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Integrating a CBR Mechanism and ISO Standards for Dispute Resolution

C.Y. Hwang and N.J. Yau
Institute of Construction Engineering and Management, National Central University,
Taiwan, 320, Republic of China

Abstract: This study integrates the case-based reasoning mechanism and international standards to develop a prototype CBRISO mechanism for resolving disputes. The CBRISO system does not fix attributes and their respective weights in advance as the traditional case-based reasoning methodologies. In order to ensure that the proposed system is user friendly and customizable, the international human-system interaction standards are applied. For the purpose of demonstration, construction disputes are used as the research theme to build the corresponding CBRISO mechanism in this study. Empirical findings suggest that the dynamic and recursive system retrieves highly suitable reference cases and predict the outcome of the target case successfully. The most important contribution of this study is consideration of end user's needs during the progression of dispute resolution that no relevant system tried before.

Key words: Artificial intelligence, case-based reasoning, dispute, human-system interaction, international standard organization

INTRODUCTION

Disputes are almost impossible to be avoided due to its complexity and diverging interests of involved parties. Consequently, multidisciplinary researchers have tried to build up methodologies for mitigation of disputes. Fortunately, the cases of disputes can be reduced significantly by experience with adequate help of computer programs such as Case Based Reasoning (CBR) applications. Beside of adequate computer applications, Standard Operation Procedures (SOP) are the strong aids to handle disputes. Since SOPs are the foundation for the daily operations of an entity, these standard procedures can be utilized to resolve disputes in a twofold manner: Software design and execution disciplines. Moreover, the mechanism would be user friendly if the factor of end users is put into design consideration. For those aforesaid reasons, this study intends to develop a prototype of user friendly system for dispute resolution through the help of international standards, ISO 9241-210, mainly. The prototype Case-based Reasoning mechanism (CBRISO) does not fix attributes and their respective weights in advance as the traditional methodologies. It considers end user's needs during the progression of dispute resolution that no relevant system tried before.

DISPUTES RESOLUTION BY INTEGRATION OF CBR AND ISO

People always look for similar cases in mind to make another decision or solve problems on daily base. Same situation happens for the different professionals. The CBR methodology offers a logical model that similar to behavior that many professionals resolve disputes. Generally, ways of dispute resolution are categories into four directions. The alternative dispute resolution (ADR) methods, arbitration, mediation and conciliation mostly, have proven very helpful in many different types of legal disputes besides formal court litigation (The Judicial Yuan of the Republic China, 2007). No matter which method is chosen to resolve disputes, the CBR mechanism would facilitate professionals to handle troublesome issues easier, faster and more economical. It offers a practicable prediction and reasoning model for resolving disputes even under civil law jurisdiction, not only in the case law jurisdiction. In order to explain how the CBR mechanism to help settling disputes, alternative ways to resolve disputes are elaborated respectively thereinafter first. Then, literatures regarding to the mechanism of CBR and dispute resolution are reviewed.

Corresponding Author: C.Y. Hwang, Institute of Construction Engineering and Management, National Central University, Jhongda Rd., Jhongli, Taiwan, 320, Republic of China

Table 1: List of AI systems handling construction disputes

	Year							
System	2003	2003	2008	2009	2009	2010	2011	2012
Model	LPM	CBR	MAS-COR	FCBR	UPM	SVM	DSS-CRP	QUEST, CHAID and C 5.0
Author	Chen	Chau	El-adaway	Cheng *et al.*	Pulket and Arditi	Mahfouz and Kandil	Kanapeckiene *et al.*	Chou

Litigation and ADR: Litigation is the traditional way to settle down disputes in modern society. The types of litigation may involve civil, criminal and state compensation ones in most of civil law countries (Wigmore, 1928). Since the types of dispute are diverse, construction dispute cases are presented as example to deliberate the mechanism in this study.

The construction disputes often involve legal responsibilities among owners, project managers, architects, professional engineers, contractors, sub-contractors and their employees (PWC, 2000). It is a chain reaction. Since construction litigation is time consuming and costly, researchers and practitioners are eager to find out optimal methods to resolve these disputes besides litigation.

Among ADRs, conciliation is a dispute resolution method with well-built consent of both disputants. The relative costs of this method are almost trivial if the time spent was not the essence. Mediation is a procedure of assisted negotiations with help of fair 3rd parties, mediators. Disputants may choose to agree offers of other parties or reply with count-offers. However, the conciliation and mediation has no enforcement power. Similar to mediation, arbitration is a procedure of assisted negotiations with help of arbitrators. Nevertheless, arbitration has enforcement power. They have proved effectively in resolving disputes everywhere.

Literature review of CBR and ADR: Practitioners and researchers have established a number of methodologies for resolve construction disputes by utilizing the Artificial Intelligence (AI) technology. These systems are constructive to aid judges, counselors and neutral third parties for predicting and resolving disputes. Over the last decade, a series of innovative and improved methods have been developed to enhance the prediction and end results of the dispute resolution. For example, Chen built up a Litigation Prediction Model (LPM) to predict the trend of litigation caused by change disputes in (Chen, 2003). The classification rate reached as high as 90%. After that, Chau (2006) indicated the result of the Case-based Reasoning model (CBR) approach could predict 80% of the outcome of construction claims successfully. In (El-Adaway, 2008) developed a way for using logical induction decision support in construction claims and disputes. The researcher also tried to simulate legal discourse in construction disputes. His multi-agent system for construction dispute resolution (MAS-COR) was then created. After that, Cheng *et al.* (2009) further enhanced the case-based reasoning model by combined it with fuzzy-set theory to establish the fuzzy case-based reasoning model (FCBR) for construction dispute settlement support system. At the same year, (Pulket and Arditi, 2009) proposed a universal prediction model (UPM) for construction litigation. The researchers found that UPM offered a better prediction rate than those obtained in previous studies. In 2010, through analyzing legal factors of construction precedent cases, (Mahfouz and Kandil, 2010) utilized support vector machines to propose an automated prediction model for construction litigations. The Support Vector Machine model (SVM) analyzed the outcome of construction litigation well. The authors claimed the accuracy can be as high as 98%. Later, some hybrid or improved methods even claimed higher rate of success. Chou (2012) compared different performances of classification and ensemble models for predicting dispute handling methods in public-private partnership projects. The author claimed the combination of quick, unbiased and efficient statistical tree, Exhaustive Chi-squared Automatic Interaction Detection and C5.0 could reach 84.65% classification accuracy. The aforesaid systems (Table 1) are all developed to assist decision makers to resolve construction disputes efficiently.

Furthermore, (Kanapeckiene *et al.*, 2011) developed a multi-attribute market value assessment system to determine the utility degrees and market values of project alternatives in 2011. The system was useful for determining the sum of losses or claims. Chiu *et al.* (2011) also emphasized that negotiation strategies could increase the system's decision support capability. However, we found only a few researchers, such as Pakdel *et al.* (2013), mentioned about usability and how to check humanity by computer applications. Particularly, no similar system was developed to resolve construction disputes that faced by most of the construction decision makers from relevant literature reviews.

Integration of CBR and ISO: CBR methodology has been widely utilized in nearly all professionals. The usability is always one of the key concerns for system end users as well. Therefore, human factors are one of major concern for developing CBR mechanism. However, human factors or ergonomics is a multidisciplinary expertise integrating involvements from engineering, industrial and graphic design, statistics, operation research, psychology and

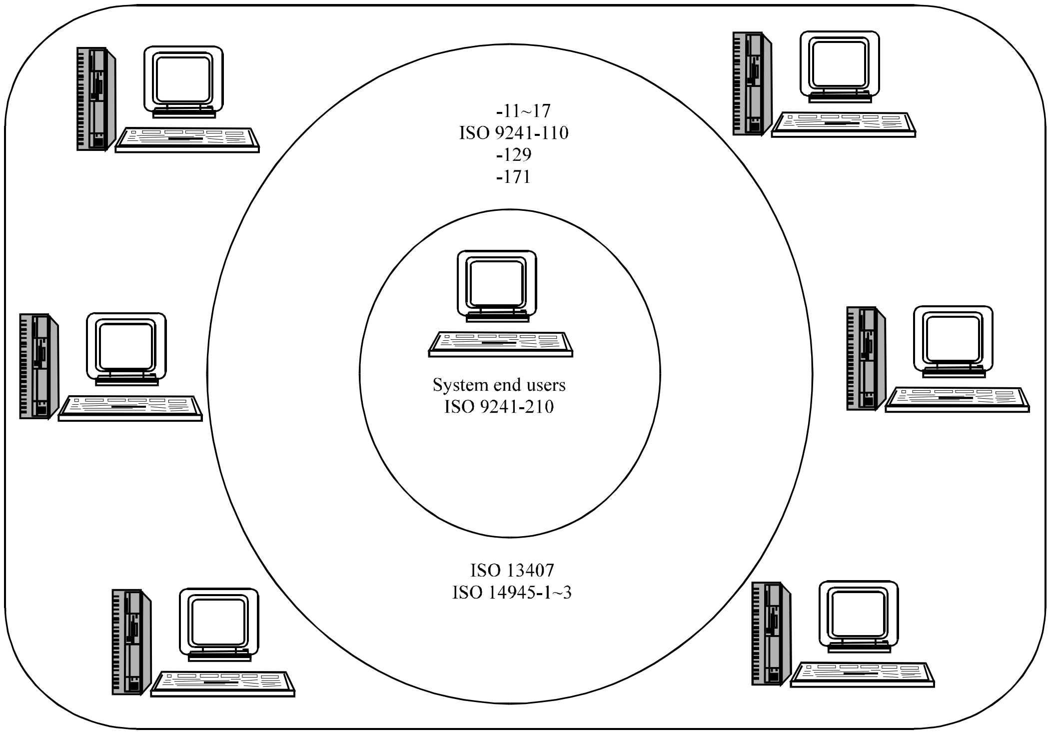

Fig. 1: Ergonomics of human-system interaction

anthropometry. The concept is difficult and complex. Especially, judgment and resolution of construction disputes shall be the same in like cases (NADRAC, 2003). Auspiciously, standards set up by International Standard Organization (ISO) are powerful tool to assure adequate design process of relevant system.

Outline of ISO human-system interaction: ISO (the International Organization for Standardization) is an international association of national standards bodies (ISO member bodies). As the world's largest developer of voluntary international standards, ISO develops more than 19,000 international standards through global consensus since 1947. Based on the need for standards, ISO standards are developed and published by ISO technical committees. The work of developing these standards is normally carried out through global experts. Therefore, the organization indicates, "Conformity to International Standards helps reassure consumers that products are safe, efficient and good for the environment".

ISO adopts ICS (International Classification for Standards) as a way of classifying standards into fields. By ICS, the ergonomics of human-computer interaction is classified into ICS: 35.180 (IT terminal and other peripheral equipment) and ICS: 13.180 (Ergonomics). Among its publications, ISO 9241 standard, developed by the Subcommittee 4 of ISO Technical Committee 159 (TC 159/SC 4), is a multi-part standard which covers ergonomics of human-computer interaction. The TC 159/SC 4 revised ISO 13407:1999, human-centred design for interactive systems, into ISO 9241-210, Ergonomics of Human-system Interaction. It was developed to provide an overview of human-centred design activities and guidance on human-system interaction throughout the life cycle of interactive systems (Fig. 1). However, it does not provide details about the methods and techniques required for human-centred design. Consequently, a human-system interaction system indicates that a system design copes with the foresaid definition.

For the thought above, ISO 9241-210:2010 is utilized to provide requirements and recommendations for human-centered design principles and activities throughout the life cycle of computer-based interactive systems. The ISO standard offers directions on human-system interaction throughout the life cycle of interactive systems. ISO 9241-210:2010 defines user experience as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service." It also helps to manage design processes of software components of interactive systems. Beyond that,

Table 2: ISO standards related to accessibility and usability

ISO No.	ICS	Standard
9241-210:2010	35.180 13.180	Ergonomics of human-system interaction. Part 210: Human-centered design for interactive systems
9241-11:1998	13.180 35.180	Ergonomic requirements for office work with visual display terminals (VDTs). Part 11: Guidance on usability
9241-12:1998	13.180 35.180	Ergonomic requirements for office work with visual display terminals (VDTs). Part 12: Presentation of information
9241-13:1998	13.180 35.180	Ergonomic requirements for office work with visual display terminals (VDTs). Part 13: User guidance
9241-14:1997	13.180 35.180	Ergonomic requirements for office work with visual display terminals (VDTs). Part 14: Menu dialogues
9241-15:1997	13.180 35.180	Ergonomic requirements for office work with visual display terminals (VDTs). Part 15: Command dialogues
9241-16:1999	13.180 35.180	Ergonomic requirements for office work with visual display terminals (VDTs). Part 16: Direct manipulation dialogues
9241-17:2008	13.180	Ergonomics of human-system interaction. Part 171: Guidance on software accessibility
9241-110:2006	13.180	Ergonomics of human-system interaction. Part 110: Dialogue principles
9241-171:2008	13.180	Ergonomics of human-system interaction. Part 171: Guidance on software accessibility
9241-129:2010	13.180 35.180	Ergonomics of human-system interaction. Part 129: Guidance on software individualization
13407:2008	13.180	Ergonomics of human-system interaction. Part 171: Guidance on software accessibility
14915-1:2002	13.180 35.200	Software ergonomics for multimedia user interfaces. Part 1: Design principles and framework
14915-2:2003	13.180 35.200	Software ergonomics for multimedia user interfaces. Part 2: Multimedia navigation and control
14915-3:2002	13.180 35.200	Software ergonomics for multimedia user interfaces. Part 3: Media selection and combination

ISO No.: All ISO standards are numbered, ICS: It is a way of classifying standards into fields such as ergonomics, ISO standards: Developed by experts from different TCs (technical committees). The standards that related to accessibility and usability are all classified into 159/SC4 (Subcommittee 4 of ISO technical committee 159)

ISO 9241-11 to ISO 9241-17, ISO 9241-110, ISO 9241-171, ISO 9241-129, ISO 13407 and ISO 14915 all addresses software considerations for general design of accessibility and usability (Table 2).

Implementation of ISO to CBR: The aforesaid ISO standards state the design requirement on human-system interaction by putting the users at the center of the design process. As the User-centered Design (UCD) frontier, Norman, indicated, UCD based on the needs of the user by leaving aside what the user considers to be secondary issues. Principally, ISO 9241-210:2010 can be employed in the CBR system designs to facilitate the generation of new product ideas and create a model integrating a CBR mechanism and ISO standards for dispute resolution.

In order to guarantee the system design meets the requirement on human-system interaction, this study follows the subsequent guidelines to reassure consumers that application is efficient for the human-system interaction based on the aforesaid ISO standards:

- Users are relevant parties of dispute cases and the task is to settle disputes among them. It would ensure that application design is under the consideration of users, tasks and environments
- System design collect not only recommendation from literature and expert reviews, it also values user's perspective. This way would ensure the design team includes multidisciplinary skills and perspectives
- In order to ensure the whole user experience is taken into account to design the system, the application design values all user's experience
- Design can be driven and refined by users through the CBR function of revision to focus user-centred evaluation
- Application design can be achieved by regular spreadsheet or database applications. It is an open and friendly system and users can get involved easily throughout design and development of the application
- Process can be iterative until the need of users reached

Since ISO 9241-210:2010 points out that outputs and inputs of the system design activity are interdependent to other activities. The following four interdependent activities shall be executed one by one to design an interactive system once kicking off the plan of the human-centered design process. The steps are as follows: (1) Understand and specify the context of use, (2) Specify the user requirements, (3) Produce design solutions to meet user requirements, (4) Evaluate the designs against requirements. Lastly, the solution shall be tested if it

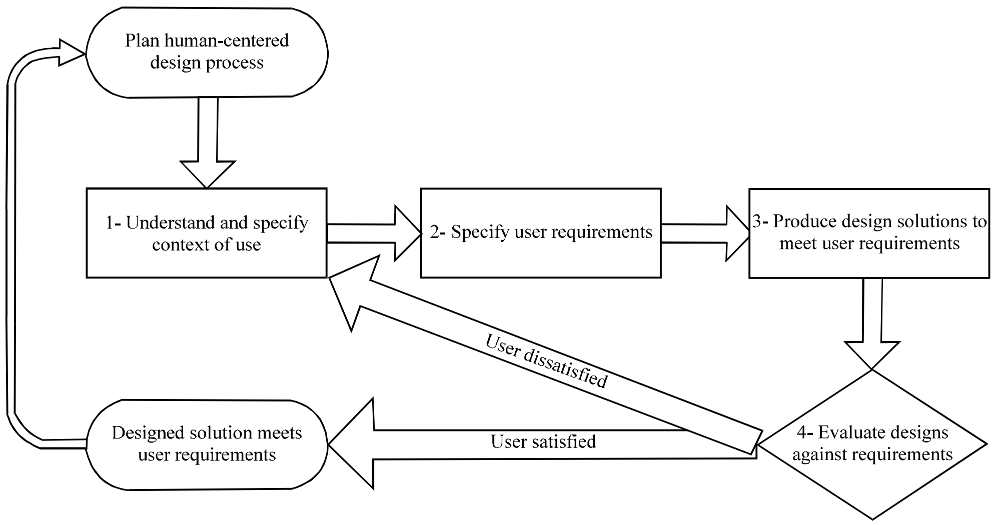

Fig. 2: Human-centered design process

meets user requirements. If not, the step shall be repeated again from any one of four activities above. Otherwise, the resulted solution meets user requirements. The process of these activities is shown on Fig. 2.

Development of CBRISO mechanism: In order to resolve construction disputes, a prototype case-based reasoning mechanism is developed together with three modules, input module, retrieval module and maintenance module, to obtain binding or un-binding decisions and agreements for the construction of the CBRISO system. Next, a usability evaluation method is then adopted to assess the usability of this prototype system. Through this way, we can see the user's satisfaction and needs on the system. Moreover, the result from the evaluation can then serve as feedback and references for system designers to repeat the process for improving the CBRISO system later. On top of existing attributes, additional attributes may be collected for enhancing the foresaid modules as well. The new CBR mechanism may enhance human system interaction after imposing the components of interactive systems and offer a reasoning prototype that is similar to the method many people solve problems habitually. This cycle may go repetitively until obtaining the optimal CBRISO system.

DESIGN OF CBRISO PROTOTYPE MODEL

Prototype model is designed according to the CBRISO mechanism mentioned above. The design of system model is initiated according to three architectural levels of a database which are the external level, the conceptual level and the physical level. Firstly, the design of prototype system begins with system analysis to meet various needs of end users after gathering available dispute resolution cases. At this external level, designers apply the aforesaid ISO requirements to organize this human-centered CBR system. Next, the overall landscape of the database is defined at conceptual level.

External and conceptual level: The system framework and flowchart shall be are defined based on the need of end system users. Then, a structured analysis technique, logical Data Flow Diagram (DFD), is adopted to show how data moves and changes through the database system. The DFD is created along with defined context diagram (Fig. 3).

Physical level of design: After completing the conceptual and physical level, major steps of the physical level are carried out one by one as follows: Distribute or input collected data into tables, set up entity-relationship model (E-R model), specify each table's primary key, establish table relationships and normalize database tables. Since the highest level of normalization is not desirable for all time, the three level of normalization is applied at this point to delete repetitive data and functional dependency and transitive dependency. Following to the table normalization, the tables are adjusted as needed. Lastly, Microsoft Access, one of stand-alone software in the market, is adopted to develop the system for its availability and usability.

Sources of dispute cases and attributes: Local dispute cases from Taiwan official law and regulations database (The Judicial Yuan of the Republic China, 2013) are

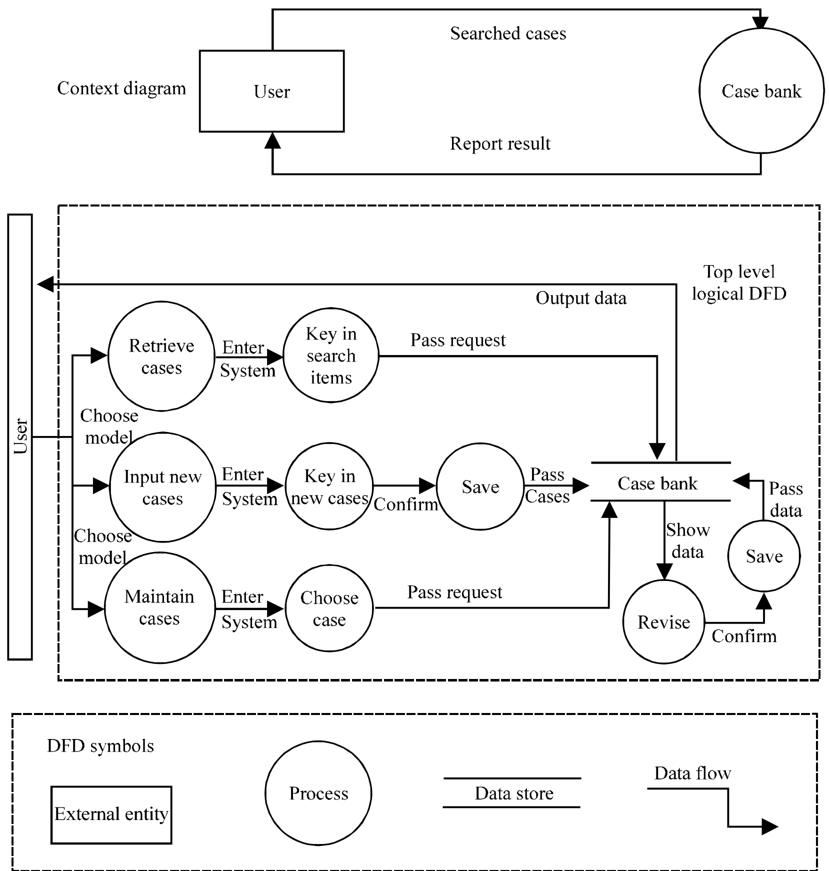

Fig. 3: Context diagram and top level DFD

extracted to develop the prototype CBR database management system and exam how this CBRISO model works in this study. The attained case information and attributes that recommended by experts and scholars are distributed into tables to set up E-R model and table relationships followed by three levels of normalization processes. Moreover, attributes and their own weights of each case will be established. In other words, cases in the CBR database are all indexed at this time. New cases shall be indexed whenever input into the database. All selected attributes of the system are categorized and their dispute types are classified in Table 3 together.

Weight of attributes: Most attributes in the first two categories, category of dispute cases information and involved parties information, provide trivial information purely. Anyhow, they are and not critical to the outcome of the cases except the following attributes, namely as case type, claimed amount, appraised lost amount, accommodation amount and insured or not. Therefore, 35 out of 55 attributes are selects for predicting the outcome of similar dispute cases. Among them, the table attribute of case type is divided into five dispute attributes, namely as arbitration, mediation, conciliation, litigation and other means further. However, other attributes in the first two categories are left solely for supporting case relevant information to end users. The method to determine the weight of each attribute in the cases is the same as the method to set up attributes. They are recommended and defined after interviewing three construction and legal practitioners. The three-point likert scale (one point = least important, two point = important and 3 = most important) is adopted as the value of the weight. These values of attribute weight can be adjusted to fit the special need of DBMS users later. Additionally, in order to be more user friendly, the value of attribute is assigned to be binary, 0 or 1. The binary attribute indicates that disputes of the case are relevant to cases in the database or not. If there is no relevance between the dispute and the cases in database, the value is 0; otherwise, it is 1. The

Table 3: Categorized attributes of CBRISO

Attribute	Categorized	Classification of dispute	Value	Weights 1-3
Contract	Dispute	Decision ground	Binary	2
Jurisprudence	Recommended	Decision ground	Binary	2
Customs	Recommended	Decision ground	Binary	1
Act	Recommended	Decision ground	Binary	2
Arbitration	Dispute cases	Decision ground	Binary	2
Mediation	Dispute cases	Decision ground	Binary	2
Conciliation	Dispute cases	Decision ground	Binary	2
Litigation	Dispute cases	Decision ground	Binary	3
Other means	Dispute cases	Decision ground	Binary	1
Claimed amount	Dispute cases	Decision ground	Binary	3
Accommodation amount	Dispute cases	Decision ground	Binary	3
Insured or not	Dispute cases	Decision ground	Binary	2
CPM	Recommended	Schedule involved	Binary	2
Coordination	Recommended	Schedule involved	Binary	1
Concurrent delay	Recommended	Schedule involved	Binary	2
Disaster	Recommended	Schedule involved	Binary	1
Cost escalation	Recommended	Damage measured	Binary	2
Advance payment	Recommended	Damage measured	Binary	2
Late payment	Recommended	Damage measured	Binary	2
Compensatory liquidated damage	Recommended	Damage measured	Binary	2
Punitive liquidated damage	Recommended	Damage measured	Binary	3
Appraised lost amount	Dispute cases	Damage measured	Binary	3
Alternative material	Recommended	Quality involved	Binary	2
Supervision	Recommended	Quality involved	Binary	2
Directed change order	Recommended	Change order	Binary	2
Constructive change order	Recommended	Change order	Binary	1
Scope	Recommended	Change order	Binary	1
Lump sum	Recommended	Contract type	Binary	3
Unit price	Recommended	Contract type	Binary	2
Cost plus fee	Recommended	Contract type	Binary	2
Time rate pay	Recommended	Contract type	Binary	2
Percentage of construction expense	Recommended	Contract type	Binary	2
Contract interpretation	Recommended	Other disagreement	Binary	2
Unknown site condition	Recommended	Other disagreement	Binary	2
Misrepresentation of site	Recommended	Other disagreement	Binary	2
Application document No.	Dispute cases	Others	0	0
Designated case No.	Dispute cases	Others	0	0
Notice of meeting date	Dispute cases	Others	0	0
Document No. of notice	Dispute cases	Others	0	0
Meeting date	Dispute cases	Others	0	0
Authorized defendant delegation	Dispute cases	Others	0	0
Undertaker of defendant	Dispute cases	Others	0	0
Undertaker of plaintiff	Dispute cases	Others	0	0
Case completed date	Dispute cases	Others	0	0
Case updated condition	Dispute cases	Others	0	0
Authorized plaintiff delegation	Involved parties	Others	0	0
Sex	Involved parties	Others	0	0
Identification No.	Involved parties	Others	0	0
Office telephone No.	Involved parties	Others	0	0
Home telephone No.	Involved parties	Others	0	0
Cellular phone No.	Involved parties	Others	0	0
Designated case No.	Involved parties	Others	0	0
Case completed date	Involved parties	Others	0	0
Case updated condition	Involved parties	Others	0	0
Others	Recommended	Others	0	0

CBRISO model manipulates 35 out of 55 identified binary attributes only. The other 20 attributes are designated as 0 for all time due to its irrelevancy to the disputes.

Calculation of similarity: In order to retrieve suitable referral case, the end users have to determine and fill in the value, 0 or 1, of aforesaid 35 attributes first. Then, the retrieval module will calculates a nearest neighbor index based on the average distance from each feature to its nearest neighboring feature and report all relevant cases after calculating similarity between the target case and cases in the database.

The similarity between the queried dispute (a) in the queried case (i) and a case in the database (j) is defined as

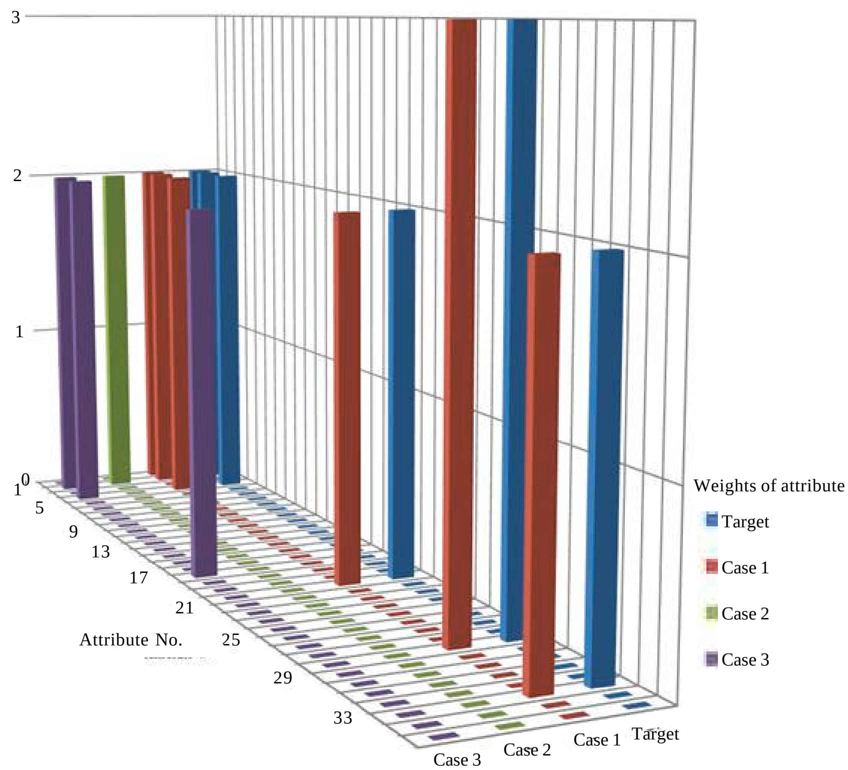

Fig. 4: Similarity (S) of the testing case

the sum of the local resemblances of its integral attributes (LSa) multiplied by their relevance weights (Wa) and divided by the total relevance weights (Eq. 1).

$$\text{Similarity}\,(i, j) = \frac{\sum_{a=1}^{n} Wa \times LSa(i, j)}{\sum_{a=1}^{n} Wa} \tag{1}$$

Equation variables: $\text{Similarity}_{(i,\ j)}$ is similarity between cases i and j. Wa is weight of dispute a is user-defined (1-3). $LS_{a(i,j)}$ is similarity of attribute a between cases i and j (0 or 1). n is number of attributes (35).

IMPLEMENTATION AND TESTING RESULT

A target case was chose to evaluate the prototype CBRISO model. The model retrieved 21 related cases which the similarity of the case was larger than 0 among 906 construction cases from Taiwan judgments database. Three of them had 100% similarity comparing to our target case. The only discrepancy of these three cases was the respondents, which were different government agencies. It had no influence to the result since the weights of these related attributes were designated as 0. However, some cases had little similarity, as low as 15%. Most of them were related to the attorney fee which was classified into the attribute of cost escalation. The calculation of the testing case was listed below and the result of similarity test was as shown in Fig. 4.

Calculation of values:

- **Denominator:** 1*(2+2+2+2+3+2)+29*0 = 13

Numerator:

- **Case 1:** 1*(2+2+2+2+3+2)+29*0 = 13
- **Case 2:** 1*2+34*0 = 2
- **Case 3:** 1*2+1*2+1*2+32*0 = 6

Similarity = Numerator/Denominator:

- **Case 1:** 13/13=100%
- **Case 2:** 2/13=15%
- **Case 3:** 6/13=46%

After retrieving best match judgments and reasoning of historical dispute cases, the reasoning behind these cases was utilized to predict the possible outcome of on-hand cases. The predicted outcome of the case then served as a precious reference for making decisions in the upcoming dispute resolution procedures. The implementation of this prototype CBRISO model showed its usability with high prediction capability. The mechanism was not only proved to be useful for pursuing claimants, but it was also a good decision support system for decision makers. Especially, it considers end user's needs during the progression of dispute resolution that no relevant system tried before.

CONCLUSION AND RECOMMENDATION

The spirit of CBR copes with the Principle of Stare decisis in Common Law System. Therefore, a CBR system can assist analytical decision making to resolve similar dispute cases. The CBR mechanism has also been proved to be effective in handling large quantity of dispute cases after catastrophes, such as Sanchung flooding in Taipei. The flooding caused almost USD 30 million dollars in losses and around 19,000 dispute cases (Yau and Hwang, 2011).

Likewise, the proposed CBRISO mechanism is designed to help decision makers in assessing valuable historical cases during the process of dispute resolution. Through the help of international standards, the condensed and straightforward mechanism is able to resolve complex disputes with end users' close involvement. In addition, the high prediction capability of the proposed mechanism supports users in dealing with contractual issues and the user friendly design served end users' needs timely.

The prototype CBRISO model improves the successful rate of dispute resolution and human-system interaction. However, appropriate attributes would play a key role to improve the accuracy of retrieval cases. More comprehensive design on competence of evidence, transparent remedy standards and property appraisal systems may also improve the efficiency. Lastly, interdisciplinary cooperation, such as the joint effort of information technology professionals and management specialists, would contribute largely to the dispute resolution without doubt. We also hope that dynamic prediction schemes which have been applied in simulating performance of different methods (Gamez *et al*., 2000) would be developed soon to assist in resolving increasing disputes.

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