A CBR based dispute resolution process selection system

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ABSTRACT | In construction, the use of Artificial Intelligence (A.I.) to assist project management in the areas of planning, quantity measurement and quality control have been reported. A.I. can minimize subjectivity which would otherwise predominate in many management decisions, one of which is the selection of a method to resolve disputes. Disputes in construction are common and resolving them has become a daily routine of project managers. Despite its importance, the use of A.I. in dispute resolution has not been extensive. Employing an appropriate resolution process is critical to resolve construction disputes. This is because that having an appropriate resolution process should pave the path to success. In this type of selection exercise, previous experience is invaluable and thus fits nicely with the function of Case-Based Reasoning technique. Case-Based Reasoning (CBR) can systematically select a dispute resolution process to fit the circumstances of a case. This paper describes the development of a CBR based dispute resolution process selection system identified as CDRe. Fourty eight cases were used to develop the system which was tested by another 9 independent cases. Seventy seven percent prediction accuracy for the testing set was achieved suggesting that the CDRe is a reasonable decision support tool for project managers.

KEYWORDS | artificial intelligence, construction dispute resolution, case-based reasoning

1 Introduction

In construction, project managers play a central role in ensuring the achievement of project objectives. In this respect, they are constantly required to make tough decisions. Obviously their experience is invaluable; however, it would be helpful if appropriate decision support systems are available to assist them to make informed decisions. In this connection, artificial intelligence can make a significant contribution. Artificial Intelligence (A.I.) has been widely used in medicine, mathematics, engineering, computer science and business. The central theme of A.I. can further be divided into sub-themes like neural networks, fuzzy logic and Case-Based Reasoning. Among these, Case-Based Reasoning can resolve problems by using past experiences and is based on the notion that human beings use analogical reasoning or experimental reasoning to learn and solve complex problems. Case-Based Reasoning means reasoning based on past cases or experience (Kolodner & Leake, 1996). A Case-Based reasoner uses memory of previous cases

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to resolve new problems. Kolodner (1993) suggests that Case-Based Reasoning is useful to human and machines to understand more about a task and domain since it gives them a way of reusing hard reasoning they have done in the past.

Reported applications of A.I. in construction industry include those in construction planning (Ashley, Levitt, 1988; Hendrickson, Zozaya-Gorostiza, Rehak, Baracco-Miller & Lim, 1987; Tah & Hows, 1998), project analysis and control (Scott & Yang, 1991), decision models (Chua & Chan, 2001), cost estimation (Arditi & Suh, 1991; Li & Love, 1999), construction management (Amirkhanian & Baker, 1992) and construction contract (Alshawi & Hope, 1989; Cheung *et al*. 2000; Diekmann & Kruppenbacher, 1984; Kim & Adams, 1989; Li, 1996). Notwithstanding the trend of applying A.I. techniques in construction, the use of A.I. in construction dispute resolution has not attracted too great attention despite the fact that dispute resolution is an important skill for project managers and administrators. One of the key decisions in dispute resolution is choosing an appropriate resolution process. As the selection of a construction dispute resolution process requires the use of previous experience, CBR technique therefore fits nicely in this application. This paper reports a study that employed the Case-Based Reasoning technique to develop a dispute resolution process selection system. The developed system is called CDRe (Case-Based Reasoning approach to **C**onstruction **D**ispute **R**esolution). The system seeks to provide a systematic method to assist construction professionals in this connection. In order to achieve the aforementioned objective, a review of literature was first conducted to identify the critical selection parameters. Project data sets were then collected for the case library. As a result, a total of 57 cases were collected, out of which 48 cases were used for model development and 9 cases were used for testing purposes. While ART*Enterprise® (Brightware, 1995) was used as the CBR software, database was administered by Microsoft Access.

2 Use of Case-Based Reasoning in construction dispute resolution process selection

Several A.I. techniques are available for use in decision support systems. Neural network is convenient and relatively easy to use as there are less modelling constraints. However, its major disadvantage is the lack of explanation or justification of the suggested solution. Genetic Algorithm (GA) as a search strategy, is based on the evolution and genetics theory. GA is useful where the decision variables can be encoded as strings of a chromosome. Each chromosome represents one of the possible solutions. With an objective function to minimise or maximise a performance measure, GA works on an initial population consists of solution candidates to derive the 'optimal' solution. GA is a powerful tool but the modelling format is not suitable for this dispute resolution process selection exercise because the variables are mostly qualitative in nature. As compared with Neural Network and Genetic Algorithm, CBR system can be built with a relatively smaller number of cases. The system can further be developed and refined as the number of cases accumulates. Case-Based Reasoning (CBR) is one of most commonly used artificial intelligence techniques in recent years (Leake 1994, Marir 2000, Morcus et al 2002, Sadek et al. 2003). In a typical CBR system, the problems will be presented by a user-interface or another programme. The system will then search its case library and find a list of cases which are of greatest similarity with the presented case. The selected cases are listed in descending order of similarity scores. The working of a CBR system can be explained as a CBR cycle as in Figure 1.

The CBR cycle is a widely accepted model and was proposed by Aamondt and Plaza (1994). The diagram in Figure 1 shows the CBR as a cyclic process comprising the four REs: REtrieve; REuse; REvise; and REtain.

When a new case is input, the CBR system will retrieve the appropriate case in the case library. The CBR

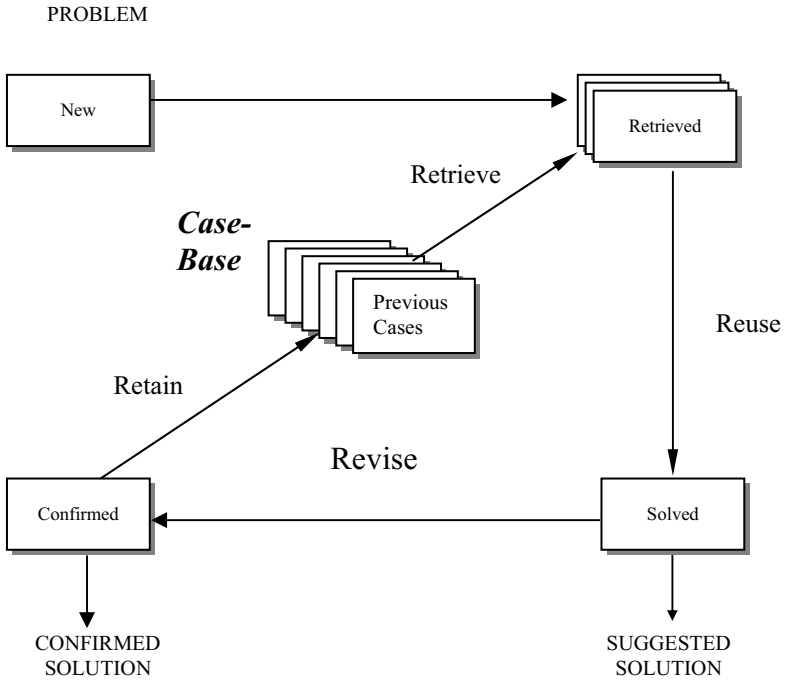

Figure 1. The CBR Cycle (Adapted from Aamodt and Plaza, 1994)

system will then use the information of the retrieved cases and suggest a way to solve the presented case. This reasoning generally involves both determining the differences between the retrieved cases and the current query case; and modifying the retrieved solution appropriately, reflecting their differences. Unless the retrieved case is a close match, the solution will probably have to be revised. Therefore, a confirmed solution will be produced and become a new case and that can be retained in the case library. It is noted that Rule Base can be added to support a CBR model. To achieve this, significant input of experts to develop the if-then rules is necessary.

3 The development framework for CDRe

The development framework of CDRe is presented in Figure 2. In Figure 2, the development process of CDRe is illustrated. The full details of the CBR system and identification of case structure are discussed in the following section.

Several applications of A.I. in dispute resolution and claims analysis are noted. For example, Diekmann & Kruppenbacher (1984) generated a construction contract legal analysis computer system named Differing Site Condition Analysis System (DSCAS) and suggested that there are much potential on further application of A.I. to claim analysis and contract management. The A.I. based DSC system for construction contract claims developed by Kim & Adams (1989), was sign that a great amount of research and development could be expected. Li (1996) developed a Case-Based Reasoning (CBR) system, MEDIATOR, to provide intelligent suggestion to construction negotiation and concluded that there is a need to improve efficiency. Although there have been quite a number of recommendations on the CBR in the construction dispute domain, yet a comprehensive

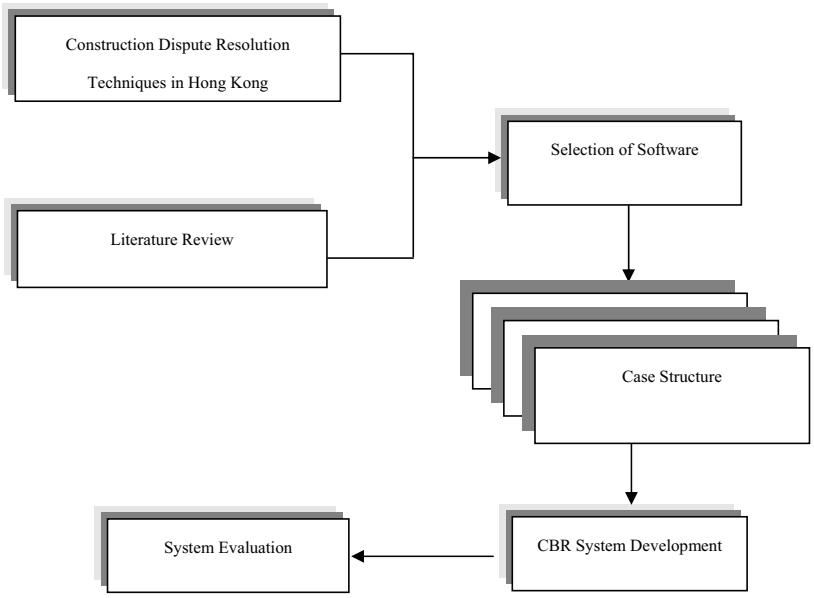

Figure 2. The Development Framework of CDRe

construction dispute resolution Case-Based Reasoning system has not been developed. Selecting a dispute resolution process is the first step to resolve a dispute and this is an important decision because of the resource implications. Formalised proceedings such as arbitration and litigation are costly and time consuming. Such decisions require experience and judgement, the A.I. technique of CBR which draws information based on past cases fits nicely with this type of selection problem.

In this project, ART*Enterprise® (Brightware, 1995) was used as the CBR software due to the following reasons:

- It provides a user-friendly development environment to give full access to the function of the tools;
- It supports a variety of programming paradigms other than Case-Based Reasoning such as object-oriented programming and rule-based programming;
- It provides easy and large database access without the need for SQL queries; and
- It includes a full featured graphical use interface (GUI) builder.

Having selected the CBR software, the development of CDRe system can proceed. Figure 3 shows the CDRe development process and the following outlines the work involved:

1. Database Development – to collect cases and build the database;
2. ART*Enterprise® Case-Based Application Model Development – to implement the ART*Enterprise® application using the built-in function of Case-Based Reasoning provided by ART*Enterprise® for indexing and retrieval; and
3. User Interface Development – to implement the input/output interface.

Figure 4 illustrates the architecture of the CDRe. The CBR display is a user interface, it has been used for developing the "forms" for entering cases, case querying and query result. The Database of Cases are created and stored by Microsoft Access. The ART*Enterprise® was used for the application model and CBR model of the system.

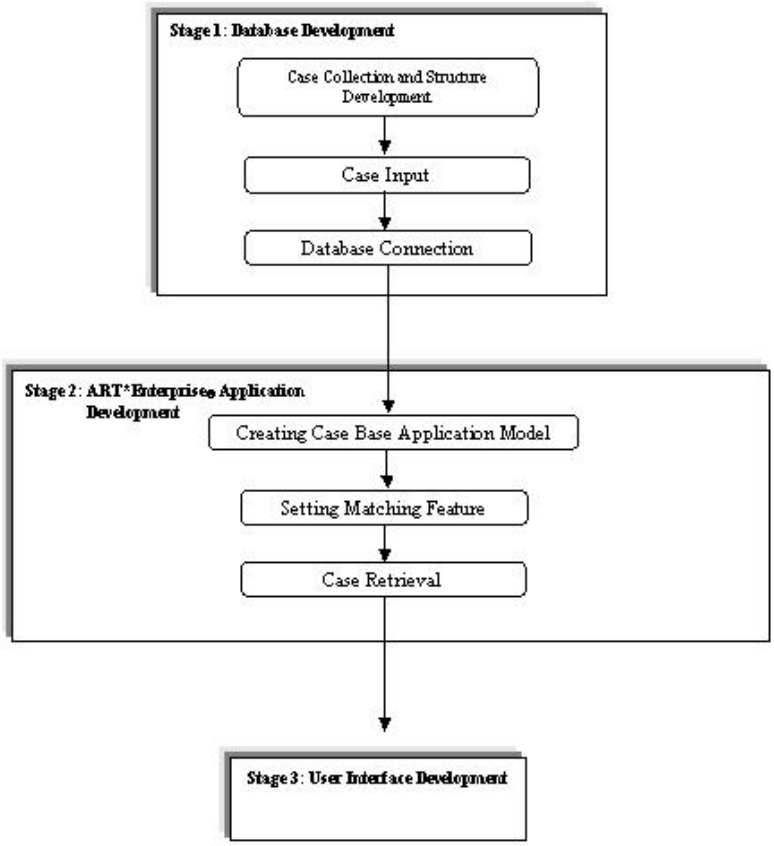

Figure 3. Flow chart of CDRe System Development

3.1 Stage one – Database Development

This section presents the database development. It includes the data analysis of 48 real construction dispute resolution cases collected for model development. Table 1 gives the summary of the dispute resolution techniques used in the 48 cases. The screenshot of the case database is shown in Figure 5.

It is believed that different dispute resolution process is suitable for different types of dispute hence selecting a suitable resolution process are important. Negotiation, arbitration, mediation and conciliation are the common resolution techniques used for settling disputes in Hong Kong (Cheung 1992, 1993; Cheung and Suen 2002).

3.2 Development of Case Structure

Kumaraswamy (1997) identifies that construction disputes can broadly be categorised as time-related and money-related. As such, the selection of variables for the definition of case structure should focus on the time-related and money-related factors. This view has also been confirmed through a pilot study with three dispute resolution experts. These experts are dispute resolution advisors on the long list of the Architectural Services Department of Hong Kong Special Administration Region. In addition, they commented that the selection of variables are fairly complex, but it is agreeable to confine our thinking along the time and money related factors as these are fundamental and often dispute specific. In actual fact, they had had experience that

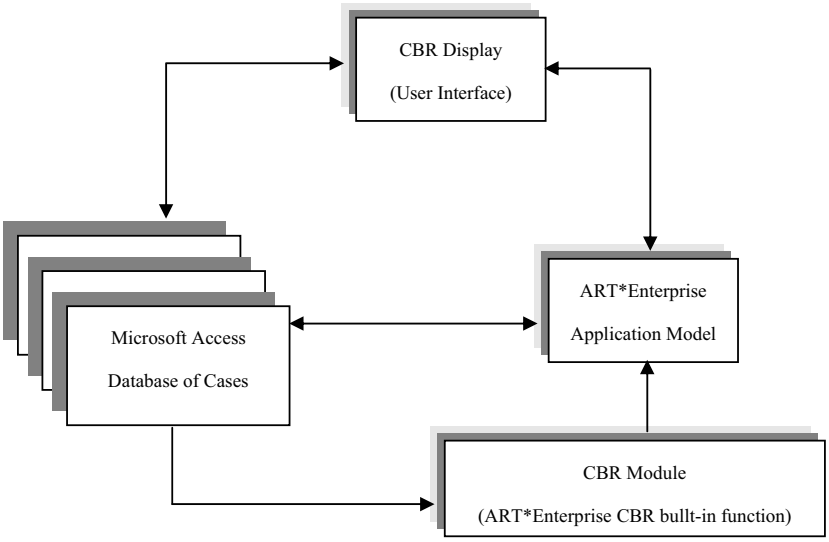

Figure 4. Internal Structure of CDRe System

Microsoft Access - [Database of Cases : Table]

File Edit View Insert Format Records Tools Window Help

case-no	contract-type	range	levy-LD	withheld-interim-cert	withheld-final-cert	withheld-PC-cert	withh
1	Lump Sum	HK$30,000,000-100,000,000	Yes	Yes	No	No	Yes
2	Lump Sum	>HK$500,000,000	No	No	No	No	No
3	Measurement	<HK$5,000,000	No	No	No	No	No
4	Design and Build	HK$100,000,000-500,000,000	Yes	Yes	No	No	No
5	Lump Sum	HK$100,000,000-500,000,000	Yes	No	Yes	No	Yes
6	Measurement	HK$100,000,000-500,000,000	Yes	No	No	No	No
7	Measurement	HK$100,000,000-500,000,000	No	No	No	No	No
8	Lump Sum	HK$5,000,000-30,000,000	No	No	No	No	Yes
9	Measurement	HK$30,000,000-100,000,000	No	No	No	No	No
10	Measurement	HK$30,000,000-100,000,000	No	No	No	No	No
11	Measurement	HK$30,000,000-100,000,000	No	Yes	No	Yes	No
12	Measurement	HK$5,000,000-30,000,000	No	No	No	No	Yes
13	Lump Sum	HK$5,000,000-30,000,000	Yes	No	No	No	No
14	Lump Sum	HK$5,000,000-30,000,000	Yes	No	Yes	No	No
15	Lump Sum	HK$30,000,000-100,000,000	No	No	No	No	No
16	Lump Sum	>HK$500,000,000	No	No	No	No	No
17	Lump Sum	HK$5,000,000-30,000,000	No	No	No	No	No
18	Lump Sum	HK$5,000,000-30,000,000	No	No	No	No	No
19	Lump Sum	HK$100,000,000-500,000,000	Yes	Yes	No	No	No
20	Lump Sum	HK$30,000,000-100,000,000	Yes	No	No	Yes	No
21	Lump Sum	HK$100,000,000-500,000,000	No	No	No	No	No
22	Management	HK$100,000,000-500,000,000	No	Yes	No	No	No
23	Cost Reimbursement	HK$100,000,000-500,000,000	No	No	No	No	No
24	Lump Sum	HK$30,000,000-100,000,000	Yes	No	No	No	No
25	Measurement	HK$100,000,000-500,000,000	No	No	No	No	No
26	Lump Sum	HK$100,000,000-500,000,000	Yes	No	Yes	No	No
27	Measurement	HK$30,000,000-100,000,000	Yes	No	No	No	No
28	Lump Sum	HK$5,000,000-30,000,000	Yes	No	No	No	No
29	Lump Sum	HK$100,000,000-500,000,000	Yes	Yes	No	No	No
30	Measurement	HK$100,000,000-500,000,000	Yes	No	No	No	No
31	Lump Sum	HK$100,000,000-500,000,000	Yes	No	Yes	No	No
32	Measurement	HK$100,000,000-500,000,000	No	No	Yes	No	No
33	Lump Sum	>HK$500,000,000	No	No	No	No	No
34	Lump Sum	HK$100,000,000-500,000,000	No	No	No	No	No

Record: 1 of 48

Case Number NUM

Figure 5. The case base database in Microsoft Access 2000

Table 1. Dispute Resolution Techniques used in the cases forming the case base

Dispute Resolution Technique	Number Techniques in Used Case
Negotiation	29
Arbitration	12
Mediation	6
Conciliation	1
Total:	48

provoked disputants did not objectively consider their cases. In those circumstances, it would be difficult to make reasoned decisions. Accordingly, the experts identified 11 variables for the determination of the case structure for the CDRe System. The brief descriptions of the selected variables and their implications on dispute resolution are given in Table 2.

3.3 Case Input

The structure of a case was developed to represent its global feature. Information of each of the 48 cases were then input and assigned with a reference case number. As such, the 48 cases forming the case library were stored using Microsoft Access as shown in Figure 5. The 11 variables in the case structure were broken down into 17 features in the database table in order to make case representation more convenient. The 17 features are as follows:

1. Type of Contract
2. Range of Contract Sum
3. Levy Liquidated Damages by client

Table 2. 11 Variables used in the CDRe System

Variable	Description	Implication to Dispute Resolution
1	Contract Sum	Contract sum reflects the contract scope. In general, the wider the contract scope, the higher the chance of having dispute.
2	Type of contract	Contract type affects the risk allocation pattern. For example, a contractor assumes design risks which normally belong to the employer in design and build type of project.
3	Any withholding of Certificates	Dispute in relation to non-payment is extremely common.
4	Stage of project during which dispute arose	Dispute arising at different stages of the project may affect the resolution method, e.g. dispute at the initial stage of a contract is less complex and negotiation for a solution is common.
5	Involvement of claims consultant(s)	There are conflicting views on the use of claim consultants. Engaging claim consultant may facilitate or deter settlement by negotiation.
6	Any V/O issue involved	Most disputes are caused by variations.
7	Any EOT issue involved	Most disputes are associated with a delay in project completion.
8	Any monetary claim involved	Most disputes are associated with loss and expenses to be recovered.
9	LD levied by employer	Liquidated damages are almost certainly involved when extension of time is a subject matter of the dispute.
10	EOT claimed (if any)	Most disputes involve entitlement of extension of time.
11	Monetary claims involved (if any)	Most disputes involve entitlement of monetary compensation

4. Withholding of Interim Certificate
5. Withholding of Final Certificate
6. Withholding of Practical Completion Certificate
7. Withholding of Making Good Defect Certificate
8. Stage of project when the dispute arose
9. Involvement of claim consultant for main contractor
10. Involvement of claim consultant for client
11. Involvement of claim consultant for other parties
12. Dispute caused by EOT
13. Dispute caused by VO
14. Dispute caused by monetary claim
15. EOT claimed
16. The quantum of the dispute
17. Dispute resolution techniques used

Microsoft Access Database is an external database and needs to be connected to the CBR system. To achieve this, the ODBC administrator of Microsoft Window was used. ODBC is a programming interface that enables access to data in database management system using Structured Query Language (SQL) as a data access standard. Figure 6 shows the method for connecting the database. Through the ODBC administrator, it is possible to link the control panel of the Microsoft Window, and then select the appropriate file in the Database Source Name (DSN).

3.4 Stage Two – Art*Enterprise® Application Model Development

In this stage, the Case-Based reasoning application model for dispute resolution strategy selection using the software ART*Enterprise® was built-up. The procedure involved in this stage can further be arranged into four phases: 1) creating application model; 2) setting matching feature parameter; 3) case retrieval.

3.5 Creating Case-Based Application Model

The application model is the most challenging part of the model development. The development

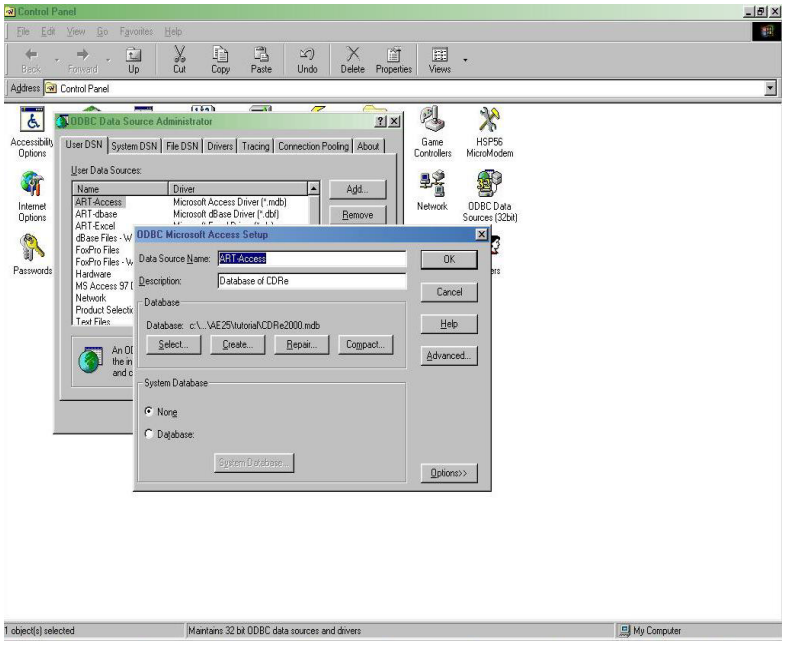

Figure 6. ODBC Connection of Access Database

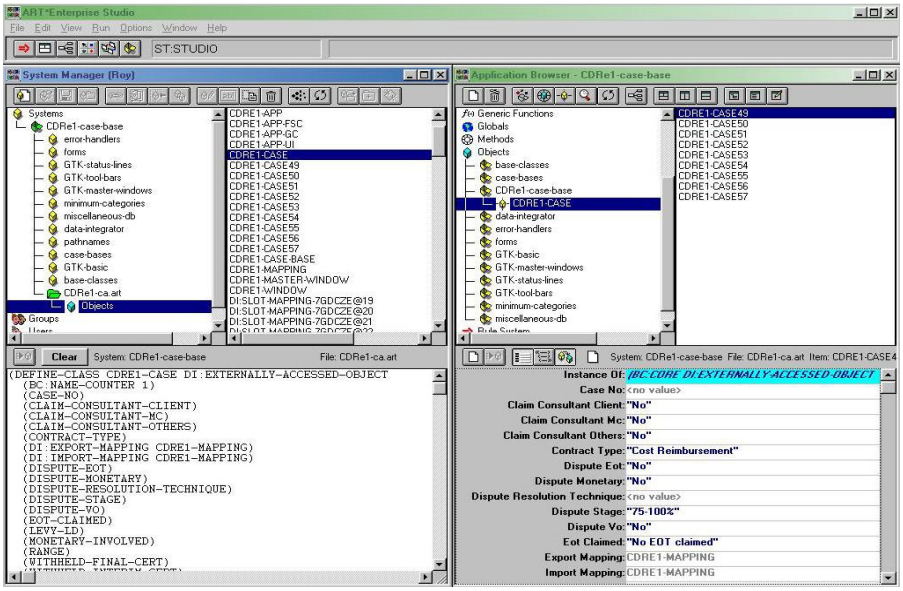

Figure 7. System Manager and Application Browser in ART*Enterprise® Studio

involved three components; (i) System Manager and Application Browser; (ii) Command Interpreter; and (iii) Data Integrator.

The System Manager and Application Browser

These are tools for managing application and their related ARTScript Code. ART*Enterprise® application consists of system, files and definition. It is a convenient user interface to ART*Enterprise®'s repository. The System Manager ensures that multiple developers working on a single application do not make simultaneous changes to components of the application. The front view of the CDRe case base in System manager and Application is shown on Figure 7.

The Command Interpreter

It is used to execute rule and call CBR functions in ARTScript language. CBR functions include the Case-Based Reasoning facility and the system case-bases. Figure 8 shows how the CBR function can be activated by the commands in the Command Interpreter window.

Data Integrator

It is used to connect the CDRe system with the external Microsoft Access database table so that the system can access each part of the case storage and retrieval process. The object built in the CDRe system is shown in Figure 9.

3.6 Setting Feature Matching Parameter

The ART*Enterprise® provides nearest neighbour retrieval method for case matching. Each retrieved case is scored based on its similarity between the presented case and stored case. Therefore, the matching parameter weightings of each case feature affect the retrieval of matching cases. When a case is presented to the case base for matching, it is matched against all the stored cases and a case list is then compiled according to their case scores. The method of case score computing in ART*Enterprise® function consists of three steps (Brightware, 1995):

1. For each feature presented in the case, a feature score is computed for all stored cases indicating how well that feature matches the stored case's

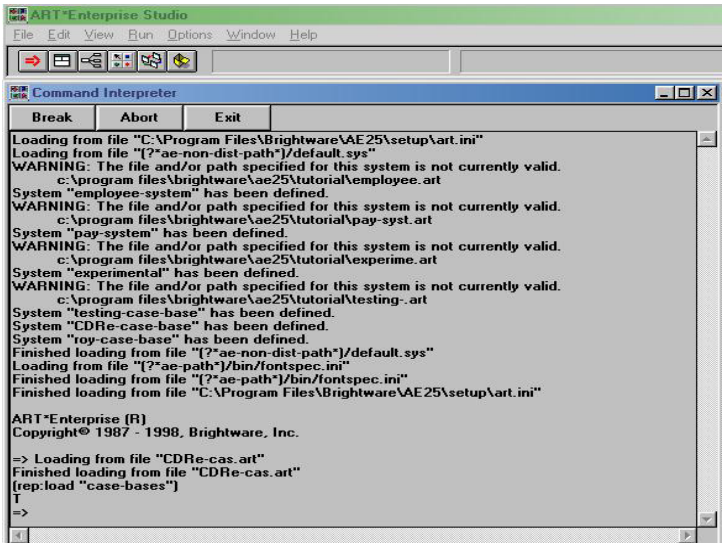

Figure 8. Loading CBR function in the Command Interpreter Window

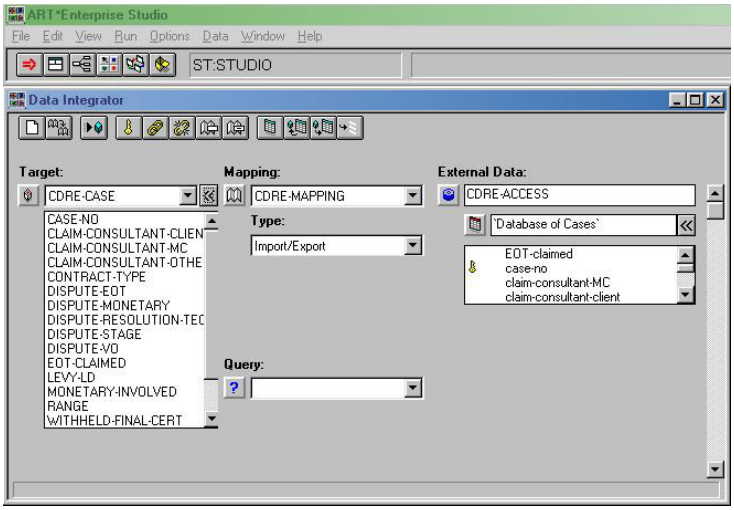

Figure 9. Creating CDRe System Object in Data Integrator

feature. Feature matching often involves dividing the feature into sub-features;

2. For each case, the sum of all feature scores is then computed to produce a raw score; and
3. The raw score is normalized to produce the case score.

3.7 The Calculation of the Feature Scores

The feature score for text matching is the product of the matching subfeature percentage and the feature score range (Brightware, 1995):

$$feature\ score_{f,i} = mmw_{f,i} + msf_{f,i} / tsf_{f} (mw_{f,i} - mmw_{f,i})$$

Where

- $mw_{f,i}$ is the match weight of feature f for case i
- $mmw_{f,i}$ is the mismatch weight of feature f for case i
- $msf_{f,i}$ is the number of matching subfeatures of feature f for case i
- tsf_f is the total number of subfeature of feature f for the presented case
- $msf_{f,i}/\ tsf_f$ is the percentage of subfeatures which match.

This equation can be illustrated in Figure 10. The feature score is a linear function of the percentage of subfeature matched in the range defined by the match and mismatch weights.

For all types of matching, these are two types of weights: the match weight and the mismatch weight. The match weight rewards matches while the mismatch weight penalizes mismatches. The value set for the mismatch weight depends on the kind of application. ART*Enterprise® presents case match scores as a value between -1 (a complete mismatch) and +1 (a perfect match).

It is acknowledged that individual dispute feature may have different degree of influence on resolution process selection. Hence although equal weights are the default setting, ART*Enterprise® allows the adjustment of the feature weights to improve the sensitivity of the selection process. The feature weights used in the CDRe is given in Table 3. The weights were assessed by the same panel of experts who selected the variables for the case structure. The sensitivity of the system can further be augmented if the weight assignment exercise can be enhanced through the use of analytical tools such as Analytical Hierarchical Process (Cheung et al. 2001). It is acknowledged that this is an important refinement as the CDRe develops.

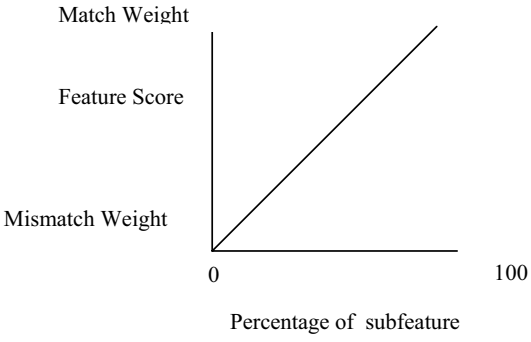

Figure 10. The relationship between percentage of subfeature matched and feature score (Adapted from Brightware, 1995)

3.8 Case Retrieval – By Nearest Neighbour Method

Retrieval is the major process in the CDRe System development. The objective of case retrieval development is to determine the relevant case in order to give recommendation for a presented case. The similarity matches are performed using the nearest neighbour retrieval, which are provided by ART*Enterprise® (Brightware, 1995).

The nearest neighbour retrieval technique matches the database of cases for a number of cases that are similar to the problem case. To perform a nearest neighbour

Table 3. Importance Level of Each Variable

Feature	Feature Matching Weights
Contract Value	5
Type of Contract	5
Stage when Dispute Arose	10
Involvement of Claims Consultant	5
Extension of Time (EOT)	5
Variation Order (VO)	5
Monetary Claims	15
LD Levied by Employer	10
EOT Claimed	15
Monetary Claims Involved	15
Certificate(s) Withheld	10
Total Σ =	100

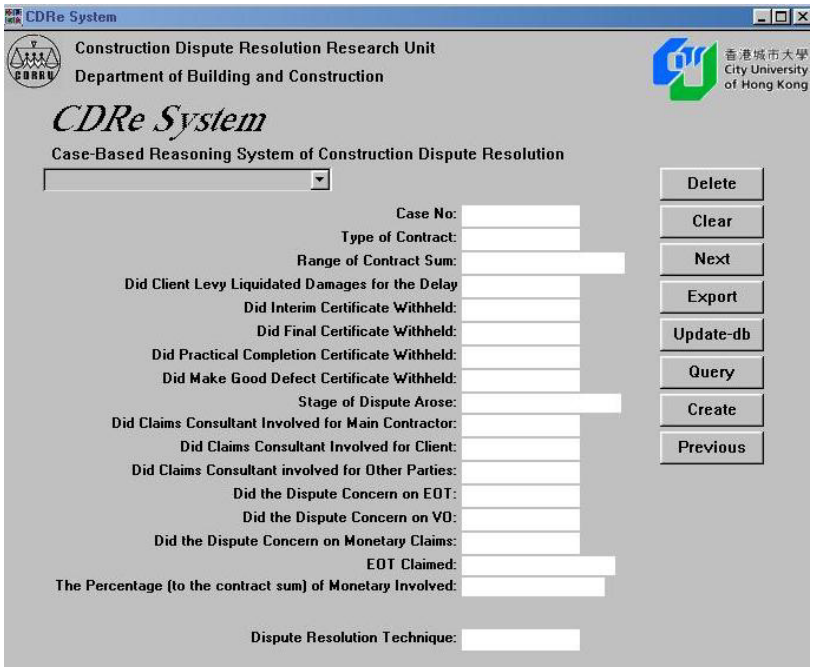

Figure 11. Default Window of the CDRe System Interface

retrieval, feature weights were taken into account to assess the similarity between the stored cases and the presented case. In the CDRe System, the score of each stored case represents the retrieval similarity with respect to the presented case.

3.9 Stage three – User Interface Development

In addition to the database and application model of the CDRe Case-Based Reasoning System, a user interface development is also necessary so that people can use the system conveniently. The user interface of the system should be user-friendly. The Graphical User Interface (GUI) is a window, which can query the stored case in order to show the solution of the case. The interface is constructed by ART*Enterprise® which provides a GUI builder so that there is no need to use other GUI software builder. Figure 11 shows the default view of CDRe System's interface. The results are presented as a list of similar cases, in descending order of similarity, in a separate window, where details about the solutions and how they have been developed can be shown in the Command Interpreter Window.

4 System evaluation

Verification and validation are essential part of the CDRe System development process. Verification ensures that the system gives correct answers and validation ensures the system is one that the users want. The CDRe system is evaluated and tested for reliability. For system evaluation, 9 cases that are independent of the 48 cases in the case library were used as the testing set. Through the reasoning process with Nearest Neighbour Retrieval Technique of Case-based Reasoning, the relationship between the retrieved results and the predicted outcome of cases were suggested and presented. By comparing the actual outcome and the expected outcome of each testing case, the level of the system's reasoning ability is evaluated.

The testing cases were identified as Cases 49, 50, 51, 52, 53, 54, 55, 56, and 57. To illustrate the working of the CDRe, the matching results of Case 50 are discussed. As the procedure on comparison among each case is similar and to simplify the presentation of the final outcome, a summary of the testing results is provided in Table 4.

5 Retrieval result of Case 50 by ART*Enterprise®

Case 50 is a design and build contract for building works with the contract sum above HK$500,000,000.00. The dispute arose when 50 – 75% of works were completed. The liquidated damage stated in the contract is HK$700,000 per day. There was no certificate withheld by the contract administrator. The main contractor of the contract claimed extension of time and monetary claims involved variation orders and insurance matters. A claim consultant was engaged by the main contractor. Accordingly, 3–6 months extension of time was claimed and the quantum of the claim was more than 0.5–3% of the contract sum. However, the employer deducted sum of money by reason other than retention. The case was ultimately resolved by negotiation.

Nearest Neighbour Retrieval Technique is used to retrieve and reason cases. There are 5 reference cases retrieved: Case15, 33, 2, 8 and 16. Both Cases 15 and 33 were retrieved with a similarity score of 0.4814 to Case 50. Other three cases with lower similarity retrieved also met the real situation of Case 50 and these are 2, 8 & 16. For case 15 the dispute resolution method used in the real situation is negotiation and matches with that used in case 50.

There are three cases in the testing set that recorded non-matching results. For example, the suggested resolution method fro case 52 is arbitration whereas the actual method used to achieve the settlement was negotiation. Case 52 arose in a project of contract sum higher than HK$500,000,000. The issue involved was fairly straightforward as only one dispute cause was involved; the responsibility of unforeseen ground condition. Moreover, the amount at stake was substantial. The case library suggested arbitration reflecting the uncompromising attitude of disputants where the amount in dispute is large. Nonetheless, the actual resolution was achieved through negotiation. This might have been the fact that there was only one single cause of dispute and negotiation being an efficient method in such an instance.

6 Summary

In this paper, the development of a Case-Based Reasoning based system for selection of construction dispute resolution process (CDRe). The CDRe system is an integration of database, case-based reasoning application model and user interface. A total of 48 real cases were used in the system as a database organized by Microsoft Access 2000. The development of user interface has been designed to be user-friendly. Retrieval results of the nine testing cases are summarized in a table (Table 4) that detailed the information on the retrieval results, its similarity, reference cases and the actual result of each testing case. The retrieval of cases employs the Nearest Neighbor Retrieval Technique. Five of the testing cases (cases 49, 50, 51, 54, 55, 56 and 57) achieved matching result, thus representing a 77% accuracy. It can be noted that the CDRe is to be used as a decision support tool. It isnot intended to and in fact cannot replace the experience and expertise of the decision maker. In principle, the selected variables for process selection are typical in most construction contracts, it is therefore suggested that the basic architecture and system framework can be extended to other contractual regimes. Moreover, as dispute resolution is contingent on the behavior of disputants, thus it is further suggested that use of such systems should take into account of these geographical differences. A 77% is considered reasonable when compared to the pure intuitive selection. In such cases the chance of choosing the ‘appropriate’ resolution process is 25%,

Table 4. Summary of Retrieval Result

Test Case	Actual Dispute Resolution Technique	Nearest Neighbour Retrieval			
		Priority	Score	Matched Case	Dispute Resolution Technique
49	Negotiation	1	0.4814	18	Arbitration
		2	0.4814	21	Negotiation
		3	0.4814	23	Negotiation
		4	0.4814	35	Negotiation
		5	0.4814	39	Negotiation
50	Negotiation	1	0.4814	15	Negotiation
		2	0.4814	33	Negotiation
		3	0.4035	2	Arbitration
		4	0.4035	8	Negotiation
		5	0.4035	16	Negotiation
51	Arbitration	1	0.4035	19	Arbitration
		2	0.4035	29	Negotiation
		3	0.3333	1	Negotiation
		4	0.3333	13	Arbitration
		5	0.3333	26	Negotiation
52	Negotiation	1	0.5686	2	Arbitration
		2	0.4814	35	Negotiation
		3	0.4814	42	Negotiation
		4	0.4035	7	Negotiation
		5	0.4035	18	Arbitration
53	Mediation	1	0.4814	28	Arbitration
		2	0.4035	18	Arbitration
		3	0.4035	41	Arbitration
		4	0.3333	14	Negotiation
		5	0.3333	16	Negotiation
54	Negotiation	1	0.5686	35	Negotiation
		2	0.4814	18	Arbitration
		3	0.4814	21	Negotiation
		4	0.4814	46	Negotiation
		5	0.4035	15	Negotiation
55	Negotiation	1	0.4814	35	Negotiation
		2	0.4814	39	Negotiation
		3	0.4814	40	Negotiation
		4	0.4814	42	Negotiation
		5	0.4035	14	Negotiation
56	Negotiation	1	0.5686	39	Negotiation
		2	0.4814	35	Negotiation
		3	0.4035	16	Negotiation
		4	0.4035	21	Negotiation
		5	0.4035	34	Negotiation
57	Negotiation	1	0.4035	21	Negotiation
		2	0.4035	23	Negotiation
		3	0.4035	28	Arbitration
		4	0.4035	31	Mediation
		5	0.3333	16	Arbitration

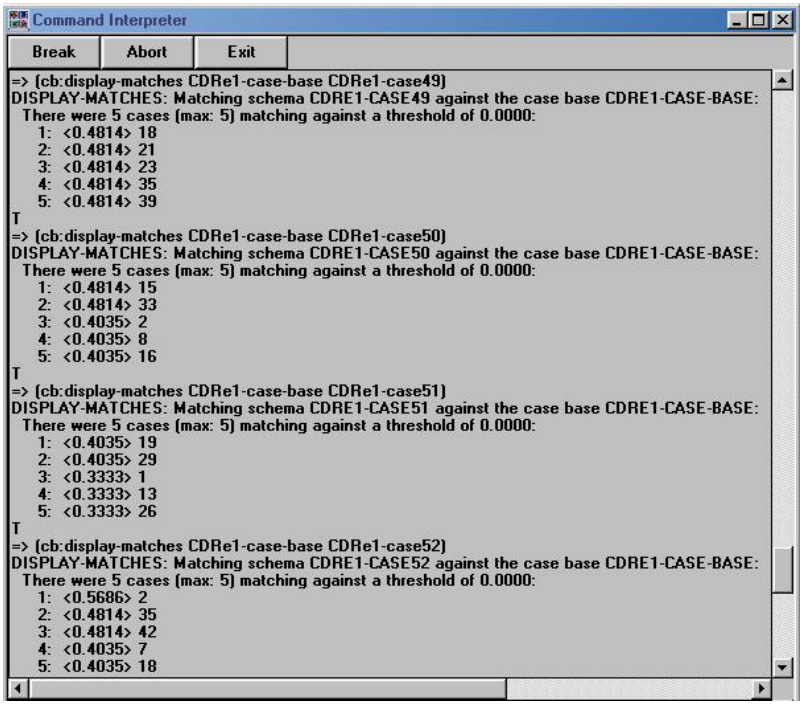

Figure 12. Nearest Neighbour Retrieval Process

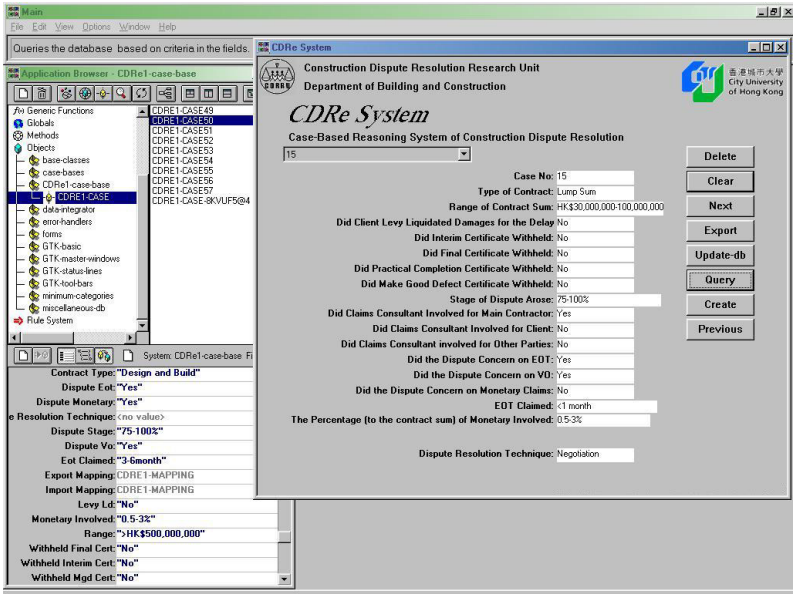

Figure 13. Retrieval Result by Nearest Neighbour Retrieval

a random chance of one in four. System refinement can be achieved by enhancing the feature weights assessment process. This will improve the sensitivity of the system. System improvement can also be expected as the number of cases in the case base increases.

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