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Prediction of Construction Litigation Outcome – A Case-Based Reasoning Approach

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Abstract. Since construction claims are normally affected by a large number of complex and interrelated factors, it will be advantageous to the parties to a dispute to know with some certainty how the case would be resolved if it were taken to court. The application of recent artificial intelligence technologies can be cost-effective in this problem domain. In this paper, a case-based reasoning (CBR) approach is adopted to predict the outcome of construction claims, on the basis of characteristics of cases and the corresponding past court decisions. The approach is demonstrated to be feasible and effective by predicting the outcome of construction claims in Hong Kong in the last 10 years. The results show that the CBR system is able to give a successful prediction rate higher than 80%. With this, the parties would be more prudent in pursuing litigation and hence the number of disputes could be reduced significantly.

1 Introduction

The construction industry is inherently prone to litigation since claims are normally affected by a large number of complex and interrelated factors. The disagreement between the involving parties can arise from interpretation of the contract, unforeseen site conditions, variation orders by the client, acceleration and suspension of works, and so on. The main forums for the resolution of construction disputes are mediation, arbitration, and the courts [1]. However, the consequence of any disagreements between the client and the contractor may be far reaching. It may lead to damage to the reputation of both sides, as well as inefficient use of resources and higher costs for both parties through settlement. The litigation process is usually very expensive since it involves specialized and complex issues. Thus, it is the interest of all the involving parties to minimize or even avoid the likelihood of litigation through conscientious management procedure and concerted effort.

It will be advantageous to the parties to a dispute to know with some certainty how the case would be resolved if it were taken to court. This would effectively help to significantly reduce the number of disputes that would need to be settled by the much more expensive litigation process. The use of artificial intelligence (AI) technologies can be cost-effective in the prediction of outcomes of construction claims, on the basis of characteristics of cases and the corresponding past court decisions. Some of these AI techniques have been used to identify the hidden relationships among various interrelated factors and to mimic decisions that were made by the court [2-3].

In this paper, a case-based reasoning (CBR) approach is employed for prediction of the outcome of construction litigation in Hong Kong, on the basis of characteristics of real cases and court decisions in the last 10 years. The focus of the present study is on the codification of simulation results and the assessment of the assumptions which have been used to evaluate the interaction of factors determining the litigation outcomes.

2 Nature of Construction Disputes

The nature of construction activities is varying and dynamic, which can be evidenced by the fact that no two sites are exactly the same. Thus the preparation of the construction contract can be recognized as the formulation of risk allocation amongst the involving parties: the client, the contractor, and the engineer. The risks involved include the time of completion, the final cost, the quality of the works, inflation, inclement weather, shortage of materials, shortage of plants, labor problems, unforeseen ground conditions, site instructions, variation orders, client-initiated changes, engineer-initiated changes, errors and omissions in drawings, mistakes in specifications, defects in works, accidents, supplier delivery failure, delay of schedule by subcontractor, poor workmanship, delayed payment, changes in regulations, third-party interference, professional negligence, and so on.

Prior to the actual construction process, the involving parties will attempt to sort out the conditions for claims and disputes through the contract documents. However, since a project usually involves thousands of separate pieces of work items to be integrated together to constitute a complete functioning structure, the potential for honest misunderstanding is extremely high. The legislation now in force requires that any disputes incurred have to be resolve successively by mediation, arbitration, and the courts.

3 Case-Based Reasoning (CBR)

CBR is the essence of human reasoning on the basis of experience, through the development of a case-memory representation of previously solved problems [4-8]. It utilizes the specific knowledge of previously experienced and concrete problem situations, which are termed cases. By searching for and reusing a similar past case, a new problem can be solved. Moreover, it represents an incremental and sustained learning since the retention of a new experience in the problem-solving process will enrich the case base for future usage. CBR has various advantages over alternative AI techniques, such as artificial neural network and knowledge-based system, for this particular domain problem in that similar reasoning process is exercised in practice. Whilst construction litigation is resolved principally by the interpretation of the law and the reference to legal precedents, CBR retrieves similar past cases for the solution of the new problems.

CBR comprises principally four steps: (1) retrieving past cases that resemble the existing problem; (2) adapting past solutions to the target situation; (3) applying these adapted solutions and evaluating the results; and (4) modifying and updating the case base. One of the key functions is the similarity measurement in the comparison between a pairs of features from the target case and the past cases.

Table 1. Definition of input features

Feature Name	List of alternatives				
Type of contract	Remeasure-ment	Lump sum	Design and build		
Contract value	Low	Medium	High		
Parties involved	Client	Contract-or	Sub-contractor	Engineer	Supplier
Plaintiff	Client	Contract-or	Sub-contractor	Engineer	Supplier
Defendant	Client	Contract-or	Sub-contractor	Engineer	Supplier
Resolution technique used	Yes	No			
Interpretation of documents	Yes	No			
Misrepresentat-ion of site	Yes	No			
Radical change in scope	Yes	No			
Directed changes	Yes	No			
Constructive changes	Yes	No			
Liquidated damages	Yes	No			
Late payment	Yes	No			

3.1 Case Retrieval

The case base is first developed based on the past cases. Cases are then retrieved from the case base in similar future situations, together with the corresponding similarity score. For a CBR system, the speed and accuracy in retrieving pertinent cases are determined largely by case indexing, which is related to the appropriate type of feature matching as well as a suitable type of similarity assessment.

3.2 Feature Matching

Feature matching represents the requirement on the rigorousness of the match between the features of the target cases and their counterparts in the case base. Different matching alternatives should be used for different types of features. In this study, exact matching, which is appropriate for the “one of a list” or “yes or no” types, is used for all features.

3.3 Similarity Score Evaluation

Two methods are adopted in the similarity assessment of this study, namely, an inductive reasoning indexing method and a manual adaptation method.

By employing the inductive reasoning indexing method, a complex decision tree, which comprises tree branches representing all the feature alternatives, is built according to the input cases. The tree generated is then used to determine weights for the features. A similarity score is then assigned to all the cases that are retrieved from the case base. The score, representing the overall similarity measurement of all features, is used to rank these cases. The outcome of the retrieved highest-scoring case is selected to be the predictor. A key advantage of this method is its ability to analyze the cases automatically, objectively and speedily. The difficult task to determine the weights of various features does not need to be borne by the analysts. However, it requires a sufficient amount of cases in order to generate accurate results [9].

In the manual adaptation method, the weights of the features are specified by the experts after a comprehensive study and iterative trials with different priorities on these features. A similarity score is also determined, yet by manual method. The demanding nature of the task to make good and subjective decisions on the weightings is noted. In this method, the inductive reasoning indexing method is used as a preparation and guideline, rather than virtually from scratch.

3.4 Case Base Updating

The predicted case is then added to enrich the representation of the case base, which will be useful for further prediction. The constant update of the case base is essential for the real application of a system to retrieve a past case and adapt it to the needs of a new problem as time arises. This will facilitate the retrieval process which begins with the search engine selecting from the system’s case base only those cases which have comparable similarity score for the target problem in hand.

4 The Study

The system is applied to study and predict the outcome of construction claims in Hong Kong. The data from 1991 to 2000 are organized case by case and the dispute characteristics and court decisions are correlated. Through a sensitivity analysis, 13 case elements that seem relevant in courts' decisions are identified. They are, namely, type of contract, contract value, parties involved, type of plaintiff, type of defendant, resolution technique involved, legal interpretation of contract documents, misrepresentation of site, radical changes in scope, directed changes, constructive changes, liquidated damages involved, and late payment.

All the 13 case elements can be expressed using "one of a list" or "yes or no" format. For example, 'type of contract' could be remeasurement contract, lump sum contract, or design and build contract. Table 1 shows the definition of input features in this case base. The outcome of court decisions is organized as an output feature from a list of 5 alternatives: client, contractor, engineer, sub-contractor, and supplier.

In total, 1105 sets of construction-related cases were available, of which 825 from years 1991 to 1997 were used for building the case base, and 280 from years 1998 to 2000 were used for testing.

Tests are performed to reduce the number of features used in the research. Two sets of input features are employed to experiment with various similarity assessment methods to test the rate of prediction of the system. Apart from the complete set of 13 input features, a restricted set of 10 input features is tried. Table 2 shows the comparison of prediction results by different methods.

Table 2. Comparison of prediction results with different methods

Method of similarity assessment	Complete set of features		Restricted set of features	
	Coefficient of correlation	Prediction rate	Coefficient of correlation	Prediction rate
Inductive reasoning indexing	0.969	0.77	0.964	0.72
Manual adaptation	0.987	0.84	0.979	0.81

5 Results and Discussions

Table 2 shows comparison of the prediction results with different methods of similarity assessments against complete or restricted set of features. The prediction rate of the inductive reasoning indexing method of similarity assessment for the complete set of features is 0.77 and the coefficient of correlation is 0.969 whilst, for the restricted set of features, the corresponding values are 0.72 and 0.964, respectively. When the manual adaptation of similarity assessment is used for the complete set of features, the prediction rate is 0.84 and the coefficient of correlation is 0.969. For the restricted set of features, the corresponding values are 0.81 and 0.979, respectively. The best prediction is obtained by using the manual adaptation of similarity assessment for the complete set of features. It can be seen that employing inductive reasoning indexing method as a preparation for manual adaptation is rather preferable. Moreover, better prediction results are in general attained with the complete set of features than those with the restricted set of features.

It is noted that the CBR is able to give a successful prediction rate of higher than 80%, which is much higher than by pure chance. It is believed that, if the involving parties to a construction dispute become aware with some certainty how the case would be resolved if it were taken to court, the number of disputes could be reduced significantly.

6 Conclusions

This paper presents a CBR approach for prediction of outcomes of construction litigation on the basis of the characteristics of the individual dispute and the corresponding past court decisions. Comparison is made of the prediction results with different methods of similarity assessments against complete or restricted set of features. Amongst various methods that are tried, the best prediction is obtained by using the manual adaptation of similarity assessment for the complete set of features. Moreover, better prediction results are in general attained with the complete set of features than those with the restricted set of features. It is demonstrated that the novel approach, which is able to provide model-free estimates in deducing the output from the input, is an appropriate prediction tool. The method presented in this study is recommended as an approximate prediction tool for the parties in dispute, since the rate of prediction is higher than 80%, which is much higher than chance. It is, of course, recognized that there are limitations in the assumptions used in this study. Other factors that may have certain bearing such as cultural, psychological, social, environmental, and political factors have not been considered here. Nevertheless, this initial study shows that it is worthwhile pursuing this method further for more detailed investigation on its effectiveness and capability.

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