If the recipient challenges the author's truthfulness then the author's intentions are called into question. Communication can only continue if the author succeeds in restoring the trust, e.g. through acting consistently, assuring the recipient of the author's sincerity etc. If the appropriateness of an utterance is challenged then the recipient questions the author's right to perform the speech act, e.g. if an author's role does not entitle him or her to do so, if an author violates recognised values or acts contradictory to norms. These problems

are usually solved by pointing to other (unproblematic) standards and norms, referring to common experiences, citing relevant literature or authorities etc.

4.3. The language-action perspective

The broader context of the present work lies in the so-called Language-Action Perspective (LAP). LAP is based on Searle's and Habermas' theories and focuses on communication aspects in information systems.

LAP was first introduced in the field of information systems by Flores and Ludlow (1980) who argued that human beings are fundamentally linguistic beings and act through language. It was argued that language is not only used for exchanging information as in reports, statements etc. but also to perform actions, e.g. promises, orders, declarations etc.

The conventional perspective on information systems stresses the contents of messages rather than the way they are exchanged (Lyytinen and Lehtinen, 1984). For example, data flow diagrams are used as primary design tools. Thus, the focus is on the form and structure of messages (Dignum and Dietz, 1997; Schoop and Taylor, 2001). In contrast, the Language-Action Perspective emphasises what people *do* while communicating, how language is used to create a common reality for all communication partners, and how their activities are coordinated through language. Here, the focus is on the pragmatic aspect of language, i.e. how language is used in particular contexts to achieve practical goals such as agreements or mutual understandings. This new approach argues that as social action is mediated through communication, the main role of an information system should be to support organisational communication (Schoop, 1998). LAP has since developed into a new paradigm for the design of information systems.

There are a number of basic assumption underlying LAP (Lyytinen, 1985; Verharen, 1997), for instance:

- The basic unit of communication is a speech act.
- Natural language sentences correspond to the performance of speech acts.
- The meaning of sentences can be revealed by specifying the speech acts that have been performed.
- Speech acts obey socially determined rules.
- Cooperative work is coordinated by the performance of language actions which are speech acts.

The early work on LAP is based on Searle's Theory of Speech Acts. As a result of criticism of the shortcomings of Searle's theory (e.g., Dietz and Widdershoven (1991) and Suchman (1994)), Habermas' Theory of Communicative Action is nowadays used in combination with Searle's theory as the philosophical foundation of LAP.

The Language-Action Perspective is not merely a philosophical framework but has stimulated the development of a number of methodologies and computer-based tools such as the Coordinator (Flores et al., 1998; Winograd and Flores, 1986), SAMPO (Lyytinen and Lehtinen, 1984; Auramäki, Lehtinen, and Lyytinen, 1988; Auramäki, Hirschheim, and Lyytinen, 1992a, 1992b), DEMO (Dietz, 1994; van Reijswoud, 1996), and Cooperative Documentation Systems (Schoop, 1998, 1999).

4.4. Summary

We presented the theoretical foundations of the present work, i.e. Searle's Theory of Speech Acts and Habermas' Theory of Communicative Action, and the broader context, namely the Language-Action Perspective.

The following section will present an architectural framework for electronic marketplaces for SMEs by introducing a three-phase model of a business transaction. The model will serve as the basis for our approach to IT systems supporting cooperative construction teams that has been influenced by the two communication theories introduced in the present section.

5. The Architecture of Electronic Markets

In this section we will discuss the general architecture of electronic markets. A three-phase model of a transaction on a business-to-business marketplace will be introduced in the following section. The model will be used to identify for each phase the current practices in electronic marketplace that show the state-of-the-art in such environments (Section 5.2). Furthermore, we will use the model in Section 6 to improve the current practices for the context of marketplaces for cooperative construction teams.

5.1. A three-phase model of marketplace transactions

During a commerce process, the involved participants usually go through three phases (Schmitt and Schneider, 2001; Schoop et al., 2001; Selz and Schubert, 1997; Papazoglou et al., 1998), see Fig. 1. Firstly, a party looks for potential business partners. A

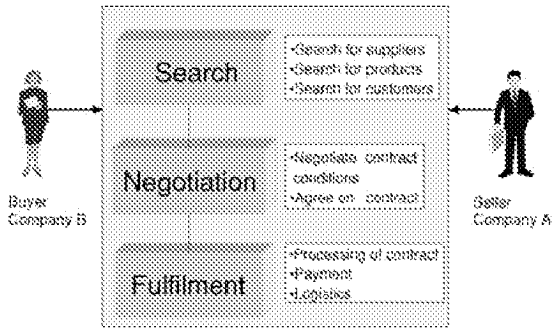

Fig. 1. Three phases of a marketplace transaction.

buyer wants to find relevant suppliers of the product (s)he is looking for; a seller might want to find potential customers for the products (s)he can supply. After locating potential (new) partners, the second step is to come to an agreement that is acceptable to all partners. Partners might bargain about the price, might find a compromise about the delivery dates, might negotiate about quality aspects of the products. The aim is to finalise a contract that specifies the business deal. Therefore, this second phase concerns negotiation about details of the agreement. If the negotiation is successful then a business deal is struck and the outcome is a contract which will then have to be processed by the partners in the third phase, for example concerning logistics, payment etc. The general model that can be extracted from the above observations is one of three phases.

The search phase is about finding business partners; the negotiation phase is about finding agreements leading to a contract; the fulfilment phase concerns the execution of the contract. The three-phase model is independent of any technological means, i.e. it is valid for traditional commerce processes as well as for electronic commerce interactions. For example, a buyer might look for potential suppliers in the yellow pages, in the catalogues of chambers of commerce, or on the internet.

The three-phase model is certainly not the only model of a marketplace transaction. There are variations on the model such as the reference model for electronic markets (Schmid and Lindemann, 1998). They name the three phases as information phase where information about companies and products is sought and which ends with the submission of an offer; agreement phase where negotiation takes place and which ends with a contract; and settlement phase which deals with the fulfilment of the contract. These three phases are combined with different views on the business process (such as transaction view and business view). There are other models that differentiate the phases on a finer scale (see, for example, Schmitt and Schneider, 2001). We found that our three-phase model represents a marketplace transaction in the present context in sufficient detail. The negotiation phase is the most important one for our work. We decided not to further dissect this phase since there is no clear-cut between, for example, informal and formal negotiations. Therefore, we deal with one negotiation phase but distinguish between negotiations in an informal way and formal negotiations. More details are presented in Section 6.2.

5.2. Current practices in the three phases

Having looked at different marketplaces in the business-to-business area, the following general observations concerning the current practices in the three phases of electronic marketplace transactions can be stated (Schoop et al., 2001).

The search phase consists of (extended) keyword search based on some classification, for instance a product catalogue, a list of companies in a certain branch etc. Using these kinds of search mechanisms presupposes good knowledge of the search items by the search party and an appropriately structured search domain. For example, if a company would like to find new business contacts or would like to find suppliers of certain products that have different names in different companies, then keyword-based search is clearly insufficient.

The protocols of electronic negotiations that are usually supported in electronic marketplaces are auctions or electronic catalogues. In the latter case, the option is one of "take it or leave it"—either to order at the price specified in the catalogue or not to enter into the business transaction at all. Auctions can be useful for settings where interactions are formalised and do not require extensive negotiation cycles. The products concerned need to be specified exactly and the main issue is getting the best price for the product (Bichler, 2001). However, certain problems are obvious. Complex negotiations cannot be supported by such a model. For example, the cheapest supplier might not be the one offering the best quality, the cheapest supplier might not be trustworthy, the third cheapest supplier might be able to deliver much quicker than the cheapest one etc. Even multi-attribute auctions can often not deal with these complex dependencies. Furthermore, if negotiations

concern frame contracts, then a different negotiation protocol is required. Highly interactive exchanges that occur in traditional commerce can be transferred to electronic commerce where, on the one hand, the potential of information technology can be exploited to offer new functionalities and to support effective interactions and, on the other hand, information technology cannot (and indeed should not) replace the human negotiator by an automated software agent but rather support human negotiators in their tasks (Schoop and Quix, 2001).

The fulfilment phase is the one that is usually covered best in any electronic marketplace. Payment models are supported (usually payment by credit card) and an integration with the companies' logistic systems is achieved. If all goes well after the contract has been finalised then such a model is sufficient. However, if disagreements occur between the parties as to which obligations need to be fulfilled, whether certain duties have been carried out according to the agreements made during the negotiation etc., there is hardly any support to help solving such problems. No history behind an agreement is usually provided that could help the parties or an independent third party to understand why certain agreements have been reached and where the specific problem lies.

To summarise, there are potential problems with respect to current practises for all three phases, especially in the context of marketplaces for SMEs that require flexible support for their dynamic structures. In the following section, we will discuss required enhancements of current practices in electronic marketplace to provide efficient support for cooperative construction teams led by architects.

6. *Electronic Markets for Architects*

The general three-phase model of a marketplace transaction (search-negotiate-fulfil) is the basis for our approach to electronic markets for architects and their cooperative construction teams.

Cooperative construction teams can be realised as half-open or closed platforms consisting of different professionals from the construction sector. In the first case, some participants of a cooperative construction team would be chosen from the marketplace participants while others would be invited from the outside and then chosen according to the traditional procedures as described in Section 2. In the latter case, the marketplace participants agree in general to make business with each other and then compete for the different construction projects.

Based on the field studies, we can state that the business system of a cooperative construction team interacting on an electronic marketplace will be that of a closed community. The team will be led by the architect because (s)he will be the one directly interacting with and acting on behalf of the client of the construction project. The architect can then enforce certain entry criteria. For example, only those companies could be admitted that would fulfil the required technological preconditions such as internet facilities, email systems, ability to interact electronically etc. Cooperative construction teams are envisioned as large networks of multiprofessional communication activities. In order to be successful and efficient, enough tradesmen must participate to provide a market of competitors large enough to choose the company that fits the current construction project best. However, in order to achieve such a large network, a half-open solution can be chosen for the beginning to get enough tradesmen interested in the cooperative approach.

A cooperative construction team emphasises the cooperative nature of a construction process. Communication is mostly done electronically via the marketplace. However, we concede that there will always be situations in which the participants will want to interact face-to-face or use the telephone. Nevertheless, these exceptions can be well integrated in our solution. The aim of a marketplace for cooperative construction teams is to bring together the companies that are well suited to the requirements of a particular construction process, to invite the participants to discuss the construction plan and give their opinions on it, to open up new communication channels and cooperation possibilities, and to enable asynchronous work. For example, the different trades can enter into discussions and can coordinate before they go out onto the building site. They might share costs for equipments etc. As has been discussed before, the new technology will change the whole structure of the processes involved while supporting the essential communication element in the interactions that is present in traditional exchanges.

We will now present our marketplace for cooperative construction teams, drawing on the empirical findings and our theoretical foundations. The basis for the marketplace is the three-phase model as discussed in the previous section.

6.1. Search

During the search phase, the architect will look for participants in the cooperative construction team that fit the requirements of the current project best. Recently, portals for the construction sector have been developed (such as www.baunetz.de/ or http://www.constructionsite.co.nz/ or http://www.buildingonline.com/). In general, portal solutions offer search facilities but do not support the actual negotiation about contract details. It is possible to place calls for tenders and thereby to reach a large audience and, on the other hand, to search for calls for tenders and thereby to be able to find potential business opportunities "under one roof". Once business partners have located each other, the support terminates. Therefore, the portal solutions do not support cooperation per se.

The current practice in marketplaces of offering (extended) keyword-based search mechanisms is not efficient when the search item cannot be defined in every detail. We expected the architects and trade companies to require sophisticated search mechanisms such as semantic search based on business ontologies (Leune and Papazoglou, 1999). However, we found that such sophisticated facilities, although helpful for finding new business partners or companies offering services or products which cannot be specified completely, were not the highest priority in electronic markets. The architects, for example, stated that based on their experience, they were often able to formulate a search query with the necessary detail. Therefore, keyword-based search is sufficient in many contexts.

The search phase for the required marketplace would thus have to offer both keyword-based and semantic search mechanisms. The commercial portals can meet most of the requirements. Therefore, such portals could be used for the search phase, extended with semantic search facilities as developed in the MEMO project (Leune, 2000).

6.2. Negotiation support system for cooperative construction teams

The second phase of an electronic marketplace transaction is that of negotiation. This phase is by far the most important one for cooperative construction teams. Negotiations are vital parts of business transactions among SMEs and the highly dynamic communication exchanges need to be supported efficiently. In this section we will present a negotiation support system as part of our marketplace for cooperative construction teams.

6.2.1. Negotiation support. As discussed in Section 5.2, negotiation approaches in electronic marketplaces have focused on automating the negotiation process. In an auction setting, a buyer places a bid and the seller chooses the highest of these bids. There are one-dimensional auction formats where the only item under negotiation is the price. In multi-attribute auctions, complex goods with many attributes or combination of attributes can be negotiated (Bichler, 2001). Another common approach to negotiation support is that the buyer indicates a preferred price together with the highest tolerable price. This model is useful when software agents take over the "negotiation" (Schoop and Quix, 2001).

However, complex negotiations are not possible using these models. Negotiations in the traditional commerce process do not always concern bargaining only nor only single bids but consist of complex interactions. Furthermore, if negotiations concern frame contracts, complex exchanges take place that cannot be covered by a simple model.

In a marketplace for cooperative construction teams, an architect will initiate the negotiation processes with the different trades. Since the ultimate aim is to achieve a cooperative agreement that will be acceptable to all business partners, the negotiations can be expected to be complex communicative exchanges. Therefore, we argue for negotiation *support* rather than automation. Human negotiators should be supported in their complex tasks by efficient technological tools but should retain control over the negotiation process.

Our approach to negotiation support is based on the following framework called DOC.COM that combines efficient communication management with document management, see Fig. 2. Each negotiation in our framework consist of messages and documents. Messages represent the dynamic interactive part of a negotiation while the documents abstract from the interactions and filter out the relevant information for a contract version. Each message leads to a new document which represents the current version of the business contract. Only if the final message is an act of acceptance, will the final document version become the business contract and the negotiation be terminated successfully. Both messages and documents are integral parts of our negotiation support system and their combination is vital to provide a holistic support of the negotiation process. Traditional document management systems support the evolution of documents by keeping track of different versions. However, such systems do not provide facilities to track

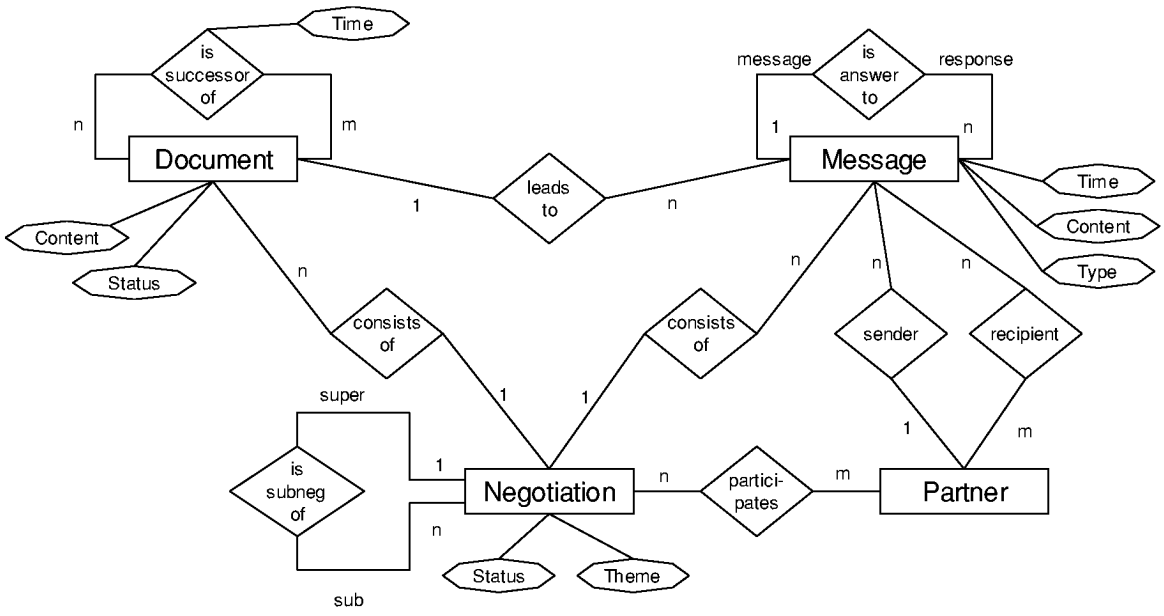

Fig. 2. *DOC.COM framework (Schoop and Quix, 2001).*

the messages which are exchanged during the evolution of a document. On the other hand, communication management systems manage the structure of messages that are exchanged but do not consider the documents that might be initiated by the messages (Schoop and Quix, 2001). Therefore, our DOC.COM framework provides a novel basis for efficient negotiation support in business-to-business electronic marketplaces that are particularly suitable for SMEs. DOC.COM shows the conceptual design of a negotiation support system. The next step in the design cycle is the logical and physical design. We will illustrate our discussion about negotiation support for cooperative construction teams by presenting an implementation of DOC.COM.

6.2.2. Negotiation protocol. In face-to-face interactions, the intended meaning of an utterance can be figured out by observing the speaker's tone, his or her body language, gestures etc. In electronic (i.e. written) forms of communication, there must be a new way of establishing the speaker's intended meaning to ensure unambiguity. A tradesman needs to know whether a message received is meant as a formal order of goods or as a mere enquiry about the possibilities of delivering the goods. To this end, two mechanisms have been developed. Firstly, we distinguish between a formal and an informal workspace for a negotiation. Interactions in the informal workspace can be questions and answers and preliminary requests and offers. No commitments arise and the participants can get into contact and get to know each other in an informal way. The informal workspace was developed to reflect current practices in traditional commerce where such informal exchanges play an important role. Once the business partners are sure that they want to enter into serious negotiations, they change to the formal workspace for their interactions. In the following, we will concentrate on the formal workspace and will not further discuss the informal exchanges.

The second mechanism for unambiguity is the introduction of message types. In our approach each message in the formal workspace has a message type which reflects its illocutionary point and thereby identifies the role of the message in the negotiation process. The type of each message is made explicit to ensure that all participants know what the sender's intended meaning of the message is. The following seven basic message types are included in the negotiation system:

- Offer: usually issued by a supplier to a potential customer; can only be used to start a negotiation or to reply to the first request made by a customer.

- Request: usually issued by a customer to potential suppliers; can only be used to start a negotiation.
- Counteroffer: can be issued by both seller and buyer as a reply to an offer, a request, or another counteroffer.
- Accept: represents the acceptance of the latest proposal; is the prerequisite for terminating a negotiation successfully.
- Reject: represents the final rejection; is the prerequisite for terminating a negotiation process without reaching an agreement.
- Confirm: is used by buyer or seller as a reaction to the acts of acceptance or rejection; terminates the negotiation.
- Information: represents an informative message and does not represent an action; can be used by all participants at any stage of the negotiation process.

It is obvious that only certain combinations of these message types are sensible combinations, see Table 1. For example, a request can only be followed by an offer, the final acceptance or rejectance of the request. It is not possible to counteroffer nor to reply with another request. The request can also be answered by an information act which shows some need for discussion on the recipient's side.

The negotiation protocol is influenced by Searle's categories of speech acts and by Habermas' remarks on rational communication flows. The *illocutionary forces* (represented explicitly by the message type) help to control the negotiation workflow. The message sequence permitted by the negotiation system reflects the logic of business negotiations. The negotiation process proceeds according to the message order predefined in the system. The implicit expressions in traditional negotiations are made explicit to ensure unambiguity and to help prevent serious communication problems.

In Habermas' theory, four *validity claims* are introduced. They have informally influenced our system design. The message type "information" aims to integrate the claims into the system while leaving the discussion of the exact problem to the users themselves. If one of the negotiators has a *comprehensibility* problem, (s)he might compose a message with the type "information" to ask for further clarification which is related to the claims of comprehensibility and *truth. Truthfulness* is an important issue in negotiations. However, this claim concerns the interpersonal level and we do not believe that technology can guarantee the fulfilment of this claim. Again, we opted for a user-controlled approach in that the negotiators can choose to discuss problems concerning each other's truthfulness using an information act. The underlying issue of trusting the business partner needs to be dealt with in the business systems and can then be supported in the IT system. As can be seen in Table 1, an information act is possible at each step in the negotiation process. Choosing an information act means stepping out of the cycle of serious negotiations to clarify or discuss in a more informal manner. *Appropriateness* of the illocutionary force is ensured by only allowing pre-defined forces that are deemed appropriate in the context. For each message, the possible replies are defined and, therefore, inappropriate message types are excluded. The appropriateness of the propositional content must be ensured by the users themselves.

Table 1. Combinations of message types

Message type	Possible answers
Offer	Counteroffer, Accept, Reject, Information
Request	Offer, Accept, Reject, Information
Counteroffer	Counteroffer, Accept, Reject, Information
Accept	Confirm, Information
Reject	Confirm, Information
Confirm	Information
Information	Information

During a negotiation process, many *obligations* are accepted by the negotiators. They can range from promises to supply information to a formal commitment of delivering goods. Searle states that directive and commissive speech acts commit the recipient and the sender respectively. For example, an order issued by an architect and accepted by a window manufacturer commits the window manufacturer to deliver the goods specified in the order before the given deadline. Furthermore, the architect is then obliged to pay the agreed price. It is very important to make obligations explicit to ensure that the negotiators know their duties at each point during the negotiation process. The obligations can automatically be derived from the message exchange based on the related contract document, the message type, and the message content.

Propositional content conditions are not explicitly included in our system. Empirical studies showed that the participants would deal with possible contents of negotiations (which would represent propositional content conditions) in their business systems of cooperative construction teams. They did not feel the need to be explicitly supported because they are all experienced

Fig. 3. *Start of a negotiation.*

members of the construction sector and know what to write and how to express it. *Preparatory conditions* in a simple form are implicitly included in the system by integrating the search and the negotiation phase, thereby enabling negotiations about products that suppliers offer (see Fig. 3). For example, an architect starting a negotiation about windows presupposes that the invited company is a window manufacturing company. This can be ensured using the above mechanisms. Complex presuppositions (such as "This window manufacturer urgently needs an offer. Thus I can negotiate a low price.") are not made explicit since this would make a negotiation process too artificial. Negotiators do not always want to make their thoughts open for the business partners since a negotiator's asset is his or her negotiation capability.

6.2.3. Message composition. Apart from the message type, other elements that are included in a structured message are the mandatory information about sender, the product name and type, quantity, price, date of delivery and the optional information about the type of payment and other information in the form of free text. The necessary information is often already filled into the message template as a result of the search process as shown in Fig. 3.

The structured message exchange is based on free-text messages enriched by a formal semantics. The negotiators can send the message content in natural language but have the possibility to classify certain elements of the free text, thereby placing a semantics on the text. Thus we deal with semi-structured message contents. The reason is twofold. On the one hand we argue that a formalisation of the message content needs to take place to ensure unambiguity of the message contents. Furthermore, the content of messages needs to be specified to enable queries such as "Which goods do we need to deliver to company A?" or "What did company B offer?" that concern the propositional content. To create contract versions based on the message content, a certain structure needs to be in place. On the other hand, systems that only offer predefined message contents appear too rigid and inflexible. There are always elements of a negotiation that are context-specific. If

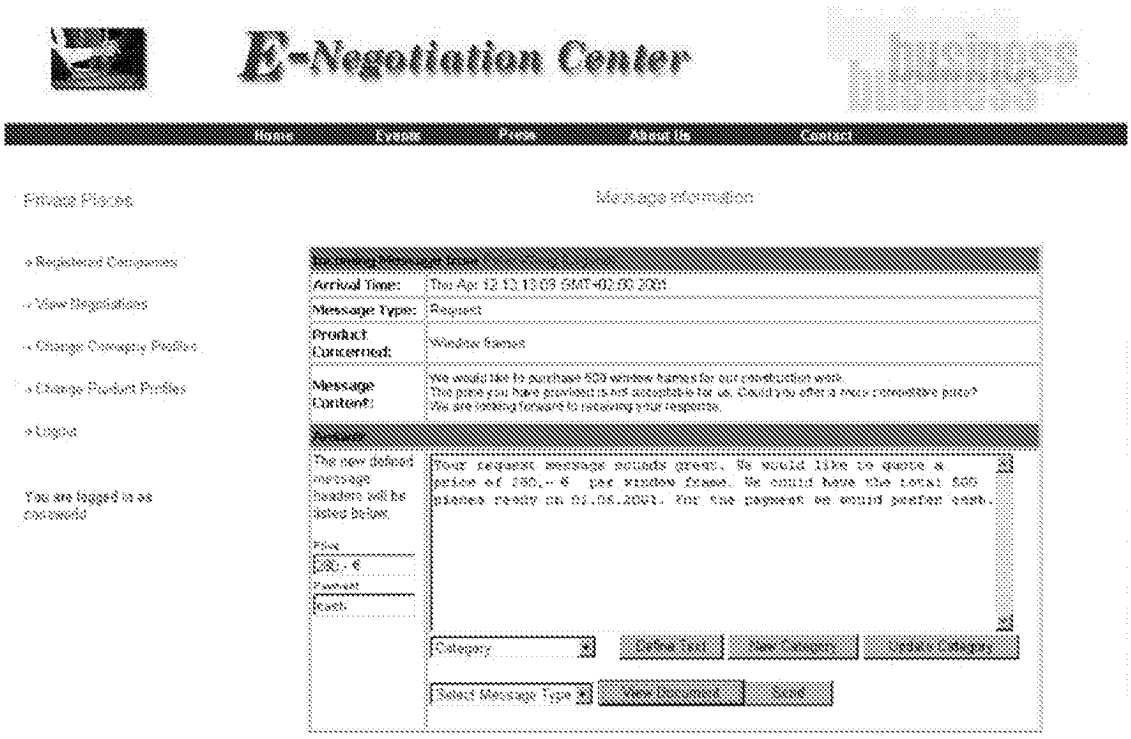

Fig. 4. Answer template.

all possible elements were included, we would have to deal with large templates that are not user-friendly and do not reflect the dynamics and individuality of negotiation processes. Therefore, semi-structured message contents should be aimed for.

In our system, semi-structure means extensible message structures. The user has the possibility of defining parts of the free text block as information of a certain category. A list of categories is pre-defined. Furthermore, the negotiators can also create new categories that they feel are important for their current negotiation. Such a new category can then be placed in the appropriate location of the existing hierarchy of categories.

Fig. 4 shows an example where the free text contains the price of 280€ and the information about cash payment. The user has defined these text blocks as "price" and "payment" respectively. If a user wants to create a category not already specified, (s)he can do so by activating the button "New Category" which opens a window to define the name of the new category as well as its place in the hierarchy of categories.

6.2.4. Contract management. As mentioned before, each message apart from an information message leads to a new contract version. The contract elements are automatically derived from the message structures, both from the pre-defined and from the user-defined fields. The changes to the previous version are shown in red so that it is clear at one glance which modifications have been made. Fig. 5 shows a document version.

An important requirement of electronic negotiations is that the exchanges should be logged to allow backtracking and traceability (Schoop and Quix, 2001). Not only the final agreement but the history behind that agreement is important since it shows the reasons for the agreement (which is often a compromise). This can be helpful for each negotiation partner to assess their negotiation strategies, to find out the reasons for conflicts in the fulfilment phase, and as a memory aid for complex negotiations that continue over a considerable length of time. The structured negotiation exchanges enable such traceability both on the message and document side and on a combined view of both. Therefore, a message-oriented view of a negotiation is presented as well as a document view on the process. Fig. 6

Document of the negotiation in subject: "Window frames for Legend"

between

Buyer: Legend
(Changan Street 28, Shanghai, China)

and

Seller: ConsWorlds
(Peterstraße 208, Aachen, Germany)

I. Description

a) The party A agrees to buy 500 window frames from party B.

II. Purchase Price

a) The purchase price is 300,- €
b) Payment will be made with Pay on delivery

III. Provisions with respect to closing

a) Closing date. The consummation of the transaction contemplated by this contract shall take place on or before 01.06.2001 , or at such earlier date as agreed mutually, unless extended by other previous agreements.

IV. Other contractual provisions

Type	cheque
Discount	10%

Fig. 5. Document version.

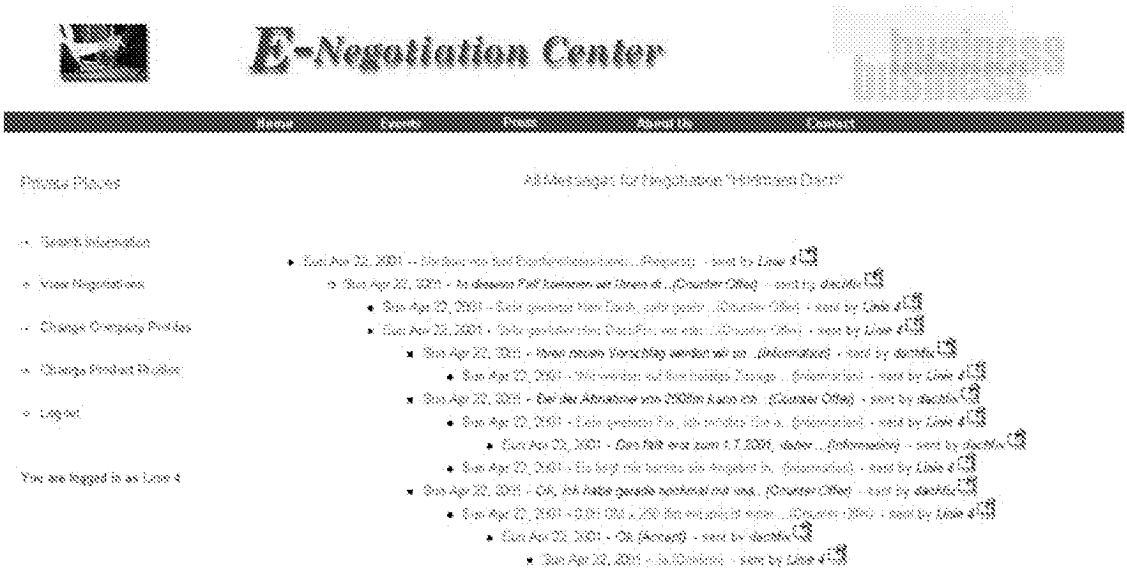

Fig. 6. Message-oriented view of the negotiation.

shows the message view which has links to the related documents.

In our empirical studies, we found that for the architects the documentation is one of the most important elements of the negotiation system. For example, in addition to the advantages discussed above, the documentation of the partner's and the own obligations was found to be vital since this would prevent any participant to pretend that certain obligations were never accepted, that certain statements were never made, that certain utterances were meant in a different way and so on.

6.3. *Fulfilment*

Once a contract is accepted, it needs to be fulfilled in the final phase of a business transaction, namely that of fulfilment. Based on our negotiation system of structured message exchange combined with efficient document management, it is possible to check the fulfilment of the contract items. This could include temporal checks (have the goods been delivered before the deadline; was the payment on time), reminders (you need to pay until tomorrow; some resources need to be ordered from a wholesaler to fulfil the contractual obligations), warnings etc. Such monitoring tasks could be performed by a trusted third party (Schoop and List, 2001).

The fulfilment phase is the one that is supported best in an electronic marketplace since it has a long history of system support. For example, EDI systems deal with the order of products as well as the internal processing of the EDI messages. Furthermore, there exist many logistic systems for inventory management and delivery control. Payment systems can deal with different mechanisms such as payment by credit card, electronic payment, money transfer etc.

6.4. *Summary*

In this section, we discussed the architecture of an electronic marketplace for architects and their cooperative construction teams. We focused on the three-phase model of a business transaction and discussed the necessary refinements for each phase. The work draws on the ethnographic findings. Moreover, an implementation of a prototypical marketplace has been developed.

The search phase is important for cooperative construction teams since the architect will search for and choose the different trades that match best the requirements of the current construction project. The existing portal solutions provide search facilities and in many contexts such simple search mechanisms would be sufficient. However, we discussed the integration with novel semantic search mechanisms for contexts where products or services cannot be completely specified, where related products should be found, or where combinations of search items are important.

The negotiation phase is by far the most important one for cooperative construction teams. These teams are networks of multiprofessional communication activities and, therefore, there must be efficient communication support. The negotiation phase is a communication-intensive phase and deals with complex interactions. We presented an innovative negotiation support system that combines communication and document management.

The fulfilment phase draws on the negotiation phase and is concerned with the fulfilment and processing of the contract details. We found that at the moment efficient IT support for this phase is beyond the scope of the cooperative construction teams. Most participants are small enterprises that have neither enterprise resource management systems nor payment nor logistic systems. What is important in this phase are deadline checks, reminders, and warnings that are already integrated in our marketplace.

7. *Conclusion*

In this paper, we have discussed the idea of cooperative construction teams and presented a framework and an implementation of an electronic marketplace to support such teams. We argued that there must be a co-design of the business system (i.e. cooperative construction teams) and the IT system (i.e. the marketplace including the search, negotiation, and fulfilment phases). The business system is the basis for the IT system to be developed and the IT system will have implications on the business system. The basis for our work is the need for cooperation that manifested in the creation of cooperative construction teams. We argued that IT systems can help to further the cooperative approaches if designed well to fit the existing requirements. We presented an approach that has a solid empirical background and is based on established theories of communication in the Language-Action Perspective.

An electronic marketplace was presented that consists of the search phase followed by highly dynamic contract negotiations and the fulfilment of the contract details. Each phase was analysed and refinements were

proposed and implemented for each phase based on the empirical findings.

Our marketplace has been successfully evaluated with an architectural practice that initiated cooperative construction teams. Our evaluation experiments were conducted in the following way. After an introduction to the system, the architects were asked to interact with a trade company electronically via our marketplace. The participants did not have any face-to-face contact and thus had to interact electronically. The second task was to negotiate about a given call-for-tenders that had been written and negotiated by the architects before using conventional means. After the practical evaluation, the participants were interviewed and filled out a questionnaire. We could show that the tasks could be achieved efficiently using our system. Furthermore, the direct comparison between the traditional and the novel way of interacting showed that our system provided additional functionalities that can help to increase the quality of the interactions. We are currently conducting validations with a cooperative construction team. The results so far are encouraging and the prototype will soon be used in a test phase.

To summarise, we presented an approach to the co-design of a business and an IT system that efficiently supports communication and cooperation structures for small and medium-sized enterprises in the construction sector. The support platform can also be beneficial to other application areas involving negotiation and contracting. For example, we work on supporting marketplace transactions for trading software components in chemical engineering (Schoop and Quix, 2001) and assess the similarities and the differences (that might lead to adaptations of our framework) between these two application areas.

Acknowledgments

We would like to thank the architectural practice Linie4, Aachen, for all their help and support. The research was partly supported by the European ESPRIT project "MeMo: Mediating and Monitoring Electronic Commerce", No. 26895 (www.abnamro.com/memo).

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