

# TOWARDS A MULTI-AGENT SYSTEM FOR CONSTRUCTION CLAIMS NEGOTIATION

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Although many research projects have been undertaken on construction claims, little research has been conducted on the improvement of claims negotiation. On the other hand, industry practice shows that claims negotiation is one of the most time and energy consuming activities in claims management. The major problems of claims negotiation are inefficiency, late client intervention and complex human factors. The development of a multi-agent system (MAS) provides an opportunity to improve these problem areas. The important characteristics of MAS: autonomy, knowledge sharing, goal orientation and learning make it possible to build a system in which agents, on behalf of their owners, can settle most of the quantifiable claim negotiation items in an effective and efficient way. To build such a system, many important aspects, such as the reasoning model, negotiation mechanism, and empowerment of agents need to be addressed. This paper reviews developments in construction claims management, analyses the nature of construction claims negotiations, and explores the potential of a multi-agent system for claim negotiations. The benefits of the proposed approach are presented and the area for further work outlined.

Keywords: claims management, claims quantification, computer-supported negotiation, dispute avoidance, multi-agent systems, construction claim.

## INTRODUCTION

Over the past three decades, the construction industry has experienced an increase in claims, liability exposures and disputes, along with an increasing difficulty in reaching reasonable settlements in an effective, economical and timely manner (Barrie and Paulson, 1992). Bradley and Langford (1987) point out that claims are now a way of life for the construction industry. In order to seek answers to the problem, hundreds of research projects, courses and publications on various aspects of claims, such as Diekmann and Nelson (1985), Scott (1992) and Levin, (1998) have been undertaken to investigate industrial practices and to explore the principles and procedures of claims settlement and disputes avoidance. Most of these efforts focus on seeking answers from principles and legal issues at the pre-construction phase, while the research projects that attempt to solve the problems through claims management procedures at the construction phase are relatively few (Vidogah and Ndekugri, 1997). The latter, in most cases, only address and emphasise the importance of contractors clearly identifying the causes of claims and maintaining adequate documentation. Claims negotiation is seldom thoroughly studied although most project managers, according to Hu's survey (1997), agree that negotiation is the most time and energy-consuming aspect of claims management.

Multi-agent systems (MASs) offer an innovative approach for the improvement of claims negotiation. The MAS paradigm models real life processes and activities in a given problem domain, and could be applied to the field of claims negotiation. The

specific characteristics of a MAS: autonomy, knowledge sharing, goal orientation and learning ability make it an ideal tool for claims negotiation in which agents, on behalf of their owners, negotiate with others to reach a desired outcome in an effective and efficient way. By utilising such a system, there is scope to address the problems of claims negotiation such as inefficiency and late client involvement.

This paper discusses the developments in claims management and negotiation, and points out the problems in current claims negotiation. It also highlights the key aspects of the application of MAS to claims negotiation, and presents a framework for agent-based claims negotiation.

## **METHODOLOGY**

The methodology adopted for this research project involves four key stages: literature review, knowledge acquisition, model development, and implementation. This paper discusses the work conducted at stages one and three; the approach adopted is briefly summarised below:

To investigate the major problems in claims management and claims negotiation, an extensive literature has been conducted on construction claims issues (industry practice, legal and management principles, risk management, claims negotiation, and IT support for claims management). Since there are only a few research projects on claims negotiations, an unstructured questionnaire was used to elicit information on the process, characteristics and problems of claims negotiation. This elicitation was conducted through emails with four experienced project managers who are managing three international projects.

To explore the potential for the application of MAS in construction claims negotiation, literature on fundamental principles of MAS, its application to negotiation and learning issues, and other computer supported negotiation systems have been reviewed. Several key aspects including system assumptions, requirements, and negotiation protocol and strategies have been explored.

To facilitate the development of a MAS for claims negotiation, a critical appraisal of negotiation theories was undertaken to establish their applicability to agent-based claims negotiation. This is expected to inform the system development.

## **CONSTRUCTION CLAIMS**

The former efforts to resolve claims are mainly of two kinds: those that seek answers through claims avoidance and those that seek answers through claims management if claims cannot be avoided (Filed *et al.* 1993). The former seeks to ensure that construction project starts right, while the later aims to ensure construction project stays right.

### **Basis of claims management: starting right**

Many researchers (Levitt *et al.*, 1980; Powell-smith and Stephenson, 1993) emphasise the importance of claims avoidance and the legal basis of claims management. They focus on the issues at pre-construction phase, which mainly include standard contract forms, risk management and project procurement systems.

Standard contract forms and conditions set up the legal bases and principal provisions for claims management. Thomas et al (1994) identified ambiguity, incompleteness and inadequate understanding of the terms of contract and conditions as the major causes

of claims and disputes. Thus, improving the legal framework for claims has been a major focus of the industry for many years. The overall objectives are to:

get the contractual language right first time in new contracts;

increase awareness of the likely construction terms by the courts and arbitrators;

encourage the amendment of the standard terms of contract; and

expose popular misunderstanding (Vidogah and Ndekugri, 1998).

Several researchers (Levitt *et al.*, 1980; Murdoch and Hughes, 1996; Cox, 1997) have also identified risk allocation in standard contract forms and project contracts as likely to be an important factor in claims management. Contractors generally prefer to assume less risk, while clients appear willing to push more risks to contractors in the contract which is a major source of the claims (Zack, 1997). Hartman *et al.* (1998) point out that the management of changes and claims is the management of risks. Equity in risk allocation in construction contracts and procurement system will reduce the root causes of claims.

To reduce claims and to facilitate claims management, new project procurement systems have been adopted, such as partnering, design-build, and construction management (CM). Generally, it is believed that partnering and design-build system can reduce claims and facilitate claims management effectively since they reduce conflicts and engender co-operation between project participants. However, the claims management process may become more confused and complex under the CM system (Barrie and Paulson, 1992) since construction managers, in many cases, are not willing to make decisions on sensitive claims to protect themselves against all possible litigation.

### **Claims management process: staying right**

In spite of the extensive literature highlighting the above problems, there is little evidence of significant improvements in construction claims management. Thus, there is a need to investigate approaches other than pre-construction theories and principles. Vidogah and Ndekugri (1997) point out that claims management and 'people' issues may be, at least, as important as having a clear understanding of contractual terms and equitable risk allocation. Keane (1994) defines claims management as the process of employing and co-ordinating resources to progress a claim through a) recognition and identification of the causes of claims; b) notification to the engineer and the owner; c) systematic and accurate documentation; d) analysis of time and cost impacts; e) pricing; f) negotiation; and g) dispute resolution and settlement.

Although studies have been undertaken on claims management, most of them, by way of defining remedial measures, do not go beyond general exhortations to the contractor to clearly identify the causes of claims and maintain adequate documentation to support and justify claims (Vidogah and Ndekugri, 1998). Very few research projects are reported on claims negotiation, which however, is of paramount importance for project collaboration, fair benefit distribution, and disputes avoidance (Semple *et al.*, 1994). However, the claim issues with greater uncertainty such as material pricing, labour productivity, and indirect costs, are generally settled through negotiation (Filed *et al.*, 1993). Thus, a further study on claims negotiation is essential.

## CLAIM NEGOTIATION

Negotiations go on throughout the whole claim process from justification to the final settlement of a claim. Although the standard contracts like *the Institution of Civil Engineering* (ICE) do not suppose that claims will be settled by negotiation, in practice, and wisely so, many claims are settled by negotiation between the contractor and the engineer (Powell-smith and Stephenson, 1993). Claims negotiation is an important element for controlling costs; providing a non-adversarial project environment; and avoiding potential litigation resulting from outstanding claims (Filed *et al.*, 1993). There are two kinds of negotiation during the claims management process: negotiations about the entitlement of claims and the negotiations about the quantification of claims. This study mainly focuses on the later.

### Problems of claims quantification

The challenges of claims quantification lie both in the process of valuing the direct costs and delays caused by an unanticipated event, and in pricing the accumulative effect of the event. Ideally, the quantification of direct costs is relatively straightforward. With the agreed rates of labour, material and equipment, quantity of impacts and general formulas, the *direct costs* of compensation can be worked out through a detailed break down analysis. However, arguments are often generated regarding the rates of compensation and quantifying the impacts of unanticipated events. Problems such as which rate should be applied if several are listed in the contract documents, or what time extension is appropriate, are very common.

However, the most difficult task of claims quantification is to evaluate the *cumulative effects* of a claim event which contractors think they deserve too, such as loss of productivity, disruption, and indirect costs. These items, in their nature, are ambiguous and sensitive. Therefore, it is very difficult to reach a satisfied solution between project participants. Semple *et al.* (1994) and Vidogah and Ndekugri (1997) show that the numbers of claims for indirect costs are higher than for direct costs, and that claims for accumulative effects are more likely to be disputed.

Industry practice shows that these uncertain items in claims are more likely to be solved through negotiation (Filed *et al.*, 1993). Turner (1989) also points out that evidence and negotiation are the two most important aspects of a successful claim.

### Negotiation procedure

A successful claims negotiation should contain two stages: preparation and negotiation. Negotiation preparation is crucial for the success of claims negotiation (Smith, 1992). Both parties need to spend time and effort on collecting data, gathering pertinent price, establishing objectives, identifying the negotiation zone, evaluating the proposal, anticipating and analysing the opponent, and building flexible strategies. For example, negotiators may need to decide which objectives cannot be compromised; which can be compromised and to what extent; and which ones are expected to be compromised or dropped totally.

During negotiation, the contractor may look for the greatest sum possible whilst the engineer, despite his contractual position, may look to reduce the claimed amount. The contractor proposes a 'negotiation figure' in his claim whilst having a reservation amount at which he will settle. The negotiation process often focuses on how much of the 'negotiation figure' may or may not be reduced. Both parties will try to influence, persuade or press another party to accept his proposal by providing backup evidence, communicating information, adopting proper tactics, and making necessary

concessions. Negotiation tactics, such as inflating the opening demands; misrepresenting position or interests; and using threatening behaviour, are often being adopted. These negotiation styles, strategies and tactics depend on project situation, claim items, participant's attributes and the personal approaches of the negotiators. Table 1 lists some of these factors summarised from the work of following researchers (Hughes and Barber, 1992; Smith, 1992; Spittler and Jentzen, 1992; Scott, 1992; Just and Torone, 1997; Levin, 1998).

**Table 1:** Factors influencing negotiations between project participants

	Factors that Hamper Negotiation	Factors that Facilitate Negotiation
Contractor	high ambitions; global claim; lack of supporting evidence; wrong calculation; ambiguous causation and consequence analysis; or poor presentation	willingness to keep good relationship; willingness to compromise due to the weakness in claims management; expectation of compensation from new claims or projects
Engineer	protect himself against any harm; discouraging any claim caused by the failure of act of the engineer	high expertise in construction management; reputation consideration; involvement of client
Client	willingness to pay less do more; discouraging claims; limited information about claim; late involvement or non-involvement of the negotiation	consideration of the entire project progress

Claims negotiations are normally started at a lower level between the contractor and the engineer's quantity surveyors. The contractor and the engineer will join the negotiation if problems cannot be solved by quantity surveyors. If agreement still cannot be reached at this stage, the contractor may prefer to contact the client in the hope that the client could join the negotiation directly and solve the problems.

### Problems of claims negotiation

In construction projects, few participants have special knowledge about negotiation. Most claims negotiations are conducted in a heuristic way. Unnecessary concession and stubbornness are common mistakes, which makes the negotiations harder and inefficient. Most project managers consider claims negotiation as the most time and energy-consuming activity in claims management (Hu, 1997). The reasons are many folds:

**The nature of negotiation items**, such as selection of unit cost, loss of productivity and impacts of interruption are ambiguous and sensitive;

Engineers and clients typically respond in a tough and unyielding manner to contractors' claim since **claims often cause project cost overruns**;

The **claims management procedures** also contribute to the inefficiency. For example, the involvement of the client is currently very low in claims management (Vidogah and Ndekugri, 1997). This late involvement of the client and the engineer's conflicting role as an independent professional and client's representative have been recognised as major factors contributing to the inefficiency by the European Construction Institute (ECI, 1992). In the cases that claims are caused by the engineer's failure of action, he is likely to discourage the claims, and to deal with the claims in an impartial manner by taking advantage of

the low client intervention. This may finally increase the difficult of negotiation and chances of disputes. Therefore, ECI (1992) recommends earlier and greater client involvement in claims management.

**Negotiation process is time-consuming.** Before negotiation, documents have to be specially presented; negotiators need to be gathered; and negotiation meetings are seldom held immediately for a claim after documents are submitted. In most cases, claims are discussed at progress meetings or special meetings where several claims are discussed. Some claims have to be delayed until such a meeting is held. During the negotiation process, unrelated arguments such as site management, quality or site safety are regularly discussed to pressure the opponent; a party may expect to get benefit by waiting or delaying until the other side is emotionally exhausted; and neither side wants to make a concession first or easily.

Negotiation involves many *human factors* rather than pure technical issues. A negotiator's personal abilities and attitudes, in some cases, determine the result of negotiation. Smith (1992) points out that negotiation has been labelled as a basic survival skill for today's project manager. Unfortunately, very few project participants have adequate negotiation knowledge. Mistakes, such as lack of planning; improper negotiation style; fixed objective versus a range; incapable negotiator; unclear authority; and no negotiation document occur in most claims negotiation, which leads to inefficient claims negotiation (Zack, 1994).

## MULTI-AGENT SYSTEM FOR CLAIMS NEGOTIATION

Multi-agent systems (MASs) provide a novel approach for the development of claims negotiation. The general principles of MAS show that it has specific advantages in communication (facilitating and filtering information), learning and facilitating collaboration between project participants. These features make it an ideal technique to support negotiations. Rosenschein and Zlotkin (1994) conclude that *negotiation is a subject of central interest in MAS*. Each agent in the system thinks locally, and this constitutes a promising approach to solve complicated negotiation problems in a natural and flexible way (Ferber, 1998). Unlike other negotiations supporting technologies, such as expert systems and decision analysis systems which can only provide suggestions to human negotiators, agents in a MAS, on behalf of their owners, can directly negotiate with each other about negotiation items to reach a solution within a specified time frame. Thus, both the efficiency and effectiveness of claims negotiation can be improved. To build such a system, two important issues need to be addressed: *reasoning model and negotiation mechanism*.

### Reasoning Model

Construction claims negotiation is identified as a bounded self-interested negotiation. Each party will be only concerned about his own benefit without considering others or group's benefits. Meanwhile, the negotiation is bounded by project contract documents and the willingness not to break the negotiation. Based on this identification (reasoning model), Zeuthen's risk evaluation model is adopted to design the multi-agent system claim negotiation mechanism.

### Negotiation Mechanism

According to Zeuthen (1975), an agent makes its decision of concession based on how much it has to lose by running into conflict at that time. If an agent has already made many concessions, it will have less to lose from a conflict, and will be less willing to

concede. Thus, it has a high acceptability to risk conflict. Here, risk acceptability is measured by the comparison of an agent's loss caused by accepting the opponent's current offer and its loss caused by a conflict deal. At each step, each agent will compare its risk acceptability with that of its opponent. The agent with smaller risk acceptability will make the next concession, which will be sufficient enough to make its opponent's risk acceptability smaller than its own (Rosenschein and Zlotkin, 1994). Also, each agent's time penalty is considered as an important factor in the negotiation process. Zeuthen's model assumes that each agent has complete information about its opponent's risk acceptability. This is not true in real negotiations, particularly claims negotiation. To solve this problem, a learning mechanism has been incorporated in this study, so that an agent can estimate and update its beliefs about its opponent's risk acceptability according to the opponent's offers. Thus, an agent can make a decision on whether to concede according to its risk acceptability and its beliefs about the opponent's. As negotiation goes on, the agent's belief and decision will be more and more accurate and finally a reasonable result is reached.

Based on this negotiation mechanism, a multi-agent system for claims negotiation will be further developed in line with the nature and characteristics of construction claims negotiation. Three essential aspects: negotiation process model, protocol and strategies are being addressed, but will not be discussed in detail here due to the space constraints.

## ADVANTAGES

The application of the MAS paradigm to support claims negotiation is expected to result in the following improvements to construction claims negotiation:

### *Improvement of negotiation efficiency*

The application of the system is expected to solve or to relieve the problems in claims negotiation preparation and negotiation process. Firstly, since the system is a network system, it reduces the long negotiation preparation time. The time for negotiation document presentation, waiting for negotiation meeting, or gathering negotiators is reduced. Secondly, negotiation time is reduced. Unhealthy tricks such as obfuscation and delays are avoided since agents have to reach a result within a specific time limit.

### *Earlier client involvement*

The application of the system provides a mechanism for the client to get involved early in the claims negotiation process. The client, through his agent, can monitor and get involved in the negotiations between the engineer and the contractor. There is a scope for the contractor directly to negotiate with the client. This is an important improvement of the current claims negotiation process. Firstly, it is possible to resolve negotiation deadlocks between the contractor and the engineer due to non-agreement by the direct involvement of the client himself. Secondly, the problems caused when the engineer tries to cover personal faults are also avoided.

### *Reduce influence of unhealthy human factors*

The application of the system avoids many unhealthy human factors which are often being used in claims negotiation. It is not rare that the outcomes of claims negotiations are strongly influenced by the human factors like personalities, emotion, irritation, and relationships. Claims and claims negotiations are continuous activities in construction projects. Once a negotiator finds that s/he suffers an unreasonable loss, the following negotiations will be much harder and finally lead to disputes. The application of the new system will reduce the influence of such human factors. Moreover, the system

could also help those project participants who do not have enough negotiation experience to avoid unnecessary mistakes caused by improper negotiation strategies.

## CONCLUSION AND FUTURE STUDY

This paper has presented a study that is investigating the application of MAS to construction claims negotiation. The paper has reviewed developments in claims management, and discussed the status, characteristics and problems of claims negotiation. It also discussed the potential application of the MAS paradigm in overcoming some of the limitations of current claims negotiation. It is expected that, using the proposed approach, construction claims can be resolved in a more effective way, and disputes avoided. However in deploying MAS for claims negotiation, it is important to give consideration to several important factors and characteristics of claims negotiation and MAS development. These include negotiation protocols and strategies, time impacts, learning, empowerment of agents, involvement of subcontractors and suppliers, and the roles of the client and the engineer in the new negotiation system. These form the focus of the further work on this project and will be reported in future publications.

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