A Multi-Objective Decision Support System for Selecting Dispute Resolution Methods in Construction Industry

Mostafa Babaeian Jelodar[1], Tak Wing Yiu[2] and Suzanne Wilkinson[3]

Department of Civil and environmental Engineering; University of Auckland; Auckland 1142, New Zealand
[1] PhD student; mjel010@aucklanduni.ac.nz
[2] Senior Lecturer; k.yiu@auckland.ac.nz
[3] Professor; s.wilkinson@auckland.ac.nz

ASTRACT

Selecting the best conflict and dispute resolution method is not easy and can be very problematic specially when the decision involves multiple objectives or attributes. Conventionally construction parties consider cost, time and the amount of control they have in selecting their dispute resolution method. However one of the most important issues is the intended relationship quality and future retention status of working relationships. Based on the range of potential relationship contingencies the conflicting parties can decide on their potential strategy, style and method of conflict management. In the current study four attributes of cost, time, control and relationship quality are used to develop a multi-objective Decision Support System (DSS). Multi Attribute Utility Theory (MAUT) methodology is employed utility of these four selected attributes are defined and the mathematical model is driven in two stages; stage one for each party and in the second stage for the integrated utilities of all the parties. The presented model although having some limitations can form the bases of a DSS for better selection of conflict and dispute resolution process.

INTRODUCTION

Conflicts and disputes are almost inevitable in construction projects, and typically a great amount of time and effort goes into their resolution process (Cheung and Yiu, 2006). A certain level of conflict always exists in any kind of engineering and construction project which potentially can escalate into disputes. A range of different methods such as dispute review boards, to mediation, mini trials, arbitration, and etc. have been suggested, implemented and also documented from for dispute resolution. Naturally these methods have been designed for different circumstances hence construction project participants need to assess the conditions and set appropriate constraints and choose the best possible resolution method. Nevertheless choosing the best method is not so obvious and easy most of the times. Which factor to consider and based on what criterions should the decision be made. The decision process can be a conundrum due to different attributes and levels that may be involved in different objectives of the parties, otherwise known as conflict of objectives. Cost of these methods and their corresponding cost benefit analysis is normally one of the important decision criterions, then some parties are looking to resolve issues as soon as possible thus time could be the major factor in making their

ultimate decisions. For some, organizational standards and most importantly strategy is also a key determinant of any decision which can add to the complexity of this enigma. For instance as part of their strategy relationships with a certain construction firm is of high importance therefore in order to maintain a good level of relationship quality some parties may compromise and disregard their loss or claim and forms the bases of the decision (Babaeian Jelodar et al, 2013b). Other issues such as power share could also be a critical player in decision making and since stronger parties have a better power base in the market they can influence the fate of other smaller entities, these organizations may be more rigid in their dispute resolution styles.

An all important question is how the decision criteria for selection of dispute resolution methods should be defined, which combination of attributes based on what objectives. Different parties follow different objectives in their decisions how could these multiple objectives be included in the decision making process. The current work aims to address this issue by exploring the common decision tendencies of construction practitioners in conflict and dispute cases and suggest a simple multi objective Decision Support Systems (DSS) for selection of the most appropriate resolution method.

DISPUTE RESOLUTION

Conflict due to being the prime cause of claims and dispute must be dealt with accordingly because if not it may get out of control. Conflict is normally noticed when it is perceived and manifested, thus most of the conflict resolution methods aim to reduce manifested conflict (Dant and Schul, 1992). The importance of future relationships with the conflicting parties and the vision of individual parties can determine how they resolve their conflicts. In light of this Thomas (1976), and Rahim (1983) developed their conflict handling styles on the two dimensions of concern for self and concern for others. The styles discussed by Rahim(1983) are; *Integrating (IN)* involving high concern for self as well as the other party involved in conflict (i.e., openness, exchange of information, and examination of differences) to reach a solution acceptable to both; *Obliging (OB)* which involves low concern for self and high concern for the other party involved in conflict trying to satisfy the concerns of the other party; *Dominating (DO)* this style involves high concern for self and low concern for the other party involved in conflict; *Avoiding (AV)* which is associated with low concern for self as well as for the other party involved in conflict; *Compromising (CO)* a style with moderate concern for self as well as the other party involved in conflict, It is normally associated with give-and-take or sharing. Thus thorough and detailed decision making process based on strategies and also information the parties involved in a conflict situation can is essential especially when the future relationships of the parties can be compromised.

When conflicts escalate and result in disputes they require adequate dispute resolution methods, Pena-Mora, et al.(2003) considering the work produced by Associated General Contractors of America (2000), the Construction Industry Institute (CII) (1995) has classified these different methods as illustrated in Figure 1. In this classification resolution methods are divided into traditional and also Alternative Dispute Resolution (ADR) methods. The traditional dispute resolution procedures normally embrace litigation and arbitration (Harmon, 2003). These

procedures are performed by a strong role of a third body which could be an individual, organization or a judge. These traditional methods are very expensive and normally proceed over a long period of time which even after a decision has been made may be subject to appeal by the dissatisfied party making the final processes even longer some time as long as a decade (Fisher, 2004). However the outcomes of these traditional approaches are a binding which is enforceable.

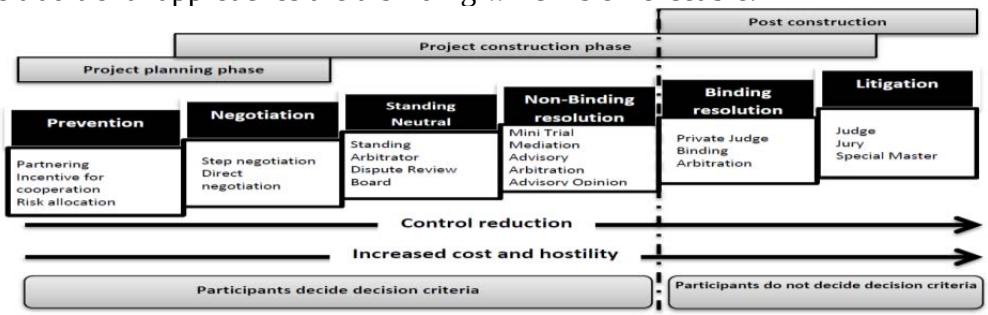

Figure 1. Steps in construction dispute resolution (AGC, 2000; CII, 1995; Menassa, 2009; Pena-Mora et al., 2003)

Alternative dispute resolution (ADR) are collection of methods that are employed to privately resolve conflicts and disputes as opposed to reaching resolutions in the public courts" (Kovach, 2004). Pena-Mora, et al.(2003) concluded that the "judicial system is no longer the most suitable and cost effective way to resolve construction disputes". A variety of methods formalize ADR into a comprehensive umbrella type concept for dispute resolution, methods such as problem solving/conciliation, formal negotiation, mediation, and non-binding arbitration (Figure 1). ADR methods are either binding (formal) or non-binding (informal) (Honeyman, 2004; Kellogg, 2001) the benefit of ADR is that these methods are relatively cheaper and also faster than the traditional approach however since they are less binding there is always a risk of one party not accepting the resolution and forcing the dispute to go through a more hostile and binding process such as arbitration or litigation. In the illustrated continuum of dispute resolution methods as we move from left to right hostility increases which implies there is the potential for adversarial behaviour, decline in quality of relationship and ultimately broken working relationships.

DECISION SUPPORT SYSTEM FOR DISPUTE RESOLUTION

Making choices are custom to any engineering project and the usual procedure is to first identify a certain criteria comprised of attributes which are important to the desired outcome and decide on the best possible trade-offs of these attributes in order to achieve that outcome. Thus for determining the most suitable method of dispute resolution these attributes must be identified and defined, the decision probably has to be made before the official contract is signed since the contract normally has to specify which root to take in case of potential in dispute resolution. As discussed choosing any of the dispute resolution methods incorporated in the continuum of Figure 1 has certain consequences which can be either inline or in conflict with the desired criteria, this congruence or incongruence with the selected criteria will form the bases of our decision making. This seems to be relatively simple

when we are dealing with one attribute but in the case of conflict or dispute according to Pena-Mora, et al. (2003) and the elaborated continuum many attributes or objectives can be pursuit in making a decision on a certain method of resolution.

MULTI OBJECTIVE DECISION CRITERIA

Based on strategy construction parties may need to make a more comprehensive and informed decision which can affect their business initiative in the long term. However strategy may change with the level of organization maturity however in general profit is the ultimate goal and the main mean of producing value in organizations. Accordingly the most immediate and simplest analysis in making any decision could be the Cost Benefit Analysis (CBA) to assess the flow of profit. The sum of money and cost of resolution methods can account for a large portion of the settlement/award amount and the original claim amount, and even the total contract value (Gebken and Gibson, 2006). However this also may provide a trap for the more myopic, urging them to take alternative actions and decision which could enhance short term benefits but conversely incurs heavy losses on the long term. In conflict and dispute cases parties can easily fall in this trap and get involved in heavy, lengthy and costly fights for a short term claim and payment in a trade-off of losing a good relationship or a reliable partner which can be very costly in the long term. This simply implies that although CBA analysis should be a deciding factor but to make a better decision a wider picture with preferences and constraints on decision attributes should be drawn.

Parties which have a rigorous cost driven agenda have a stronger preference to make decisions based on the Cost Benefit Analysis (CBA). Some parties as mentioned before want everything to end on time since they may have other commitments elsewhere for them time is of the essence and they will base their decisions mainly on time as a criteria. Others may prefer to have control over their chosen method consequently they can guide through as they proceed into the resolution process then they tend to go for more controlled processes such as direct negotiation and mediation as resolution processes. Some parties think strategically and their preference will be to maintain relationships for longer periods of time to earn more value, they tend to go for less hostile approaches such as negotiation review boards, or even in cases take preventive actions and go for partnering and collaboration. But often the decisions are not so easy because of certain preferences and also constraints that parties have during their projects the most basic of these constraints are cost, time, quality and scope in project management. These constraints simply mean that an extent of trade-off has to be made between these criteria to fulfil the preferences and constraints. This calls for multi-objective decision support systems, and the task is to identify criteria based on the objectives and preferences of different parties involved. Scaling system to compare each of the different attributes to the set criteria is required, and in order to fulfil this goal the use of Multi Attribute Utility Theory (MAUT) is proposed since it is capable to translate different types of attributes into comparable utilities.

MULTI ATTRIBUTE UTILITY THEORY METHODOLOGY

The Multi Attribute Utility Theory (MAUT) is a methodology to address the problem of multi objectives (Keeney and Raiffa, 1976). It is a popular methodology

in Multi-Attribute Decision Making with applications in diverse areas of knowledge and industry. The methodology is designed to handle the trade-offs among multiple objectives, with defining and applying utility functions to convert numerical attribute scales to utility unit scales enabling direct comparison of diverse measures. Comparison of different attributes becomes possible when their different scale or units are converted and scaled into unified form as utility. Thus for this method to be applicable for decision making in choosing the most appropriate conflict and dispute resolution method the utility of each contributing attribute must be defined and certain boundaries must be set. For the purpose of this DSS model 4 attributes as related to the four main strategic objectives elaborated in previous sections are considered and the utility of the four attributes of cost, time, control, and relationship quality are defined as follows:

Utility of cost or money $\boldsymbol{U(Cost)}$***;*** this attribute basically is an indicator of how much a party is willing to invest in a dispute resolution process, demonstrating their cost agenda which preferably is to minimize cost. This can also be defined by performing a cost benefit analysis of each resolution method and the earned value can be substituted in this case the initiative is to maximize the value.

Utility of time $\boldsymbol{U(Time)}$***;*** this attribute shows the flexibility of the party in terms of time and how much they insist on timely dispute resolution procedures, preferably parties seek to minimize time.

Utility of control $\boldsymbol{U(Control)}$***;*** this attribute allows for the parties to be in control of the resolution outcomes and the utility value is an indication of preference for being in control of the resolution processes and its possible implication. Being in control is more desirable and preferred. For Some resolution methods such as arbitration and litigation parties loose almost all control over the outcomes which is not preferred.

Utility of relationship quality $\boldsymbol{U(RQ)}$***;*** this basically shows the preference of parties in maintaining their working relationship with the disputant party. A systematic model was proposed for Relationship quality of construction participants this model tried to capture the working relationship status of construction parties (Babaeian Jelodar and Yiu, 2012b). The model was proposed to be a high order construct and a process model was proposed for this high order construct(Babaeian Jelodar and Yiu, 2012a). This process model indicates the direct effect of conflicts and disputes on relationship quality. Based on this Babaeian et al, (2013a) have argued that the resolution process and the management of conflicts and dispute will have an effect on relationship quality of working parties. They discussed how formal resolution methodologies apply evidence reasoning and contractual provisions to deal with claims and discussed their implications on relationship quality

Consequently parties who prefer to have a better relationship with others have higher $U(RQ)$ values, and also seek to maximise this utility. On the other hand these preferences can change as the organizational maturity level changes or the power structure changes. Ultimately this utility is absolutely strategy driven and will change based on changes of strategy and circumstances. For instance if one party feels that they do not need the assistance of the other party for their future projects and also they have the upper hand in terms of market power, core competencies and competition they may choose a more hostile or aggressive resolution method. Generally the preference is to maintain good relationship quality.

The MAUT models. For a consequence set such as $x_1, x_2, \dots, x_n$ with different levels of the attributes corresponding to n objectives, the utility is computed in the following separate forms:

Formula 1; Simplified additive utility model

$$U(x_1, x_2, \dots, x_n) = w_1U_1(x_1) + w_2U_2(x_2) + \cdots + w_nU_n(x_n) = \sum_{i=1}^{n} w_iU_i(x_i)$$

Where: $\sum_{i=1}^{n} w_i = 1$, $0 < U_i(x_i) < 1$, $0 < U(x_1, x_2, \dots, x_n) < 1$

Formula 2; Multiplicative utility model

$$U(x_1, x_2, \dots, x_n) = \frac{1}{W}(\prod_{i=1}^{n}[Ww_iU_i(x_i) + 1] - 1)$$

Where: $(1 + W) = \prod_{i=1}^{n}(1 + Ww_i)$, $0 < U_i(x_i) < 1$, $0 < U(x_1, x_2, \dots, x_n) < 1$

The above forms of utility models are used based on assumptions of mutual utility independence and preferential independence and the multi-linear form is not engaged (Farajian and Cui, 2011; Keeney and Raiffa, 1976) . This basically means that a change in preference order of any one attribute for instance relationship quality does not change the rank of others such as cost, time and control.

A utility function comprised of all the contributing utilities to the decision is derived and the aim is to maximize this function. In this case the utility functions for the best possible case is assumed to be 1 implying the minimum cost, minimum time, maximum control and maximum relationship quality and worst possible circumstances will be 0 as formalized bellow:

$$U(min\ Cost, min\ Time, max\ controle, max\ RQ) = U(1,1,1,1) = 1$$
$$U(max\ Cost, max\ Time, min\ controle, min\ RQ) = U(0,0,0,0) = 0$$

Based on the above mentioned scaling factors and the equivalent lottery method (Hillier and Lieberman, 2010) the decision makers are asked for what level of p they would be indifferent between alternative 1 and alternative2,

If $p = \frac{1}{3}$ is made by the decision maker, then $U(Cost) = U(1,0,0,0) = 0.33$ ultimately w_i=0.33 (Figure 2).

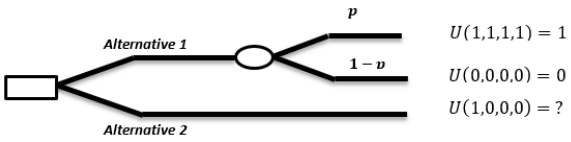

Figure2: Scaling and the equivalent lottery method $U(Cost)$

This process should be repeated for U(Time), U(Control), and also U(RQ) to acquiring all the w_i and complete the utility function demonstrated by formula 1. However for formula 2 the W can be obtained and the utility function completed as follows in formula 3:

$$W = \prod_{i=1}^{n}[Ww_iU_i(x_i) + 1] - 1$$

The utility function of all parties can be obtained, for instance if there are two parties involved in the dispute process then $U_{Party1}(Cost, Time, controle, RQ)$ and

also $U_{Party2}(Cost, Time, controle, RQ)$ can be assessed, this is especially helpful for resolution negotiators or in cases where the two parties want to make an integrated decision which accounts for both parties preferences for the resolution method. The attributes used in this DSS cannot be integrated easily in one model formula since different preferences exist between different parties and the weighting and rating system varies from one party to the other. Thus a two-step utility function may be used as proposed by Farajian and Cui (2011). At the second step an integrated utility function of the two parties is obtained through formula 2.

$$U_{integrated}\left(U_{Party1}, U_{Party2}\right) = \frac{1}{W}\left(\prod_{i=1}^{2}[Ww_iU_i(x_i) + 1] - 1\right)$$

The scaling process;

$$U_{integrated}\left(max\ U_{Party1}, max\ U_{Party2}\right) = U(1,1) = 1$$
$$U_{integrated}\left(min\ U_{Party1}, min\ U_{Party2}\right) = U(0,0) = 0$$

And also the utility function is obtained by applying the equivalent lottery method and acquiring all the weights required as illustrated in Figure 3.

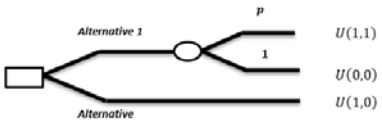

Figure 3: Scaling and the equivalent lottery method for utility of different parties

This two stage MAUT model with all its limitation can form the bases of a DSS model which can assist the construction industry participants, clients, contractors, resolution facilitators and consultants in making better dispute resolution decisions.

CONCLUSION

With the goal of developing a decision support system (DSS) this article has initially identified the decision criteria that different parties in construction may employ in order to choose the appropriate dispute resolution method. It is clear that different parties have different preferences and also objectives which they seek to fulfil through their decisions. Consequently a strategic attribute such as relationship quality in addition to more conventional attributes such as cost, time and control where identified as the basis of this multi-objective DSS. Via the Multi Attribute Utility Theory (MAUT) methodology the utility of these four attributes where defined and was combined into two steps of applying the utility functions. Ultimately the mathematical procedure of obtaining the utility functions was described and disseminated. These mathematical models form the bases of the DSS for selecting more appropriate dispute resolution methods. The study is facing many limitations at the moment, data is needed to validate the model and test the sensitivity of each attribute and the corresponding utility, based on which the model can be optimised and presented.

REFERENCES

Associated General Contractors of America. (2000). Enlightened Risk Allocation - The 21st Century Owner's Guide to Cost Effectiveness: AGC.

Babaeian Jelodar, M., and Yiu, T. W. (2012a). *Evaluation of relationship quality in construction cases using a process model of conflict and disputes in project management*. Paper presented at the The 8th International Project Management Conference (IPMC2012), Tehran-Iran.

Babaeian Jelodar, M., and Yiu, T. W. (2012b). *Systematic framework of conflict, dispute and relationship quality in construction projects* Paper presented at the 37th Annual Conference of the Australasian Universities Building Educators Association (AUBEA), The University of New South Wales, Australia.

Babaeian Jelodar, M., Yiu, T. W., and Wilkinson, S. (2013a). *Sources of Conflict and Dispute as Impediments to Sustainability of Construction Relationships*. Paper presented at the 38th Annual Conference of the Australasian Universities Building Educators Association (AUBEA), Auckland, New Zealand.

Babaeian Jelodar, M., Yiu, T. W., and Wilkinson, S. (2013b). *Stirring sustainable procurement by conceptualizing relationship quality in construction.* Paper presented at the World Building Congress 2013, Brisbane Convention and Exhibition Centre, Queensland, Australia.

Cheung, S. O., and Yiu, T. W. (2006). Are Construction Disputes Inevitable? *Engineering Management, IEEE Transactions on, 53*(3), 456-470.

Construction Industry Institute. (1995). Dispute Prevention and Resolution Techniques in the Construction Industry." Prepared by the Dispute Prevention and Resolution Research Team: CII, Research Summary 23-1, The University of Texas at Austin.

Dant, R. P., and Schul, P. L. (1992). Conflict Resolution Processes in Contractual Channels of Distribution. *The Journal of Marketing, 56*(1), 38-54.

Farajian, M., and Cui, Q. (2011). A Multi-Objective Decision Support System for PPP Funding Decisions *Computing in Civil Engineering (2011)* (pp. 210-218): American Society of Civil Engineers.

Fisher, R. B. (2004). *Partnering public sector construction contracts: A conflict avoidance process.* (Ph.D dissertation), Virginia Commonwealth University, Virginia.

Gebken, R., and Gibson, G. (2006). Quantification of Costs for Dispute Resolution Procedures in the Construction Industry. *Journal of Professional Issues in Engineering Education and Practice, 132*(3), 264-271. doi: 10.1061/(asce)1052-3928(2006)132:3(264)

Harmon, K. M. J. (2003). *Dispute review boards and construction conflicts Attitudes and opinions of construction industry members.* (Ph.D dissertation), Nova Southeastern University, United States, Florida.

Hillier, F. S., and Lieberman, G. J. (2010). *Introduction to Operations Research*: McGraw-Hill Higher Education.

Honeyman. (2004). Skill is not enough: seeking connectedness and a Authority in mediation. *Negotiation Journal, 20*(4), p 489.

Keeney, R. L., and Raiffa, H. (1976). *Decisions with Multiple Objectives: Preferences and Value Trade-Offs*: Cambridge University Press.

Kellogg, J. C. (2001). The contract disputes resolution continuum. *Kellogg News, 11*(1), p 2.

Kovach, K. K. (2004). *Mediation: principles and practice*. St. Paul, MN: Thomson West.

Menassa, C. (2009). *Quantitative framework to evaluate alternative dispute resolution investments in architecture engineering and construction projects using option and real option theory.* (Ph.D dissertation), University of Illinois at Urbana-Champaign, United States, Illinois.

Pena-Mora, F., Sosa, C. E., and McCone, D. S. (2003). *Introduction to construction dispute resolution*. New Jersey: Prentice Hall.

Rahim, M. A. (1983). A Measure of Styles of Handling Interpersonal Conflict. *The Academy of Management Journal, 26*(2), 368-376.

Thomas, K. W. (1976). Conflict and conflict management. In M. D. Dunnette (Ed.), *Handbook in industrial and organizational psychology* (pp. 889-935). Chicago: Rand McNally.