

Uncertainty Factors affecting Bid Price from Pre-bid Clarification Document of Transport Construction Projects

YeEun Jang¹, HaYoung Kim², June-Seong Yi^{3*}, and Bum-Sik Lee⁴

¹ Department of Architectural and Urban Systems Engineering, Ewha Womans University, 52 Ewhayeodae-gil, Seodaemun-gu, Seoul, 03760, South Korea, ORCID: <https://orcid.org/0000-0002-2831-6061>, E-mail address: jyee@ewha.ac.kr

² Department of Architectural and Urban Systems Engineering, Ewha Womans University, 52 Ewhayeodae-gil, Seodaemun-gu, Seoul, 03760, South Korea, E-mail address: gfdglddl@gmail.com

^{3*} Department of Architectural and Urban Systems Engineering, Ewha Womans University, 52 Ewhayeodae-gil, Seodaemun-gu, Seoul, 03760, South Korea, E-mail address: jsyi@ewha.ac.kr

⁴ Public Housing Research Dept., LH Land & Housing Institute, 539-99 Expo-ro, Yuseong-gu, Daejeon, 34047, South Korea, E-mail address: bslee@gmail.com

Abstract: Civil projects are associated with many uncertainties because they involve a long duration, many resources, a large area, and many supply chains. Therefore, the price of a civil project is not simply proportional to the quantity and unit price of the item but has a variable value, including uncertainty risk. This study investigates the influence of the uncertainty factors in the pre-bid clarification document on bid price formation during the project bidding phase. To this end, civil projects from the California Department of Transportation (Caltrans) were used as research data. This study randomly selected fifty sample data from each of twelve counties from 2008-to 2020: six hundred. The authors observed that each project sample had 0 to n query cases due to uncertainty. Then, this study examined the project uncertainty cases and categorized them into the following four uncertainty factors: ‘conflict’ (UF1), ‘impossibility’ (UF2), ‘lack’ (UF3), and ‘missing’ (UF4). Under the extracting process, the cases are classified into four uncertainty factors. With the project not containing any uncertainty factors as a control group, the project containing these uncertainty factors was designated as an experimental group. After comparing the bidder’s price, the experimental group’s bid price was higher than the control group’s. This result suggests that uncertainty factors in bid documents induce bidders to set a high bid price as a defense against uncertainty.

Key words: civil project, bid price, cost management, uncertainty factor, risk analysis

1. INTRODUCTION

Construction is a typical custom-made industry, where owners and builders want to complete a project at the best price. The project price is determined during the tender process, which should be calculated in consideration of various uncertainties as well as material costs, labor costs, and expenses required for the completion of the project [1], [2], [3]. If the bid price is calculated without sufficiently considering the necessary factors, it may not guarantee the expected profit to the builder but may cause serious financial difficulties [4]. In addition, making the owner bear the various risks that occur when the project is not carried out as planned will harm the project. Thus, setting prices for construction works is significant for both the investors and the contractor companies [5], [6].

Generally, two project prices are usually calculated during the tender process: the engineer's estimate offered by the owner and the bidders' price offered by the bidders. Despite the cost estimates required for the same project, these amounts differ. First, there is a difference between the perspectives of owners and bidders. The owner sets the price based on the completed project in the future, while the builder estimates the price based on all the steps necessary to complete the project. Second, the bidders' amounts are different because they put strategic costs in the price rather than just calculating the pure cost of completing the project. Strategic costs are invested not only to pursue greater profits but also to prepare reserves for uncertainty. Construction projects require a long time and high costs compared to other industries. Because the uncertainties that can be expected during a project are infinite, it is impossible to take them into account for the bid price. However, it is necessary to consider the uncertainty of the essential matters for implementing the project. These essentials are documented during the bidding stage. If the content to be provided is uncertain, the bid amount varies according to the bidder who judges it. Therefore, the research goal of this study is to determine how uncertain contents in the bidding document affect the bidding price of the project based on the actual project case analysis.

2. LITERATURE REVIEW

There are pieces of literature dealing with risk management in construction projects. Researchers noted that risk affects the planning and implementation of a project and investigated how uncertainty affects participants' decision-making in the early stage of a project [7], [8]. The relationship between risk and time ([9]), cost ([10], [11]), and quality ([12]), which are specific goals in the implementation phase, are also documented in many works. Existing literature has revealed that indeterminate, apparent factors associated with the project negatively affect performance. However, detailed and in-depth research on risk factors that can be resolved in the bidding stage still needs to be supplemented.

3. DATA AND METHOD

3.1. Data

Since this study aims to examine the relationship between the uncertainty in the bidding document and the bid price, it is essential to select a case that meets this purpose. The bid price is offered in a lump sum, which is unknown. In this regard, a project involving too many uncertainties in the bidding document is challenging to observe the relationship between the bid document's uncertainty and bid price. However, if a typical project with only an uncertain bid document is selected, the tendency between the uncertainty of the bid document and the price is relatively figured out. Consequently, this study set Caltrans's transport project as a material. The projects have been carried out in California for a long time, so they are standardized with low uncertainty. Therefore, the authors collected data from 2008, when data was accessible on the web, to 2020, the most recent, and randomly selected 50 projects from 12 counties in California to prepare 600 data samples. This study determined this source according to the method presented below.

3.2. Method

The pre-bid clarification document is created through communication between the client and the bidders regarding the bid document's contents, which are later included in the contract. This document is critical because it contains uncertainties in project implementation as well as simple questions that are not related to the project or inquiries caused by bidders' mistakes. Therefore, it is necessary to select the content on uncertainty before data analysis. Next, the uncertainty factors are extracted by observing the types appearing in the chosen uncertainty cases. We then label all

uncertainty cases in the pre-bid clarification document as one of these four factors. Projects that contain many uncertainty factors are grouped into the experimental group, and projects that do not include the uncertainty factors are grouped in the control group. On the other hand, the bidding price varies greatly depending on the size of the project. This study intends to examine how much strategic premium was added for project completion according to the uncertainty of the bidding document interpreted by each bidder. Therefore, based on the mean of the bid price for each bidder, we suggested how this price has increased or decreased compared to the expected price.

4. EXPERIMENT AND RESULT

4.1. Unresolved Uncertainty Cases in Pre-bid Clarification Document

Table 1 shows the examples of bid inquiries from bidders related to projects. The owner must answer the bid inquiry within a certain period. If there is a problem, an addendum is issued. However, these cases were unanswered from the client, remaining unresolved and uncertain.

Table 10. Examples of unresolved uncertainty cases in a pre-bid clarification document

Example No.	Unresolved uncertainty case
	<Required information deficiency for estimation>
Example 1	<i>... With reference to the Information Handout provided, the Geotechnical analysis and design discuss the need to dewater for the installation of underground utilities, yet we did not seem to find (or maybe we have overlooked it) information relating to what depth dewatering is required in relation to invert of proposed pipes. To what depth (above, at invert, or below pipe invert) is the contractor required to dewater? ...</i>
	<Conflicting BOQ and drawings>
Example 2	<i>... Based on the area shown for the Y-1 excavation @ 1.5' and sheet C-23, we can only come up with about half of the bid item quantity for Y-1 excavation. Is there an error in the excavation quantity? ...</i>
	<Conflicting drawings>
Example 3	<i>... Comparing Layout drawing L-1 (pg 17) with pavement elevation plan C-1 (pg 37), the dimensions of the Alhambra Ave EB on-ramp (right) are not the same. Please clarify or re-issue correct drawings. ...</i>
	<Insufficient specifications>
Example 4	<i>... In some situations, Contrast Stripe may be Paint adjacent to Thermoplastic. is the paint expected to last for 5 yrs also? ...</i>
	<Discrepancy between BOQ and drawings>
Example 5	<i>... Bid Item 34 Timber hardware; Quantity is 1,142 LB however plan sheet 13 general plan quantities depicts 285 LB, please advise. ...</i>
	<Possible quantity error (based on other parts of the document) >
Example 6	<i>... Item 110 Minor Concrete Quantities appear to be overstated and duplicated, please check and revise quantities. ...</i>
	<Item omission indicated on the drawing>
Example 7	<i>... Reference Plan Sheet No. 6, Construction Details C-1, Detail A. Under what Pay Item is the 8" Diameter Perforated Plastic Pipe Paid? ...</i>
	<Impossible to carry out without guidance on risky situations>
Example 8	<i>... One of the first orders of work on this project will be to remove the AC Dike which will allow the Contractor to place HMA on the shoulder in preparation for placing RHMA on the same shoulder. However, the Department has not addressed the need for a Temporary HMA Dike that may be required to protect the slopes, we are seeking a bid item for a Temporary HMA Dike. ...</i>
	<NOT indicated in drawing but included in BOQ>
Example 9	<i>... The quantity for Bid Item #219 is shown in the Quantities table for RW #245. Where on the plans is the 18" WSP(.375") to be installed? ...</i>

With this process of resolving uncertainty, the bid price is directed toward a more reasonable price [13], [14]. Generally, a project has from zero to many inquiries. However, not all queries imply uncertainty. Pre-bid clarification documents include simple inquiries such as questions about the online bidding system and queries not related to project uncertainty or inquiries due to the bidder's error. Therefore, the authors checked all the queries of 600 projects, and finally, only the

queries containing uncertainty were extracted. More specifically, in this study, questions for which no final answers were posted, unresolved questions, were identified first. Not all of these queries are classified as uncertainty. This is because some queries are so irrelevant to the project that the owner is not obligated to answer them.

Referring to the examples of uncertainty cases shown in Table 1, even though the bidding document is the basis for the bid price, there are pending cases where there is a problem with the requirements for completing the project or inconsistencies between various bidding documents. Example 1 is caused by uncertainty about what is needed to carry out the project. The bidder should know to what depth the dewatering work should be carried out to calculate the bid price for installing underground facilities. Therefore, the bidder requested an answer to the insufficient information. Example 4 is also a similar query, but it is uncertain in interpretation whether the durability of paint should also be guaranteed for five years. On the other hand, public bidding documents include the bill of quantities (BOQ), drawings, and specifications. Examples 2 and 5 are cases where the contents specified in the BOQ and drawing contradict each other. Also, as in example 3, there may be a contradiction between drawings. In the case of example 6, the bidder inquired that there may be errors in the BOQ based on the drawings, although there is no conflict between the stated contents. Similarly, there is also a query such as for example 7 where the item itself, which is expected to be essential, is omitted based on the drawing review. Finally, example 8 inquires about the uncertainty in carrying out the guidelines required for project completion.

4.2. Uncertainty Factors Extraction

As discussed in the previous section, an uncertainty case arises when the contents of the bidding document conflict, cannot be realized, or necessary is missing. The authors typed uncertainty queries to identify uncertainty cases in each project’s pre-bid clarification document.

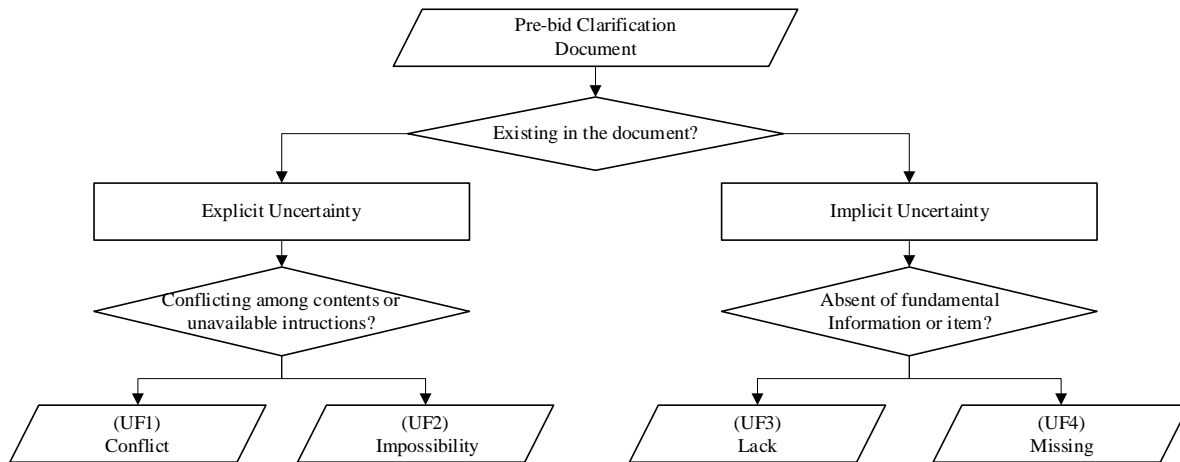


Figure 23. Extracting uncertainty factors from pre-bid clarification document

Four uncertainty factors were defined according to the diagram in Figure 1 to classify factors to be mutually exclusive and collectively exhaustive. The queries contained in the pre-bid clarification document are primarily divided into explicitly stated cases and implicitly inferred cases. First, the clearly stated contents are composed of a case where the contents contradict each other (UF1, ‘Conflict’) and a case that cannot be performed (UF2, ‘Impossibility’). Second, the absence of specific content causes uncertainty because essential information (UF3, ‘Lack’) or important items (UF4, ‘Missing’) are omitted. This study extracted uncertainty factors UF1-4 in the bidding document following this process. Table 2 presents the results of classifying the nine examples

shown in Table 1. Similarly, the authors labeled the uncertainty-related queries in every 600 projects into four categories.

Table 11. Classifying uncertainty cases (Example 1-9) into the uncertainty factors (UF1-4)

Example NO.	Description	Classifying into the uncertainty factors			
		UF1	UF2	UF3	UF4
Example 1	Required information deficiency for estimation			⊙	
Example 2	Conflicting BOQ and drawing	⊙			
Example 3	Conflicting drawings	⊙			
Example 4	Insufficient specifications			⊙	
Example 5	The discrepancy between BOQ and drawings	⊙			
Example 6	Possible quantity error (based on other parts of the document)	⊙			
Example 7	Item omission indicated on the drawing				⊙
Example 8	Impossible to carry out without guidance on risky situations		⊙		
Example 9	NOT indicated in drawing but included in BOQ				⊙

As a result of identifying the status of uncertainty queries by project, each project had a very diverse number of queries. The authors divided 600 data samples into control and experimental groups: projects with less than one uncertainty query as the control group and projects with two or more questions as the experimental group. On the other hand, using the bid price as a dependent variable involves several problems. First, the number of bidders varies among each project, and the number of bid prices also varies. For this reason, this study used the average of the bid price as a dependent variable. Second, the price varies greatly depending on the size of each project. Since the purpose of this study is to examine how much uncertainty in the bidding document causes an increase or decrease compared to the expected price of the project, an engineer's estimate, which can be used as a standard for project cost at the tender time, is included as a dependent variable. In other words, this study used the bidders' mean bid price divided by the engineer's estimate as to the dependent variable. Table 3 below shows the experimental results.

Table 12. Results

Descriptive statistics	Control group	Experimental group
Mean	0.9759	1.1172
Maximum	1.2787	1.6612
Minimum	0.6482	0.7295
Median	0.8653	1.1303

5. CONCLUSION

This study designed and conducted an experiment based on Caltrans's project cases to investigate how the uncertainty of the bidding document affects the bidding price of the project. The results showed that the average value of the bid price was higher for the project, including the uncertainty of the bid document compared to the expected project cost compared to the general project. However, since this is an interpretation using only descriptive statistics, a more clear

follow-up study is needed to determine whether the value is significant in the future. Suppose the uncertainty of the project is not resolved during the bidding process. In that case, the gap increase between the planned project price and the bid price means the gap increase between the view of the owner and the builder. Failure to agree among stakeholders on project completion results in disputes or litigation, incurring huge losses for both parties. The contribution of this study is to reduce this gap affected by the uncertainty of the bidding document. The project will reach a more prosperous and reasonable price by eliminating uncertainty in the bidding stage.

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