Insurance as a Risk Management Tool for ADR Implementation in Construction Disputes

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Abstract: Nowadays, along with the inherent intricacy and magnitude of large-scale construction projects come increasingly complex disputes. Because most projects operate on tight budgets, alternative dispute-resolution (ADR) techniques such as negotiation, mediation, and arbitration are being widely adopted in large-scale construction projects to help handle disputes in more effective and cost-saving ways. However, the risk of incurring uncertain ADR-implementation costs in the dispute-resolution process has become an important issue. The traditional self-insured approach of simply retaining all risks is no longer considered economical. One way to reduce the potential for variations in the dispute-resolution budget is to price ADR techniques as an insurance product, which allows project participants to transfer the risk of incurring unexpectedly high ADR-implementation costs to the insurance company. Despite this advantage, many factors are preventing project participants from investing in ADR-implementation insurance. This paper proposes a model on how to use ADR-implementation insurance as a risk management tool for construction dispute resolution. It first investigates the possibility of using insurance for ADR-implementation and then uses subjective loss to represent the risk-averse attitude of project participants and quantify the effect of ADR-implementation costs in monetary terms. Event-tree analysis (ETA) is used to simulate different dispute-resolution processes and determine the probability mass function of ADR-implementation costs by drawing analogies from seismic risk insurance. These probabilities are employed to calculate the expected ADR-implementation costs and to derive the insurance premium. Finally, the gross premium is compared to project participants' subjective loss to help them determine whether purchasing ADR-implementation insurance is necessary. At the end, a numerical example is presented to illustrate the application of the methodology. **DOI:** 10.1061/(ASCE)CO.1943-7862.0000401. *© 2012 American Society of Civil Engineers.*

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Introduction

In recent years, the inherent intricacy and magnitude of large-scale construction projects has made construction disputes nearly inevitable and increasingly complex (Harmon 2003). Because court proceedings are extremely costly and time-consuming and are generally considered ineffective in construction dispute resolution, most construction contracts now contain some provision for alternative dispute resolution (ADR), the most generally acceptable contractual means to resolve disputes without going into litigation (Kovach 2004). Common ADR methods include negotiation, dispute review board (DRB), mediation, and arbitration (Peña-Mora et al. 2003). Often, a dispute-resolution ladder (DRL) is proposed in the contract for ADR implementation, in which multiple ADR techniques are organized in a stepped manner [United States Army Corps of Engineers (USACE) 1989; Caltrans 2000; Peña-Mora et al. 2003]. When disputes escalate from a lower stage of prevention to an upper stage of arbitration or litigation, the expenses and antagonism also increase (Peña-Mora et al. 2003; Menassa and Peña-Mora 2007).

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 and Gibson 2006; Menassa et al. 2010).

Although ADR is recognized as a more effective and less adversarial technique than litigation in construction dispute resolution (Treacy 1995), project participants face uncertainty about future ADR-implementation costs because the number of disputes and the amount of ADR-implementation costs in each dispute will not be known until the actual occurrence of disputes during the construction phase. In the traditional wait-and-see model, in which the ADR-implementation costs are self-financed from the project's own fund, this uncertainty prevents efficient use of funds because some amount needs to be held in reserve as part of contingency to cover potential dispute occurrence during the construction phase (Touran 2003b) and thus causes project participant to worry about what will happen in the future.

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Drawing an analogy from the insurance industry, in which businesses and individuals transfer potential financial consequences of their losses to an insurer by purchasing an insurance product (Myhr and Markham 2003), one approach to reduce the negative influence of uncertain ADR-implementation costs is to structure and price those costs as an insurance product. This transfers the risk of unexpectedly high ADR-implementation costs from the project participants to the insurance company. In return, the insurance company receives a premium that covers the company's underwriting expenses and targeted profit. Although the risk transfer process does not directly eliminate the possibility that a dispute will occur, it does reimburse any ADR-implementation costs associated with that dispute. Moreover, compared to the uneven occurrence of ADR-implementation costs in the traditional self-funded model, periodic payout of premiums helps maintain a stable cash flow and thus makes it easier to budget and plan for insurance expenditures, as shown in Fig. 1 (Song et al. 2009).

This paper proposes a methodology for the design of ADR-implementation insurance. The purpose of this model is to provide a mutually advantageous insurance policy for both the insured and the insurer, thus providing project participants with an opportunity to invest a certain amount of premium in exchange for compensation from the insurance company if unknown ADR-implementation costs are incurred during the construction phase.

The paper is organized as follows: first, it investigates the possibility of using insurance for ADR implementation. Adopting utility theory from behavioral economics, subjective loss is used to represent the risk-averse attitude of project participants and to quantify the effect of ADR-implementation costs in monetary terms. Second, a financial model is proposed for determining an acceptable premium for project participants using event-tree analysis (ETA) (Hoshiya et al. 2004). Finally, a numerical example is presented to illustrate the application of the methodology.

Problem Statement

The design of ADR implementation as an insurance product remains an uncharted area in both academia and industry. To understand why necessitates a basic idea of the pricing methodology used in the insurance industry to determine premium rates. Three categories of rate-making methods exist: the pure premium method, the loss ratio method and the judgment method. Among these, the most commonly used is the pure premium method, which develops rates from estimates of future claims and expenses on the basis of an examination of historic claims and past expense experience (Myhr and Markman 2003). In simple terms, pure premium is

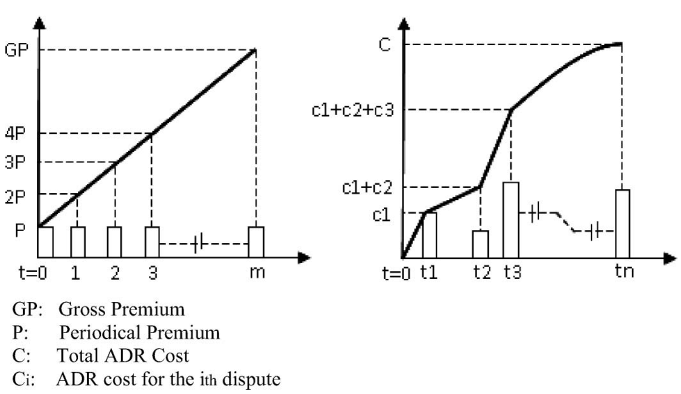

Fig. 1. Comparison of cash flows of ADR cost in two models (Song et al. 2009, with permission)

the total expected loss for a specified period of time and gross premium is the final premium paid to the insurance company, which consists of the pure premium plus the expense and profit loading (Myhr and Markman 2003). For example, assume that for a specific project the expected number of disputes is $E(n)$ (the frequency of dispute occurrence) and the expected average ADR cost per dispute is $E(c)$ (the expected severity of ADR-implementation costs). According to previous work by Song et al. (2009), the gross premium (GP) for ADR insurance is

$$GP = E(C) + \alpha = E(n) \times E(c) + \alpha \tag{1}$$

where $E(C)$ = pure premium or total expected ADR-implementation costs, and α = expense-loading factor to cover the expenses and target profits of the insurance company. As long as α is greater than zero, then ADR insurance is meaningless to project participants on an expected value (EV) basis. In EV theory, when a decision maker is facing uncertainty about a possible random loss X, the decision maker is willing to pay no more than the expected loss amount, $E(X)$, to be relieved from future loss (Bowers et al. 1997). However, the premium that an insurance company charges as a return for bearing risk $[E(C) + \alpha]$ is almost always greater than the expected dispute-resolution cost $E(C)$ because of α. Thus, project participants might avoid investing in ADR-implementation insurance and just hold the expectation that a project will be properly managed; therefore, it will not incur significant, unexpected ADR-implementation costs. This decision-making process using EV theory exists in most insurance situations; for example, auto insurance, in which uninsured drivers often claim that they do not expect to have any accidents (Myhr and Markman 2003).

However, analogous to health insurance, in which individuals purchase policies to cover uncertain medical costs that they might incur in the future, decision makers do not necessarily follow the result that EV theory would predict. This is because most people are risk-averse to some degree; they are willing to pay a fixed insurance premium that is in excess of the mean expected value of ADR-implementation costs in exchange for shedding some uncertainty about the future (Bowers et al. 1997). Some authors refer to this as an exchange of a certain loss (the premium) for an uncertain loss (Pritchett et al. 1996). Thus, quantifying the risk-averse attitude of project participants is the key to providing a mutually advantageous ADR-implementation insurance policy.

Utility Theory and Subjective-Loss Function

Because EV does not capture a decision maker's risk attitudes, utility theory was developed to infer the subjective value or utility of different choices, and thus provide insights into decision making in the face of uncertainty (Bell et al. 1988; Keeney and Raiffa 1993; Bowers et al. 1997; Norstad 2005). The utility function, $u(w)$, is used to indicate the value or utility attached to a certain wealth of amount w (Bowers et al. 1997). 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 example, consider the following scenarios. In the first scenario, project participants can choose to pay a premium of \$1,500 or bear the risk of incurring \$4,000 ADR-implementation costs (with a probability of 0.3) or incurring nothing (with a probability

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of 0.7). In the other scenario, the choice is between a certain premium of \$1.5 million and possible ADR-implementation costs of \$4 million (with a probability of 0.3). For project participants in the first scenario, purchasing insurance might not be favorable compared to simply bearing the risk of losing \$4,000, because the expected ADR cost is only \$1,200; however, for risk-averse project participants, if the negative prospect of incurring significant ADR-implementation costs as high as \$4 million is taken into consideration, there is motivation to consider investing in ADR-implementation insurance. In this case, project participants make decisions based not on the expected loss (\$1.2 M) but on the subjective loss, which could be quantified by their subjective-loss function, $u(c)$. In this case, the subjective loss is $0.3 \times u(\$4\text{ million})$ and $u(\$4\text{ million}) \geq \$4\text{ million}$ for risk-averse project participants, because their subjective-loss function is a convex upward function.

It is natural to assume that for risk-averse decision makers, $u(c)$ is an increasing function, because "the more loss, the worse (more negative utility) it gets" (Bowers et al. 1997). For example, an ADR-implementation cost of \$4,000 might be of little concern to project participants, whereas possible dispute-resolution implementation costs of \$4 million are certainly worth considering. In addition, each additional equal increment of loss results in a larger increment of associated negative utility (Bowers et al. 1997). For example, a loss of \$2 million should have more than twice the negative utility of a loss of \$1 million. This is the mirror image of the principle of decreasing marginal utility in economics (Bowers et al. 1997). In this paper, it is referred to as increasing marginal negative utility (Fig. 2).

The two properties suggested by Fig. 2 are $u'(c) > 0$ and $u''(c) > 0$, where $u'(c) = du/dc$ measures the slope of the line at each point of the curve; a positive $u'(c)$ suggests that $u(c)$ is an increasing function. The second inequality indicates that $u(c)$ is a strictly convex upward function. From the viewpoint of the project participants, the maximum acceptable GP for assuming ADR-implementation costs (C) is determined as follows (Hoshiya et al. 2004):

$$E(C) + \alpha = E[u(C)] \tag{2}$$

The left-hand side of the equation represents the situation in which the project has ADR-implementation insurance; thus, project participants only need to pay the premium. The right-hand side is the case without insurance, in which project participants should bear all future losses. In the latter case, project participants view the undesirable financial outlay of possible uncertain ADR-implementation costs subjectively with the function u, which quantifies their risk-averse attitude toward a future risk in monetary terms. In the former case, project participants could choose to carry insurance for certainty.

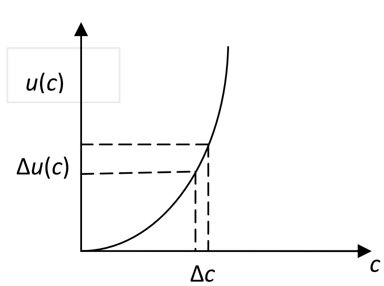

Fig. 2. Characteristics of subjective-loss function (Song et al. 2010, with permission)

According to Jensen's inequalities (Bowers et al. 1997), for a random variable X and function $u(c)$ with a convex characteristic

$$\text{If } u''(c) > 0, \quad \text{then } E[u(X)] \geq u[E(X)]$$

$$\text{If } u''(c) < 0, \quad \text{then } E[u(X)] \leq u[E(X)]$$

According to Eq. (2), the maximum premium that risk-averse project participants should be willing to pay is

$$GP = E[u(C)]$$

Combining this with Jensen's inequalities

$$E[u(C)] \geq u[E(C)]$$

Then, for a risk-averse project participant, an acceptable maximum premium is

$$GP \geq u[E(C)] \geq E(C)$$

In other words, the participant is willing to pay an amount greater than the expected value of ADR-implementation costs for insurance to remove the uncertainty. Project participants with SLF$u(c)$ are risk-averse if $u''(c) > 0$ (Bowers et al. 1997). The relationship between GP and $E[u(C)]$ is schematically illustrated in Fig. 3.

Subjective-Loss Function for ADR-Implementation Costs

Building the SLF of project participants is a way to change their qualitative preference from alternatives that have uncertain payoffs to those with a consistent numerical comparison (Bowers et al. 1997). The process can be complicated because it is a matter of subjective judgment and depends on many factors such as conflicting attitudes toward risk among project participants, project type, and the environment of the financial market (Bowers et al. 1997). Even for the same project participants, different projects will have different subjective-loss functions that require reevaluation (Bowers et al. 1997). Usually, SLF is expressed by several elementary functions such as quadratic, exponential, and fractional power functions (Bowers et al. 1997). It can be obtained by conducting a financial survey with project participants to determine the negative utilities (in monetary units) that they attach to a series of future losses.

ADR-Implementation Insurance Model

The ADR-implementation insurance model has been constructed to help project participants determine whether investing in

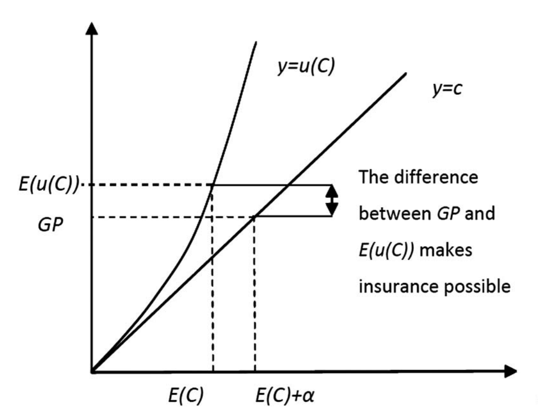

Fig. 3. Relationship between GP and $E[u(C)]$

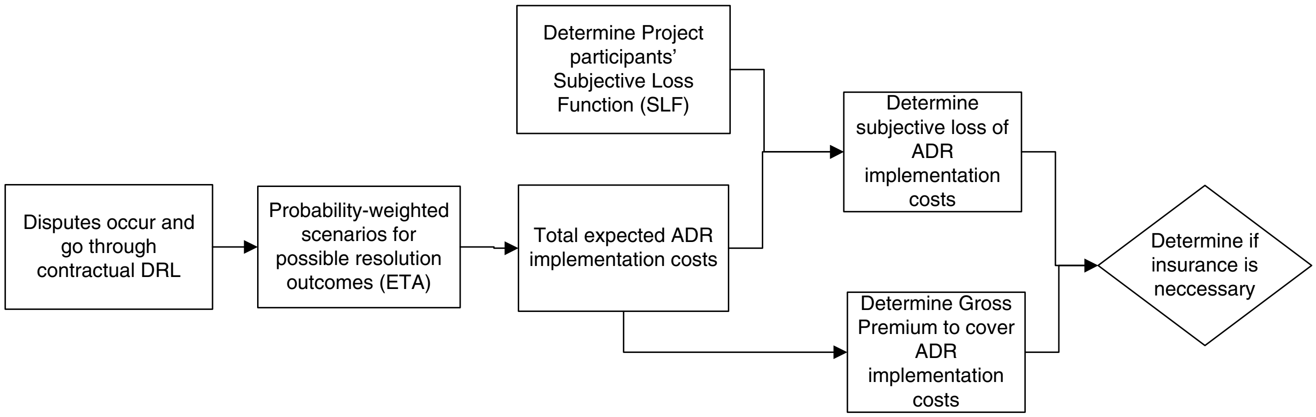

Fig. 4. Analytic flow of ADR insurance model

ADR-implementation insurance is beneficial for a certain project. It has five key parts shown in Fig. 4.

Each stage in Fig. 4 is evaluated on the basis of past experience, statistical data, and the unique characteristics of a project. Specifically, ETA is applied to simulate scenarios of dispute-resolution outcomes and to determine the probability mass function of expected ADR-implementation costs (Hoshiya et al. 2004). Then, gross premium (as quoted by 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.

Event Tree Analysis

Event tree analysis 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). By studying all relevant accidental events, ETA can be used to identify all potential accident scenarios and sequences in a complex system. To determine the frequencies of outcomes, let $P(y)$ denote the frequency of the initiating event and let $P(xi)$ denote the probability of event xi. Once the initiating event Y has occurred, according to conditional probability (Ang and Tang 2006), the probability of outcome X is

$$P(\text{Outcome } X|\text{Initiating event } Y) = P(x1 \cap x2 \cap x3 \ldots \cap xn) = P(x1) \times P(x2|x1) \times P(x3|x1 \cap x2) \times \cdots \times P(xn|x1 \cap x2 \cap \cdots \cap xn-1)$$

Then the frequency of outcome X is

$$P(x) = P(y) \times P(x1) \times P(x2|x1) \times P(x3|x1 \cap x2) \cdots \times P(xn|x1 \cap x2 \cap \cdots \cap xn-1)$$

The frequencies of the other outcomes can be determined in a similar way.

In seismic risk analysis, ETA is utilized to identify the sequential damages 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 involving the dispute-resolution process and to quantitatively determine the probability of the corresponding ADR-implementation cost, making it possible to calculate the total expected ADR-implementation costs. The event of dispute occurrence is first set up as a specified condition. Assume that the contractual DRL has m stages on the ladder: ADR1, ADR2, …, ADRm. For the jth stage, assume the effectiveness of ADRj is kj and the average cost for ADRi is cj. For example, $k1 = 0.5$ indicates that 50% of the disputes can be resolved in the

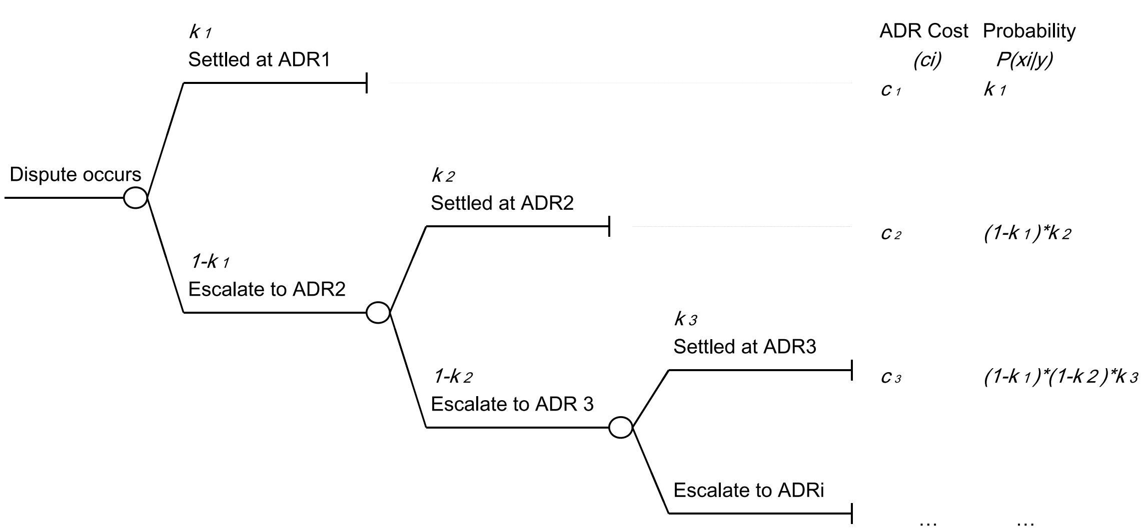

Fig. 5. ETA of ADR-implementation costs

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first stage. When a dispute occurs, it initially goes to ADR1, the first stage of the contractual DRL. If dispute resolution does not come to a satisfactory settlement for both parties, it goes to the next stage ADR2, and so on. The whole process is shown in Fig. 5.

Total Expected ADR-Implementation Costs

Without loss of generality, the risk of incurring ADR-implementation costs in any construction project can be mathematically represented as follows:

1. By n, the total number of disputes occurring in the period [from the notice to proceed ($t = 0$) to project completion ($t = T$)]; $n = N1, N2, \ldots, Nk$ with probability $q1, q2, \ldots, qk$, respectively, where $N1$ is the minimum possible number of disputes and $N1 \geq 0$; and Nk is the maximum number of possible disputes. Because construction disputes occur randomly over time, the arrival of disputes can be approximated with a Poisson process (Touran 2003a). Let $t1$ = time of the first dispute occurrence and ti = time elapsed between the $(i-1)$th and ith events, $i > 1$; and $\{ti\}$ = sequence of interarrival times. In a Poisson process, $t1, t2, \ldots$ are independent and identically distributed with an exponential (λ) distribution, where λ = rate of dispute occurrence. Although the Poisson process shows very good memoryless properties, it does not necessarily fit reality because it cannot model situations in which the occurrence rate λ changes over time. Thus, to simulate construction dispute occurrence, a nonhomogenous Poisson process is used in which λ is a function of time t. expressed as $\lambda(t)$.
2. By cj, the average ADR-implementation cost for each dispute-resolution process, in which $j = 1, 2, \ldots, m$ represents the jth stage on the contractual DRL. Then, for each dispute, its resolution process bears m possible outcomes: resolved at ADR1 and cost $c1$, resolved at ADR2 and cost $c2$, …, resolved at ADRm and cost cm, with probability $p1$, $p2$, and pm, respectively, in which $\sum_{j=1}^{m} p_j = 1$. According to Fig. 5, the following can be obtained:

$$p_j = (1 - k_1)(1 - k_2)\ldots(1 - k_{j-1})k_j \tag{3}$$

   Assume that the cost on each stage is independent.
3. For the ith dispute ($i = 1, 2, \ldots, n$), $xij = 1$ denotes that the ith dispute is resolved in the jth stage; otherwise, $xij = 0$. Thus, $x_j = \sum_{i=1}^{n} x_{ij}$ represents the total number of disputes that are resolved in the jth stage and follows a multinomial distribution $M(n, p1p2, \ldots, pm)$, with the expected value $E(xj) = npj$, in which $j = 1, 2, \ldots, m$. Specifically, when $m = 2$, then x_j follows binomial distribution $B(n, p1p2)$. $E(xj)$ = expected number of disputes that are resolved in the jth stage.
4. Among all n disputes, a total of R different possible outcomes exists. For each outcome, there could be xj disputes resolved with ADRj. Consequently, the total ADR-implementation cost throughout the time horizon for the rth 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 that 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

$$\begin{aligned} E(C) &= \sum_{n=N_1}^{N_k} q_n \sum_{r=1}^{R} \binom{n}{x_1 \cdots x_j \cdots x_m} C_r P_r \\ &= \sum_{n=N_1}^{N_k} q_n \sum_{r=1}^{R} \binom{n}{x_1 \cdots x_j \cdots x_m} \sum_{j=1}^{m} c_j x_j \prod_{j=1}^{m} p_j^{x_j} \\ &= \sum_{n=N_1}^{N_k} q_n \sum_{j=1}^{m} c_j \left(\sum_{r=1}^{R} \binom{n}{x_1 \cdots x_j \cdots x_m} \prod_{j=1}^{m} p_j^{x_j} \right) x_j \\ &= \sum_{n=N_2}^{N_k} q_n \sum_{j=1}^{m} c_j (np_j) = \sum_{n=N_2}^{N_k} nq_n \sum_{j=1}^{m} c_j p_j \end{aligned} \tag{4}$$

Total Expected Subjective Loss of ADR Cost

As mentioned previously, 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 can be expressed as follows

$$E[u(C)] = \sum_{n=N_1}^{N_k} p_n SL_n \tag{5}$$

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

Eq. (6) defines the total expected subjective loss as

$$SL_n = \sum_{r=1}^{R} \left\{ \binom{n}{x_1 \cdots x_2 \cdots x_m} \prod_{j=1}^{m} p_j^{x_j} \left[\sum_{j=1}^{m} x_j u(c_j) \right] \right\} \tag{6}$$

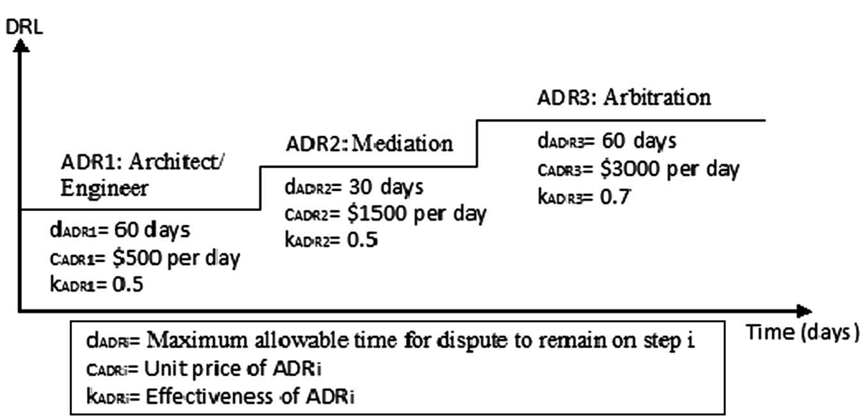

Fig. 6. Project DRL (adapted from Menassa et al. 2010)

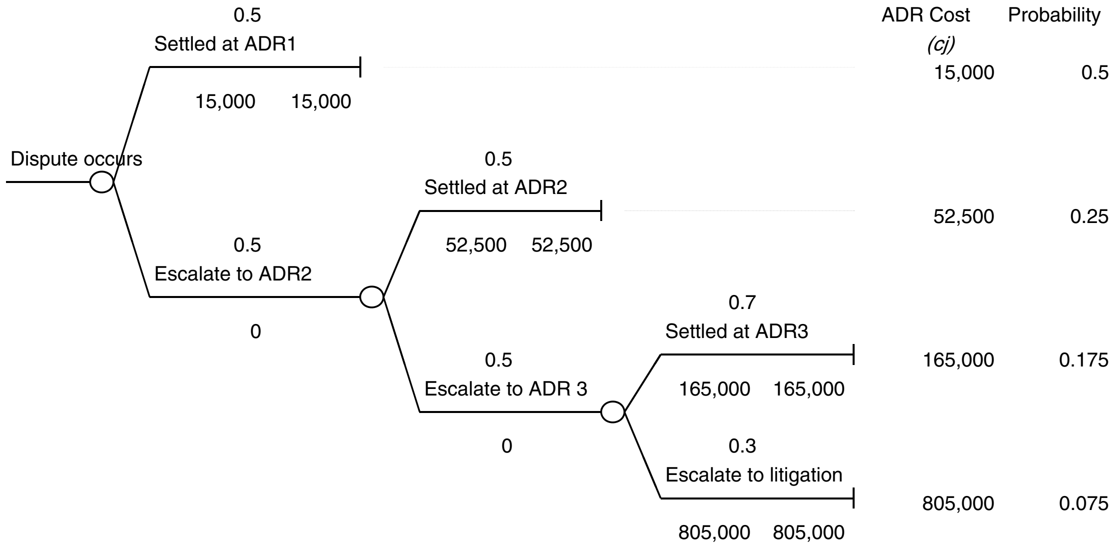

Fig. 7. Project ETA of ADR costs

Comparison between Gross Premium and Total Expected Subjective Loss

The last step of the model is to compare the gross premium and expected subjective loss and determine whether investing in ADR-implementation insurance is favorable. According to Eq. (2), if $GP \leq E[u(C)]$, then the possibility for an insurance policy exists.

Illustrative Example

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 to arbitration (ADR3). If the DRL fails to provide a satisfactory settlement, dispute resolution will eventually escalate to litigation, which will be much more costly. Details are shown in Fig. 6.

The estimated duration of this project is $T = 720$ days from notice to proceed (assuming 30 days in each month, $T = 24$ months). Assuming that disputes occur according to a nonhomogenous Poisson process, the rate of dispute occurrence is

$$\lambda(t)\begin{cases} 2 & t \in [0,8] \\ 4 & t \in [8,16] \\ 3 & t \in (16,24] \end{cases}$$

In this case, disputes occur more frequently in the middle phase and toward the end of the project, which is comparatively realistic because more and more problems would emerge as the project processes.

To determine the total expected ADR-implementation costs, ETA is determined as in Fig. 7.

The following SLF is then adopted:

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

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

Table 1 and Fig. 8 show one run of the simulation. It indicates when a dispute incurs (t/day); at which stage of the DRL it is resolved (ADR1 = architect/engineer; ADR2 = mediation; ADR3 = arbitration; and ADR4 = eventually going to litigation); and finally the implementation costs and project participants' subjective loss for each dispute resolution.

The results of 1,000 simulation runs and a 25% expense loading for the gross premium are presented in Table 2.

Then, according to Eq. (2), a maximum fixed-loss GP that satisfies the following equation should exist to make insurance attractive to a participant:

$$GP = 9.95 \leq E[u(C)] = 112.90$$

This means that project participants are willing to pay more than the expected loss to transfer the risk from themselves to the insurance company. For a GP of \$9.95 million, insurance would

Table 1. Simulation Results for One Run

Number	t/day	ADR	ADR-implementation costs (c) (millions of dollars)	Subjective loss [$u(c)$] (millions of dollars)
1	32	1	0.015	0.212
2	34	4	0.805	11.429
3	36	4	0.805	11.429
4	40	1	0.015	0.212
5	50	1	0.015	0.212
6	81	4	0.805	11.429
7	90	1	0.015	0.212
8	108	4	0.805	11.429
9	125	1	0.015	0.212
10	132	2	0.0525	0.744
—				
71	634	1	0.015	0.212
72	646	1	0.015	0.212
73	648	3	0.165	2.338
74	654	1	0.015	0.212
75	671	1	0.015	0.212
76	692	2	0.0525	0.744
77	706	3	0.165	2.338
78	712	2	0.0525	0.744
Total (millions of dollars)			12.52	177.67

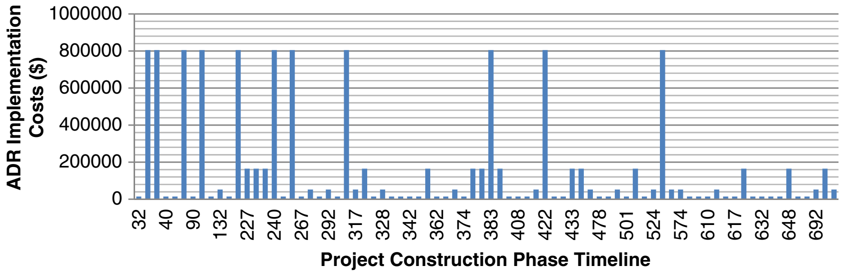

Fig. 8. Illustrative example of ADR-implementation costs and distribution

Table 2. Simulation Results

Average number of disputes	Expected ADR-implementation costs $E(C)$ (millions of dollars)	Expected subjective loss $E[u(C)]$ (millions of dollars)	Gross premium (GP) (millions of dollars)
75	7.96	112.90	9.95

be an attractive option for project participants. In other words, for this specific project, the insurance company can potentially charge an expense loading factor (ELF) of more than 25%. Therefore, the gross premium for the ADR-implementation insurance is feasible and mutually advantageous to both the project participants and the insurance company.

Conclusion

Pricing ADR-implementation insurance is a complex process that involves many factors. This paper investigates the application of utility theory in the decision-making process for project participants considering investment in ADR-implementation insurance. Subjective loss can better represent risk-averse project participants in evaluating uncertainty, thus providing a possible explanation for the validity of third-party insurance in construction management. Using subjective loss makes an insurance policy possible for risk-averse project participants, although the gross premium is higher than the expected loss. Moreover, ETA can effectively find the probability for each step on the DRL and obtain the expected loss. Although this ADR-implementation insurance does not eliminate the possibility of dispute-resolution costs, it is a powerful alternative in risk management for transferring the financial risk to a third party.

Future research should focus on the following aspects: first, sensitivity analysis should be conducted on critical parameters such as the effectiveness of ADRi (ki), the average ADR-implementation costs for each DRL stage (ci), and the assumption of possible disputes (distribution parameters). Second, the time value of money should be applied to the model to make it more realistic. Third, a deductible should be included in the insurance policy to prevent moral hazard. In this case, the maximum gross premium that project participants will accept is determined in a different way, because they will also carry part of the future loss. Finally, close collaboration with the industry can determine how to make this type of insurance more feasible with real projects.

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