Analysis of Critical Parameters In The ADR Implementation Insurance Model

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ABSTRACT

In construction projects the implementation of Alternative Dispute Resolution (ADR) techniques requires capital expenditures to cover related costs such as fees and expenses paid to the owner's/contractor's employees, lawyers, claims consultants, third party neutrals, and other experts associated with the resolution process. Since most projects today operate on tight budgets, one way to ease the potential for variations from an already financially stressed project budget is to price ADR techniques as an insurance product. However, since the premium charged by insurance company is designed to cover its underwriting expenses and profit target, the benefits of purchasing ADR implementation insurance for a specific project must outweigh its cost for the investment to be worthwhile. A number of factors in the ADR implementation insurance model combine to determine whether it is financially advantageous for project participants to invest in ADR implementation insurance, and the purpose of this paper is to identify and analyze the critical parameters in the model. Sensitivity analysis is conducted on the effectiveness of each ADR technique chosen for the project, average ADR implementation cost on each stage of dispute resolution, and distribution of possible disputes. These results will help determine the most critical factors related to the pricing of ADR as an insurance product.

INTRODUCTION

Although using Alternative Dispute Resolution (ADR) techniques such as negotiation, mediation or Dispute Review Board (DRB) to resolve disputes has been widely adopted in construction projects as a more effective and cost-saving approach compared to litigation, ADR implementation costs incurred throughout the dispute resolution process sometimes could account for a large portion of the settlement/award amount, the original claim amount, and even the total contract value (Gebken II and Gibson 2006). Typical ADR implementation costs may include fees and expenses paid to the owner's/contractor's employees, lawyers, claims consultants, third party neutrals, and other experts associated with the resolution process (Gebken II and Gibson 2006, Menassa and Peña-Mora 2009). However, because the number of disputes and the amount of ADR implementation costs for each dispute won't be known until the actual occurrence of disputes during the construction phase, project participants have to face the uncertainty of unexpected high costs. From the perspective of transferring risk, pricing ADR implementation costs as an insurance product is worth being considered in order to shift the uncertainty of potential implementation costs from project participants to the insurance company (Song et al 2009). In this process, insurance company reimburses any costs incurred related to ADR implementation, and in return it receives a premium. However, since the premium charged by insurance company is designed to cover its underwriting expenses and profit target, the benefits of purchasing ADR implementation insurance for a specific project must outweigh its cost for the investment to be worthwhile. Thus the key of the ADR implementation insurance model is to find the optimal premium acceptable to both project participants and the insurance company. A number of factors in the model combine to determine whether it is financially advantageous for project participants to invest in ADR implementation insurance, and the purpose of this paper is to identify and analyze the critical parameters in the model. Sensitivity analysis is conducted on the effectiveness of each ADR technique chosen for the project, average ADR implementation cost on each stage of dispute resolution, and distribution of possible disputes. These results will help determine the most critical factors related to the pricing of ADR implementation as an insurance product.

ADR IMPLEMENTATION INSURANCE MODEL

The ADR implementation insurance model proposed by Song et al 2010 is constructed to help project participants determine whether investing in ADR implementation insurance is beneficial for a certain project. It includes five key parts as shown in the flow chart in Figure 1. First, by drawing analogy from seismic risk insurance, Event Tree Analysis (ETA) is used to simulate scenarios of dispute resolution process and to determine the probability mass function of ADR implementation costs (Hoshiya et al. 2004). These probabilities are then employed to calculate the total expected ADR implementation costs based on which we derive the policy premium. Then, gross premium as quoted from an insurance company is calculated and compared with the maximum fixed cost derived from subjective loss to determine whether insurance is acceptable to project participants. Subjective loss is defined as the negative value attached by project participants to the uncertain ADR implementation costs that they might incur based on their degree of aversion to the risk that they face. Unlike the traditional definition of a utility function, a subjective loss function (SLF) is used in this research to indicate the negative utility $u(c)$ that is attached to a given loss amount of ADR cost c resulting from implementation of the dispute resolution process. For risk-averse project participants, their subjective function is a convex upward function and the maximum premium they should be willing to pay is: $GP = E(u(C))$ (Bowers et al. 1997).

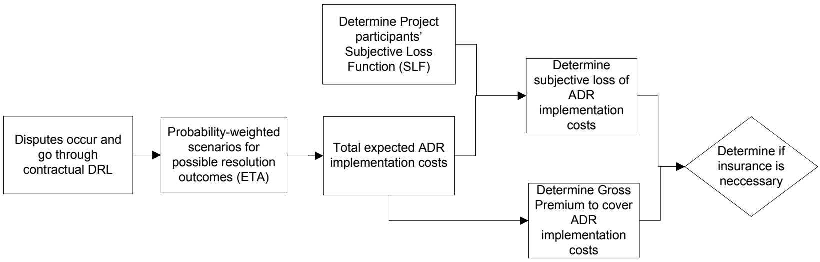

Figure 1 Analytic flow of the ADR insurance model

First, Event Tree Analysis (ETA) is a graphical representation of a logic model that identifies and quantifies all possible outcomes resulting from an accidental initiating event (Rausand and Høyland 2005). In seismic risk analysis, ETA is utilized to identify the sequential damage and their probabilities to a concerned structure (Hoshiya et al. 2004; U.S. Nuclear Regulatory Commission 1975). In this paper, ETA is used to help identify scenarios of dispute resolution process and quantitatively determine the probability of corresponding ADR implementation cost, making it possible to calculate the total expected ADR implementation costs. It first sets up the event of dispute occurrence as a specified condition. Assume the contractual Dispute Resolution Ladder (DRL) has *m* stages on the ladder: ADR1, ADR2,…ADRm. For the j^{th} stage, assume the effectiveness of ADRj is *kj*, and the average cost for ADRi is *cj*. For example, *k*1= 0.5 means 50% of the disputes can be resolved in the first stage. When a dispute occurs, it first goes to ADR1, the first stage of the contractual DRL. If dispute resolution does not come to a satisfied settlement by both parties, it will go to the next stage ADR2, and so on. The whole process is shown in Figure 2 in the illustrative example.

Then, use the probability mass function derived by ETA to calculate the Total Expected ADR Implementation Costs. Without loss of generality, the risk of incurring ADR implementation costs in any construction project can be mathematically represented by:

1. *n*, the total number of disputes occurring in the period from the notice to proceed (t = 0) to the project completion (t = T); n = *N*1, *N*2,.., *Nk* with probability q1, *q*2,.., *qk* respectively, where *N*1 is the minimum possible number of disputes and *N*1 ≥ 0, while *N*k is the maximum number of possible disputes. Since construction disputes occur randomly over time, the arrival of disputes can be approximated with a Poisson Process with occurrence rate λ (Touran 2003).

2. *cj*, the average amount of ADR implementation costs for each dispute resolution process, where j = 1, 2,…, m represents the j^{th} stage on the contractual DRL. Then, for each dispute, its resolution process bears *m* possible outcomes: resolved at ADR1 and cost *c*1, resolved at ADR2 and cost

*c*2, … , resolved at ADRm and cost *cm*, with probability *p*1, *p*2, and *pm*, respectively, where $\sum_{j=1}^{m} p_j = 1$, and

$$p_j = (1 - k_1)(1 - k_2) \dots \left(1 - k_{j-1}\right)k_j \qquad \text{Eq. (1)}$$

Assume that the cost on each stage is independent.

3. For the i^{th} dispute (*i*=1,2,…,*n*), define *xij* = 1 represents that the i^{th} dispute is resolved in the j^{th} stage; otherwise, *xij* = 0. Thus $x_j = \sum_{i=1}^{n} x_{ij}$ represents the total number of disputes that are resolved in the j^{th} stage and follows a multinomial distribution *M(n, p*1 *p*2*,…, pm)*, with the expected value *E(xj) = n pj*, where *j* = 1, 2,…, *m*. Specifically, when *m* = 2, then x_j follows binomial distribution *B(n, p*1 *p*2*)*. *E(xj)* is the expected number of disputes that are resolved in the j^{th} stage.

4. Among all *n* disputes, there are a total of *R* different possible outcomes. For each outcome, there could be *xj* disputes resolved with ADRj. Consequently, the total ADR implementation cost throughout the time horizon for the r^{th} outcome is $C_r = \sum_{j=1}^{m} c_j x_j$ with a probability of $P_r = \prod_{j=1}^{m} p_j^{x_j}$, given a total of *n* disputes. The number of outcome which bears the same total cost and probability is $\binom{n}{x_1 \cdots x_j \cdots x_m}$.

   Then the total expected ADR cost is:

$$E(C) = \sum_{n=N_1}^{N_k} q_n \sum_{r=1}^{R} \binom{n}{x_1 \cdots x_j \cdots x_m} C_r P_r$$

$$= \sum_{n=N_1}^{N_k} q_n \sum_{r=1}^{R} \binom{n}{x_1 \cdots x_j \cdots x_m} \sum_{j=1}^{m} c_j x_j \prod_{j=1}^{m} p_j^{x_j}$$

$$= \sum_{n=N_1}^{N_k} q_n \sum_{j=1}^{m} c_j \left(\sum_{r=1}^{R} \binom{n}{x_1 \cdots x_j \cdots x_m} \prod_{j=1}^{m} p_j^{x_j} \right) x_j \qquad \text{Eq. (2)}$$

$$= \sum_{n=N_1}^{N_k} q_n \sum_{j=1}^{m} c_j \left(n p_j\right)$$

$$= \sum_{n=N_1}^{N_k} n q_n \sum_{j=1}^{m} c_j p_j$$

The fourth step in the flow chart is to calculate the Total Expected Subjective Loss of ADR Implementation Costs. As mentioned earlier, a subjective loss function (SLF) is used to indicate the negative utility *u(c)* that project participants attach to a given loss amount of ADR implementation costs *C* resulting from dispute resolution. The total expected subjective loss could be expressed as follows:

$$E\big(u(C)\big) = \sum_{n=N_1}^{N_k} p_n SL_n \qquad \text{Eq. (3)}$$

where SL_n is the total subjective loss when the total number of disputes is n.

Eq. (4) defines the total expected subjective loss as

$$SL_n = \sum_{r=1}^{R}\left(\binom{n}{x_1 \cdots x_j \cdots x_m}\prod_{j=1}^{m} p_j^{x_j}\left(\sum_{j=1}^{m} x_j\, u(c_j)\right)\right) \qquad \text{Eq. (4)}$$

The last step of the model is to compare the gross premium and expected subjective loss and to determine whether investing in ADR implementation insurance is favorable. If $GP \le E\big(u(C)\big)$, then there exists the possibility for an insurance policy.

SENSITIVITY ANALYSIS

To determine the most critical factors of the model, sensitivity analysis is conducted with an illustrative example on the effectiveness of each ADR technique chosen for the project (*kj*), average ADR implementation cost on each stage of dispute resolution (*cj*), and distribution of possible disputes (λ).

Assume there is a highway bridge project in which project participants decide to include a three-step DRL in the contract for dispute resolution (m = 3). In this DRL, a dispute goes through the Architect/Engineer or Supervising Officer (ADR1) to mediation (ADR2) and then arbitration (ADR3). If the DRL fails to provide a satisfactory settlement, then dispute resolution will eventually escalate to litigation, which will be much more costly. Details are shown in Figure 2.

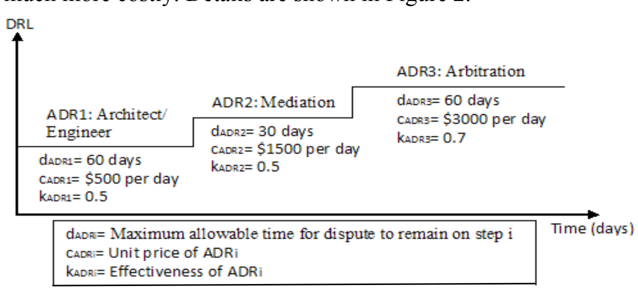

Figure 2. Project DRL (Adapted from Menassa et al. 2010)

The estimated duration of this project is T = 720 days from Notice To Proceed (assume there are 30 days in each month, T = 24 months). Assume that disputes occur according to Poisson Process with rate λ = 3. To determine the total expected ADR implementation costs, ETA, is determined as in Figure 3.

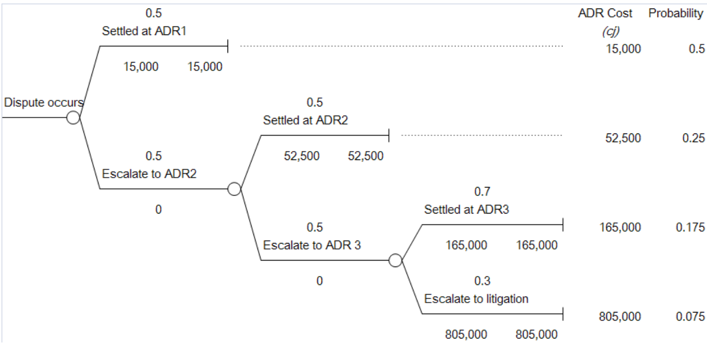

Figure 3. Project ETA of ADR Implementation costs

and the following SLF is adopted:

$$u(x)=x+1880[\exp(0.007x)-1]$$

which is calculated based on 96 samples taken from insurance purchasing owners in a financial survey (Hoshiya 2004).

The results of 1000 simulation runs and a 25% expense loading for the gross premium are presented in Table 1.

Table 1. Simulation results

Average No. of Disputes	Expected ADR Implementation Costs E(C) (MM$)	Expected Subjective Loss E(u(C)) (MM$)	Gross Premium GP(MM$)
75	7.90	112.14	9.88

The following figures show the results of sensitivity analysis with parameter on a range of -30%~30%:

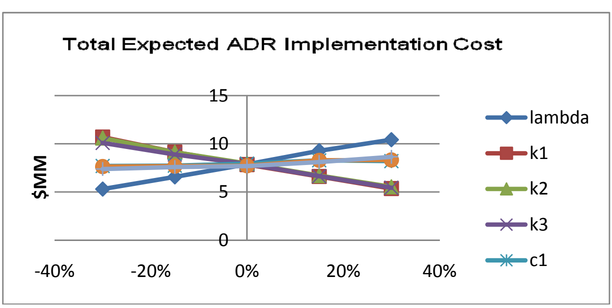

Figure 4. Sensitivity Analysis I: Total Expected ADR Implementation Costs

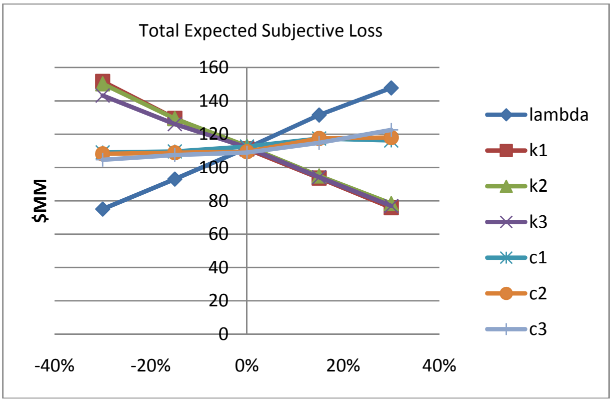

Figure 5 Sensitivity Analysis II: Total Expected Subjective Loss

RESULTS AND CONCLUSIONS

From the figures we can conclude that the effectiveness of each ADR technique chosen for the project (*kj*) and the rate of dispute occurrence (λ) have larger influence on Total Expected ADR Implementation Costs and Subjective Loss. The limitation is that this is just a simplified model with assumptions such as the independence between dispute occurrences and the effectiveness of each ADR. The real situation could be more complicated. Thus a more detailed analysis with tests on more parameters is required in order for the model to be applied to real projects. Moreover, drawing analogy from other commercial insurances such as medical insurance, the policy will have a deductible limit on project participants to prevent moral hazard. In this case project participants will have to bear part of the ADR implementation costs before insurance kicks in. future work will focus on finding the optimal point on project participants' subjective loss curve which will minimize their total expected subjective loss.

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