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Article

Collar Option Model for Managing the Cost Overrun Caused by Change Orders

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Abstract: Effective change order management is very important in maintaining the financial sustainability of various stakeholders related to construction projects by minimizing cost overruns. In this study, we propose a zero-cost risk management approach based on the collar option model in order to control for the loss caused by change orders, the main cause of cost overruns in construction projects. We apply this model to actual projects for empirical analysis. The analysis, based on 237 projects, indicates that insurance buyers benefit from the collar option model in 46% of the cases, while insurance sellers do so in 53% of the cases. In most cases, the insurance buyer is the owner. According to the model, the owner experiences a loss when the cost overrun caused by change orders is lower than what was expected. In such cases, it is appropriate to conclude that the loss is not caused by the collar option model, but by the absence of additional revenue. However, the insurance seller suffers a loss if the cost overrun is higher than the strike price of the call option. Thus, the insurance seller needs to have expertise in construction management.

Keywords: insurance; change orders; cost overrun; collar option model; option theory; financial sustainability

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1. Introduction

Changes during the construction phase are inevitable in most construction projects. Change orders are issued to correct or modify the original design or scope of work. These corrections or modifications are carried out for various reasons, including changes in scope made by the client and changes made as per the consultant's change requests because of design errors or new findings. Most of the change orders issued during the construction period generally lead to significant time and cost overruns, disruption, and disputes [1]. Therefore, change orders significantly affect whether the construction project succeeds or fails.

As construction projects are mostly financed through borrowing, the increase in the project cost leads to financial distress of many stakeholders such as the client, the financial institution and the construction company [2]. Financial distress threatens the financial sustainability of these stakeholders [3]. Financial sustainability is defined as the likelihood that market participants secure the financial stability by minimizing external influence [4]. Therefore, it is essential to establish strategies for efficiently managing multiple risks related to change orders in order to implement projects and ensure the financial sustainability of various market participants during the construction execution phase [5].

In order to manage the cost overrun caused by factors such as change orders, contingency is calculated using historical data. If the cost overrun caused by change orders exceeds the scope of contingency, it would adversely affect the profitability of the project. Therefore, risk management measures are required to address the problem.

Insurance is a form of risk management that is primarily used to hedge against the risk of a contingent loss [6]. Thus, insurance is defined as the equitable transfer of the risk of a loss from one entity to another in exchange for an insurance fee, called premium [7]. That is, it is possible to limit the risk to a certain range by paying the costs associated with change orders. However, contractors may be reluctant to buy insurance since they would have to pay for risks that may or may not happen in the future. Therefore, an insurance model that can supplement this option is required.

In financial engineering, there is the collar option strategy, which is a zero-cost model that supplements contracts involving costs, such as insurance [8]. Using the collar option strategy, change orders can be effectively managed without the burden of costs.

This study proposes a zero-cost risk management model for construction projects based on the collar option strategy as a way to manage the cost overrun caused by change orders.

2. Literature Review

The review of the extant literature related to change orders indicates that prior studies generally focused on identifying the causes of change orders and developing models to quantify their effects. Thomas and Napolitan [9] quantify the impact of changes on field-labor efficiency and determine the relationship between changes and various types of disruption. Riley *et al.* [10] investigate 598 change orders issued by a company in 120 projects and analyze the trends in the cost and frequency of change orders. Chen [11] develops a mathematical model based on the knowledge-sharing concept that is intended to avoid the possibility that a given change order might lead to future litigation. Serag *et al.* [12] analyze the change orders issued by the owner and their impact on project cost. The data collected from the change order log is used to identify problem areas during the lifetime of the project and to develop a model that would help the owner quantify the percentage increase in the contract price caused by change orders. Zhao *et al.* [13] propose an activity change prediction system to simulate the process and to generate detailed information about changes that could happen during the construction process. However, these prior studies mostly focused on the fundamentals of the measures for responding to change orders; they do not suggest ways to manage the risk of cost overrun caused by change orders. In contrast, the insurance literature proposes the use of insurance—one of the main risk management measures—as a way of controlling uncertainty.

Ranasinghe [14] studies the risk management approach adopted by a subsidiary of a major international insurance firm and compares it with the risk management practices of the engineering construction industry. Odeyinka [15] identifies the insurable construction risks encountered in the Nigerian construction industry and examines how effectively they are managed through insurance. Griffis and Christodoulou [16] present a case study and a methodology for determining the expected loss to an insurance company when insuring for liquidated damages. Wang *et al.* [17] investigate how professional liability insurance can be implemented for supervision engineers in China. This study identifies the professional liabilities of the supervision engineer and the typical professional faults, as well as the scope of the insurance liability, exclusions, and types of assured.

Although risk transfer through insurance is an effective way of controlling uncertainty, it comes with costs, which could adversely affect insurance utilization. The collar option strategy allows contracts to be signed at zero cost. Therefore, insurance based on a collar option strategy may prove to be effective in managing additional costs.

The collar option is mainly used in currency trading in the financial sector. Linden [18] investigates ways to reduce the risks in a foreign currency trade by using the zero-cost currency option collar as a hedging tool. Bettis *et al.* [8] use the collar option to flexibly hedge at zero cost the fluctuation risk of the assets held by corporate shareholders. Further, Shan *et al.* [19] present a collar option—a class of financial derivatives—as a technique for managing revenue risks in real toll projects. Its potential features are derived from an examination of the existing risk management practices in real toll projects.

This study proposes a model for utilizing the collar option strategy as a way to manage the cost overrun caused by change orders and verifies its effectiveness in doing so.

3. Research Methodology

3.1. Concept of a Collar Option Model for Hedging Change Order Risk

An option is a security that gives the owner the right to buy or sell an asset—subject to certain conditions—within a specified period of time [20]. An option is a right, not an obligation, to take an action in the future. In financial markets, the most common types of options are call options and put options. A call option gives the owner the right to buy a stock at a predetermined exercise price on a specified maturity date. A put option can be viewed as the opposite of a call option: a put option gives its owner the right to sell the stock at a fixed exercise price [21]. A collar option is more complex than a put option or a call option: it is a combination of a call option and a put option [22]. A popular type of collar is the zero-cost collar. Typically, the proceeds from the sale of a call option are used to offset the cost of the put, eliminating the cost of the hedging instrument. The put insures the holder against any downward movement in the stock price below the strike price. Any movement above the strike price of the call is lost profit [8].

As shown in Figure 1, the collar option model, which is a way of managing the cost overrun caused by change orders, consists of the insurance buyer's section of striking a call option according to the increase in cost overrun and the insurance seller's section of striking a put option according to the decrease in cost overrun. If S_0 is the current expected loss due to the cost overrun at present ($t = 0$), S_0 is within the range of the strike price (X_p) of the put option and the strike price (X_c) of the call option.

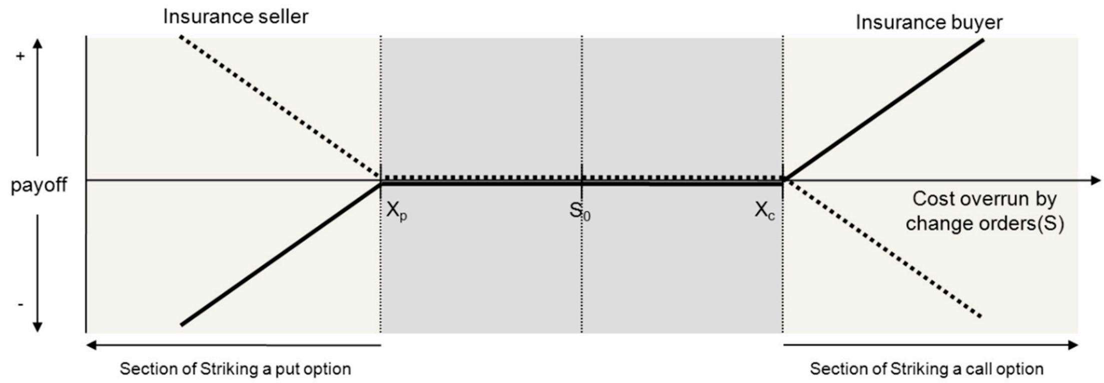

Figure 1. Concept of material contract model based on collar option.

When the actual cost overrun caused by change orders exceeds the estimate, and S exceeds X_c, the insurance buyer exercises the call option, realizing the call option value shown in Figure 2. Therefore, X_c of the call option indicates the maximum permissible limit of the cost overrun caused by change orders in the corresponding project. In other words, the insurance becomes meaningless when the cost overrun is lower than X_c; *i.e.*, the value of the insurance becomes zero. However, when the cost overrun exceeds X_c, the insurance creates value because a hedge on the cost overrun can be placed through the insurance. In this case, the insurance seller's side incurs a loss that is proportionate to the avoidance of the cost overrun caused by change orders placed through the insurance by the insurance buyer.

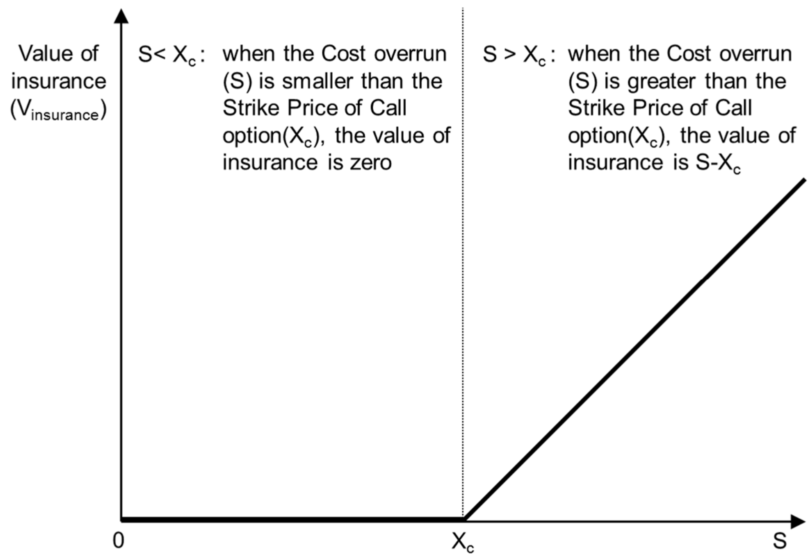

Figure 2. Value of insurance depending on the increase in cost overrun.

If the actual cost overrun caused by change orders is lower than expected, and *S* is below X_p, the insurance seller exercises the put option, realizing the put option value shown in Figure 3. Therefore, X_p of the put option indicates the starting point from which the insurance seller can secure a fee for providing insurance without baseline cost. In other words, when the cost overrun is lower than X_p, the potential net profit margin of the insurance buyer is restored to the insurance seller.

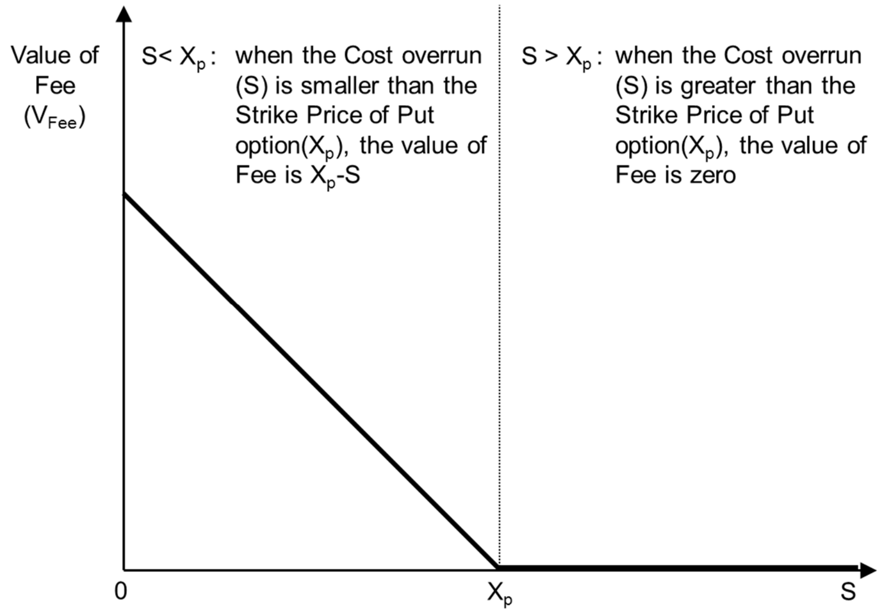

Figure 3. Value of fee depending on the decrease in cost overrun.

In summary, the insurance premium is not fixed. When the cost overrun caused by change orders is lower than X_p, the insurance buyer pays the difference between the X_p value and the cost overrun as the insurance premium to the insurance seller. Therefore, the insurance premium varies according to changes in the cost overrun caused by change orders.

Ultimately, when the collar option model is applied, the loss that could occur because of the cost overrun caused by change orders can be controlled within a set range, as shown in Figure 4.

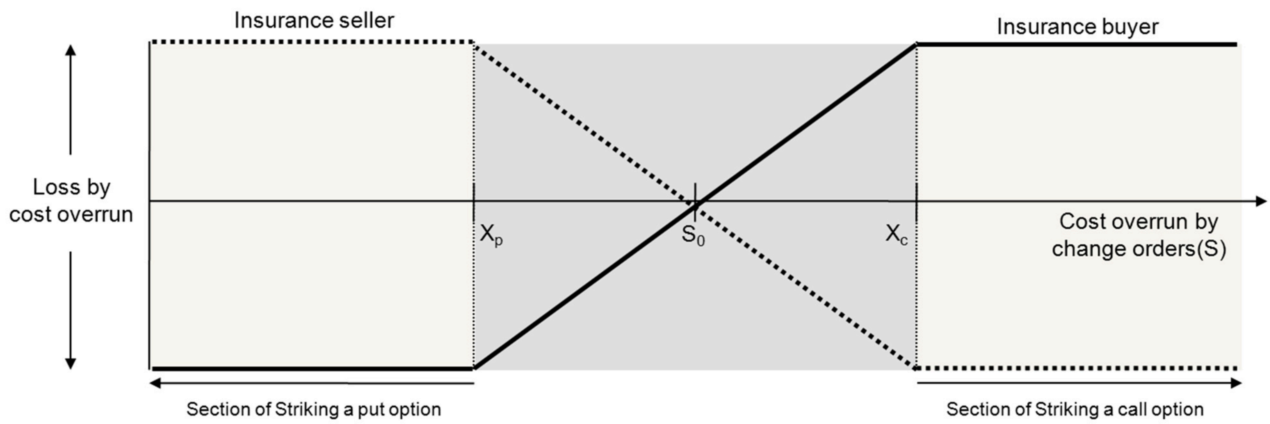

Figure 4. Range of loss caused by cost overrun when the collar option model is applied.

To complete the collar option model, X_c and X_p must be selected so that the value of the call option and the put option are identical based on S_0, the current expected loss because of cost overrun. In general, the expected loss of a construction project is estimated based on past data, using which a contingency is projected. That is, a contingency can be used to respond to a cost overrun that is lower than the expected loss. Thus, insurance has value when the cost overrun exceeds the expected loss. Therefore, in order to conduct an empirical analysis, this study estimates the expected loss caused by change orders. This study defines the expected loss as X_c. The value of the call and put options are identical. Therefore, the value of the insurance is calculated using X_c in order to produce X_p, the strike price of the put option.

3.2. Binomial Lattice Model for Calculating Option Value

Cox *et al.* [22] propose the binomial lattice model as a method for evaluating the option value under the assumption that the underlying asset fluctuates according to a binomial distribution. Binomial lattice models can solve complex and realistic option pricing problems. The binomial lattice model employs a two-stage calculation process. The first step is the creation of a binomial tree of distribution for the underlying asset, as shown in Figure 5. The second step is the creation of a binomial tree for calculating the option value, as shown in Figure 6 [23].

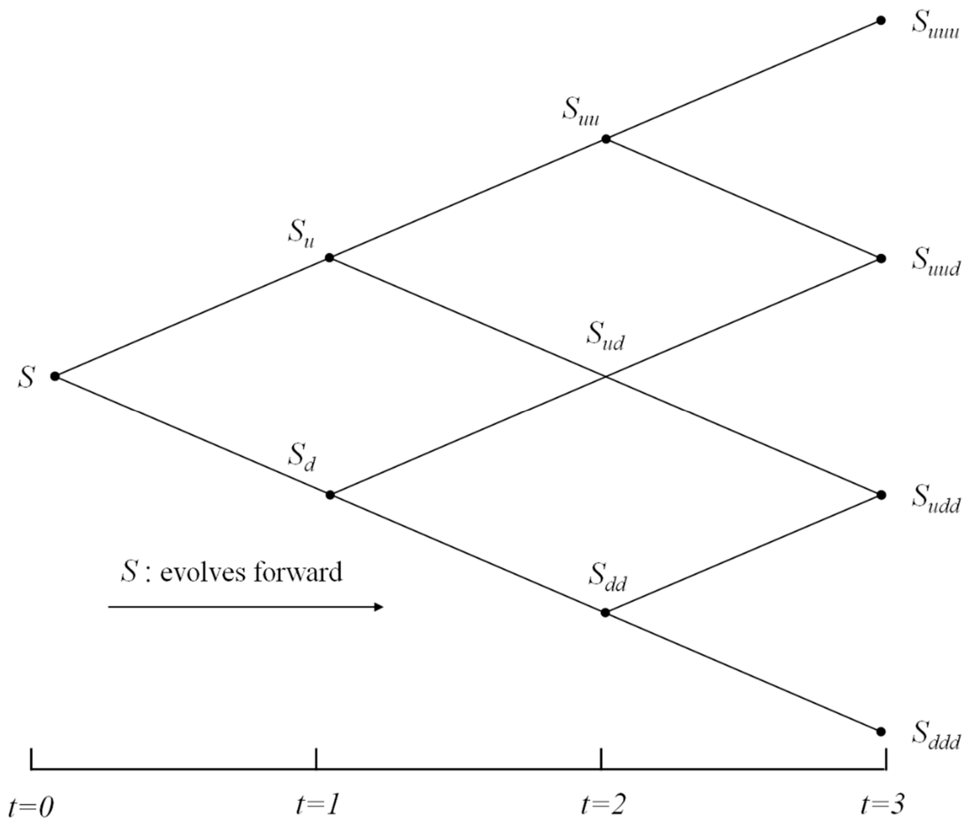

Figure 5. Binomial tree of *S*'s distribution.

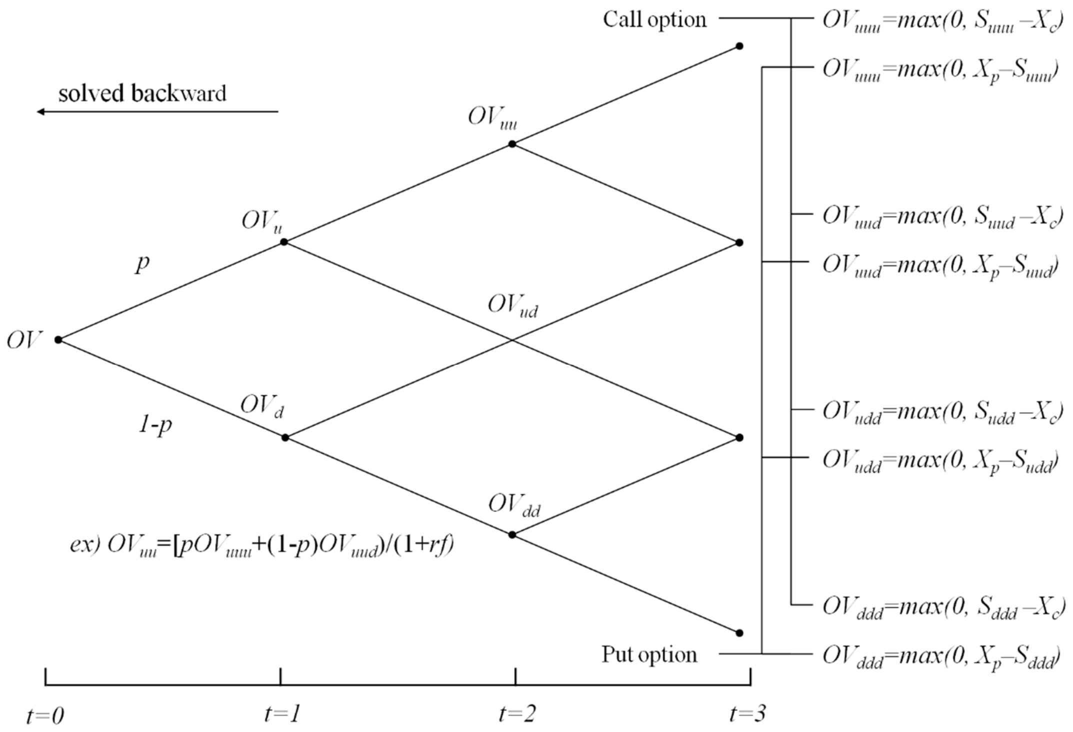

Figure 6. Binomial tree for solving option value.

First, the underlying asset (*S*) must be determined in the binomial tree. As shown in Figure 1, this study assumes that the changes in option value are caused by the changes in cost overrun. Therefore, the current value of the cost overrun that is expected to occur because of change orders is modeled as the underlying asset (*S*). As shown in Figure 5, the binomial tree—with the underlying asset (*S*) progressing through a forward process—models a case in which the cost overrun changes with time according to future uncertainty. The binomial tree in Figure 5 operates by calculating the probability of increase (u) and the probability of decrease (d) repeatedly for the underlying asset (*S*). The increase and decrease probabilities are calculated by default based on the volatility of the underlying asset. However, when the maximum and minimum values can be confirmed at the final point, the following equations can be used for the calculation [24].

$$u = \sqrt[t]{\frac{S_{ut}}{S_o}} \tag{1}$$

$$d = \sqrt[t]{\frac{S_{dt}}{S_o}} \tag{2}$$

t = construction period (monthly)
S_{ut} = the maximum value of cost overrun that can occur during the construction period t
S_{dt} = the minimum value of cost overrun that can occur during the construction period t

The option value is calculated according to the backward process in Figure 6, which is based on the binomial tree that is created through the forward process in Figure 5. As shown in Figure 6, the value of the call option or put option is calculated using the equation at the end of the binomial process.

Equation (3) is an example of the correlation between the node at t–1 and the two nodes at t. In other words, Equation (3) indicates that the OV_{uu} node is obtained by calculating the expected value using the OV_{uuu} node, OV_{uud} node, and risk-neutral probabilities (p) and discounting it using the risk-free rate.

Finally, the option value (OV node) at $t = 0$ can be calculated by applying this equation to other nodes. The risk-neutral probabilities (p) are calculated according to Equation (4). In this paper, rf_{month} is the monthly risk-free rate for which the three-year government bond interest rate is utilized.

$$OV_{uu} = [pOV_{uuu} + (1-p)OV_{uud}]/\,(1 + rf_{month}) \tag{3}$$

$$p = \frac{(1 + rf_{month}) - d}{u - d} \tag{4}$$

rf_{month} = monthly risk-free rate
p = risk-neutral probabilities
u = rise rates
d = fall rates

This study uses the binomial lattice model to produce the call option value and calculate the initial insurance value. Subsequently, this model is used to produce the strike price of an identically-valued put option in order to derive the point at which profit is generated for the insurance seller.

4. Analysis

4.1. Data Collection

This study investigates 9028 change orders from 237 apartment house businesses that were completed between 2005 and 2011 in South Korea. In the Table 1, contract cost, final cost, cost overrun due to price fluctuation, and cost overrun due to change orders are average values for each category as well as real values. In this paper, 1000 KRW was converted into US dollars.

Table 1. Cost overruns of projects due to change orders.

Cost overrun rate (%)	Project number (%)		Contract cost (US$ thousand)	Final cost (US$ thousand)	Cost overrun due to price fluctuation (US$ thousand)	Cost overrun due to change orders (US$ thousand)
Total	237	(100.0)	33,348	37,726	1636	2743
<5	152	(64.1)	32,043	33,770	1063	663
5–10	22	(9.3)	30,370	34,711	2373	1968
10–15	15	(6.3)	43,402	51,941	3337	5203
15–20	14	(5.9)	32,440	40,257	2301	5516
20–25	16	(6.8)	38,453	49,603	2554	8596
25–30	9	(3.8)	32,724	44,293	2242	9327
30–35	4	(1.7)	35,282	48,052	1455	11,314
35–40	4	(1.7)	39,003	58,529	4812	14,714
>40	1	(0.4)	48,815	73,252	4328	20,108

As shown in Table 1, an examination of the change orders indicates that cases in which the cost overrun rate was below 5% account for a large proportion of the total cases (64.1%). However, approximately 15% of the cases had a cost overrun rate over 20%; additionally, a case with a cost overrun rate of 40% was found. Although cost overruns lower than 5% account for the majority of the cases, issues with the cost overrun caused by change orders should not be overlooked. That is, secondary risk-hedging measures, such as insurance, are necessary because of the limitations in responding to risks through contingencies when the cost overrun exceeds the expected loss and leads to volatility.

Further, the cost overrun caused by price fluctuations was found to be higher when the cost overrun rate was below 10%. In contrast, the cost overrun caused by change orders was higher when the cost overrun rate was over 10%. Additionally, the cost overrun caused by change orders was found to grow higher as the cost overrun rate increases. Thus, there is a need to prepare for greater uncertainty when the cost overrun increases with the project's scale.

4.2. Approach for Setting up the Underlying Asset and the Strike Price of a Call Option

This study uses the call option valuation model to evaluate the value of insurance, and subsequently sets the strike price (X_p) of the put option so that its value is identical to the value of the insurance. For this calculation, the strike price (X_c) of the call option must be set in advance. The strike price (X_c) of the call option indicates the starting point at which the loss caused by change orders is guaranteed by insurance. Generally, in a construction project, the contingency is determined by calculating the expected loss using past data. Thus, contingency covers the basic risks that occur within the range of the expected loss; insurance responds to the risk that the expected loss will be exceeded. Therefore, the study first calculates the expected loss using the change order data and subsequently sets this value equal to the strike price (X_c) of the call option.

In order to calculate the expected loss, the cost overrun data were used to derive a frequency distribution and a severity distribution. Frequency indicates the number of cases in which loss occurs during a certain period; severity indicates the size of the loss that occurred. The severity of the loss could differ according to the cost of construction. Therefore, this study defines severity as the amount of loss scaled by the cost of the construction.

In this paper, Monte Carlo simulation was carried out based on the severity and frequency distribution, and the loss distribution caused by change orders was calculated as shown in Figure 7. The loss distribution derived in this study has considered more diverse possibilities than the distribution of actual project data collected from 237 apartment projects. Therefore, it is expected that the expected loss can be calculated more accurately. The loss ratio (on the horizontal axis in Figure 7) represents the risk associated with change orders, and the vertical axis indicates the probability of a risk occurring because of these change orders.

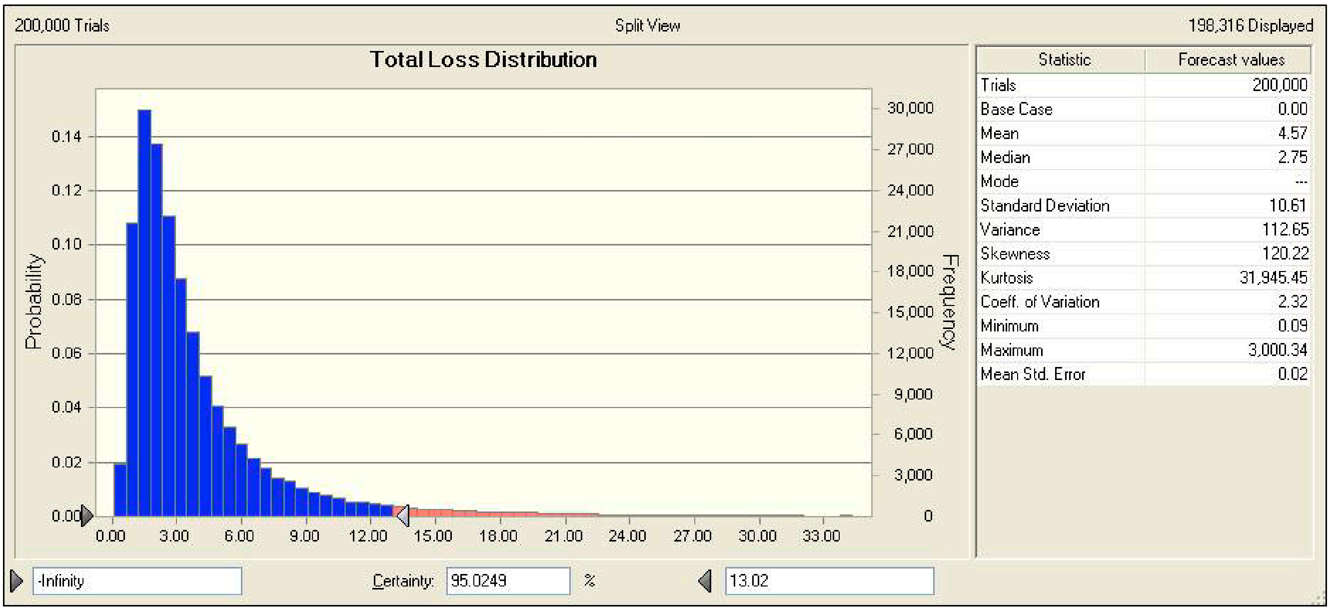

Figure 7. Loss distribution.

Table 2 presents the loss distribution shown in Figure 7, summarized into percentiles. As shown in Table 2, the average value of the total loss distribution is approximately 4.57%. Treating this value as the ratio of the loss caused by change orders to the construction cost and multiplying this ratio by the construction cost of the corresponding project yields an estimate of the cost overrun caused by change orders. That is, the average value of the loss distribution can be set as the expected loss when using contingency or cash reserves to prepare for a cost overrun. Any amount above the average value could be considered as unexpected loss; project managers can prepare for such unexpected loss through insurance when estimating the cost of the project. Therefore, this study sets the average value of 4.57% as the strike price (X_c) of the call option that produces insurance value.

Table 2. Total loss by percentile.

Percentile	Value (%)	Percentile	Value (%)
5%	0.09	60%	3.37
10%	1.09	70%	4.22
20%	1.48	80%	5.61
30%	1.86	90%	8.67
40%	2.27	95%	13.02
50%	2.75	**Average**	**4.57**

The underlying asset indicates the present value of the cost overrun that could occur in the future, and it is ultimately the present value of the strike price (X_c) of the call option. A call option structure such as this indicates that insurance operates when the current cost overrun (estimated at present) exceeds the final expected value. Therefore, the underlying asset is set by reducing the expected loss calculated on a monthly basis relative to inflation (3%). The monthly reduction occurs over the corresponding construction period, which was the timeline in this context.

4.3. Results

After determining the strike price of the call option using the binomial lattice model on the 237 projects, this study calculates the call option value for each project. This call option value ultimately indicates the value of insurance. Subsequently, the strike price of the put option is calculated, such that the value of the put option is equal to the value of the call option for each project. Thus, the put option is the section in which the insurance seller can secure a profit from providing insurance. When the cost overrun is lower than the strike price of the put option, the insurance seller stands to profit.

Figure 8 presents the ratio of the 237 projects according to each section in Figure 1. In 109 cases (46%), the cost overrun is higher than the strike price of the call option, which is when the insurance buyer gains a benefit from the collar option model. This is indicated as $\text{Group}_{\text{call}}$. In other words, these are projects where additional losses are guaranteed by the insurance since the strike price of the call option (calculated based on the expected loss) goes beyond the corresponding range. In addition, in 126 projects (53%), the cost overrun was found to be lower than the strike price of the put option ($\text{Group}_{\text{put}}$). In these projects, the insurance seller gains benefits *via* the collar option model by providing insurance, since the cost overrun is lower than the strike price of the put option. Lastly, two projects accounting for approximately 1% are included in $\text{Group}_{\text{not}}$. In this group, the cost overrun is higher than the strike price of the put option and lower than the strike price of the call option.

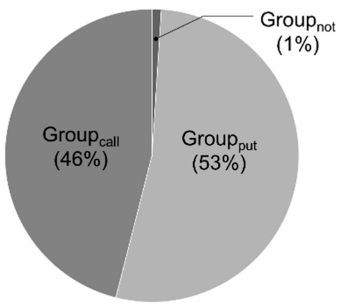

Figure 8. Percentage of the projects by each collar option model section.

The results of the detailed analysis on the projects within $\text{Group}_{\text{call}}$ are presented in Tables 3 and 4. Table 3 presents the ratio of the cost overrun caused by change orders net the amount guaranteed by insurance to construction cost. Thus, the DC_{call} rate indicates the range of the cost overrun (cost overrun—strike price of call option) guaranteed by insurance in relation to the construction cost. As shown in Table 3, cases in which the DC_{call} rate is below 0.05 account for 48.9% of the total projects, and cases in which the rate is above 0.15 account for approximately 20.6%. Thus, Table 3 indicates that although cases in which the strike price is within 5% of the construction cost account for a significant proportion of the overall percentage, in approximately 20.6% of the cases, the cost overrun that exceeds the estimation ends up accounting for over 15% of the construction cost. In reality, the cost overrun exceeding the estimated range is, in itself, a problem. When the exceeding amount accounts for a significant portion of the construction cost, it becomes an issue that is directly linked to the success or failure of the project. Therefore, insurance is an effective risk management measure for cost overruns caused by change orders.

Table 3. Ratio of the cost overrun guaranteed by insurance to construction cost.

	DC_{call} rate						**Total**
	<0.05	**0.05–0.10**	**0.10–0.15**	**0.15–0.20**	**0.20–0.25**	**>0.25**	
Project number (%)	53 (48.9)	20 (18.5)	13 (12.0)	5 (4.3)	13 (12.0)	5 (4.3)	109 (100)

Note: DC_{call} rate = (cost overrun − strike price of call option)/construction cost.

Table 4 presents the ratio of the cost overrun guaranteed by insurance to option value. An examination of the benefits gained by the insurance buyer from insurance when the cost overrun is higher than the strike price of the call option indicates that instances of a DO_{call} rate below 10 account for approximately 52.5% of the cases; instances of a rate over 20 account for approximately 20% of the cases. This signifies that a contract is actually effective when the cost overrun on the collar option model is in a section where the insurance buyer gains benefits.

Table 4. Ratio of the cost overrun guaranteed by insurance to option value.

	DO_{call} rate										**Total**
	<1	**1–5**	**5–10**	**10–15**	**15–20**	**20–25**	**25–30**	**30–35**	**35–40**	**>40**	
Project number (%)	15 (14.1)	30 (27.5)	12 (10.9)	17 (15.2)	6 (5.4)	8 (7.6)	1 (0.9)	7 (6.5)	11 (9.8)	2 (2.2)	109 (100)

Note: DO_{call} rate = (cost overrun − strike price of call option)/option value.

The results of the detailed analysis of the projects included in $Group_{put}$ are shown in Tables 5 and 6. Table 5 presents the ratio of the insurance seller's earnings to construction cost. Thus, the DC_{put} rate indicates the range of cost overrun (strike price of put option—cost overrun) in relation to construction cost over which an insurance seller gains a profit for providing insurance. As shown in Table 5, the cases in which the DC_{put} rate is below 0.020 account for approximately 53% of the overall cases, and the cases in which the rate is above 0.020 account for approximately 46% of all the cases. Compared to the DC_{call} rate, the DC_{put} rate is relatively lower. In other words, the benefits that the insurance buyer or seller can gain greatly differ when the cost overrun exceeds the strike price of the call option and the put option. However, the perspective regarding the gain is different: the insurance buyer is reducing a loss, and the insurance seller is gaining a fee for providing insurance. Further, as shown in Table 5, the fee of 2% of the total construction cost that the insurance seller charges for providing insurance is a significant amount. Therefore, the insurance seller can create a profit structure through the insurance contract.

Table 5. Ratio of insurance seller's earnings to construction cost.

	DC_{put} rate								**Total**
	<0.005	**0.005–0.010**	**0.010–0.015**	**0.015–0.020**	**0.020–0.025**	**0.025–0.030**	**0.030–0.035**	**>0.035**	
Project number (%)	21 (17.0)	13 (10.4)	14 (11.3)	18 (14.2)	14 (11.3)	20 (16.0)	15 (12.3)	10 (7.5)	126 (100)

Note: DC_{put} rate = (strike price of put option − cost overrun)/construction cost.

Table 6 presents the ratio of the insurance seller's earnings to option value. An examination of the benefits that the insurance seller gains indicates that when the cost overrun is lower than the strike price of the put option, the DO_{put} rate is below 3 in approximately 52% of the cases. The option value generally indicates the cost of the insurance as per the insurance contract. However, in the collar option model, the insurance seller can acquire a fee that is higher than the option value in most cases (as shown in Table 6).

Table 6. Ratio of insurance seller's earnings to option value.

	DO_{put} rate						Total
	<1	**1–2**	**2–3**	**3–4**	**4–5**	**>5**	
Project number	25	24	17	29	23	10	126
(%)	(19.8)	(18.9)	(13.2)	(22.6)	(17.9)	(7.5)	(100)

Note: DO_{put} rate = (strike price of put option − cost overrun)/option value.

5. Discussion and Conclusions

This study proposed a collar option model that can be implemented without straining the initial budget as a way to respond to change orders, which significantly affects cost overrun. The effectiveness of the model was verified through empirical analysis.

The analysis indicated that among the 237 projects that were studied, insurance buyers benefit from the collar option model in 46% of the cases, while insurance sellers benefit from the collar option model in 53% of the cases. This result was derived from the calculation of the expected loss by estimating the losses incurred because of the cost overrun caused by change orders and using that estimate as the strike price of a call option. However, the range of cost overruns that the insurance buyer would wish to be guaranteed against can be determined flexibly according to the risk level that the insurance buyer perceives. Thus, limiting the loss that could result from change orders to a predetermined range is an option for the insurance buyer, and the insurance seller's revenue would vary accordingly.

In the proposed collar option model, the cost and benefit to the parties (insurance buyers and sellers) differ according to the cost overrun. If the cost overrun is lower than the strike price of the put option, the insurance buyer must pay the insurance seller the difference between the strike price of the put option and the cost overrun. However, it would not be appropriate to consider this payment as loss for the insurance buyer. In most cases, the insurance buyer is the owner. The owner calculates a contingency to prepare for cost overruns. Thus, if the cost overrun caused by change orders is lower than the put option of the striking price, it would mean that the cost overrun caused by change orders is lower than what was expected, thereby generating additional revenue. Therefore, it can be concluded that the owner does not suffer losses because of the collar option model; rather, it receives no additional revenue. However, the insurance seller would suffer a loss if the cost overrun were higher than the strike price of the call option. The owner may be lax in proceeding with the project when relying on insurance; therefore, the insurance seller must have expertise in construction management. Accordingly, the subject providing insurance should be the construction management company. The construction management company in the project would have additional incentives on providing insurance, as well as revenue from providing construction management service. Additionally, the relevant incentive could act as a motivator for the construction management company, influencing performance related to construction management.

As construction projects require large-scale funding, the success or failure of the project may heavily affect the financial stability of many stakeholders. It is very important to implement construction projects stably by minimizing the cost overrun for ensuring the financial sustainability of many stakeholders. It is expected that the model proposed in this paper will contribute to ensuring the financial sustainability of stakeholders by controlling the cost overrun caused by change orders effectively.

This study focused on change orders caused by cost overruns. However, various other factors could lead to change orders. Therefore, insurance should be provided for factors such as site conditions and design errors. However, with regard to factors such as owner requirements, there could be disputes over whether insurance should be provided. Accordingly, the party providing insurance must clearly indicate in the contract the scope of insurance provided in the case of change orders. Additionally, it would be best to classify the factors causing change orders and to provide a collar option model specifying the scope of insurance provided.

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Author Contributions

Sanghyo Lee developed the concept and drafted the manuscript. Kyunghwan Kim revised the manuscript and supervised the overall work. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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