

Decision Criteria for Subcontractor Selection in International Construction Projects

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Abstract

An international construction project executed by poor-quality subcontractors leads mostly to time and cost overruns, reworks, conflicts, and dissatisfaction of customers. Therefore, this paper presents a study of subcontractor selection criteria in international construction projects. Toward this aim, an in-depth survey was administered to 96 construction firms which are members of Turkish Contractors Association. Results were analyzed through the rank ordering method used for eliciting the respondents' perceived importance. Since assessing preferences by a questionnaire can be employed to assign membership values to a fuzzy variable, fuzzy importance weights as well as their rankings were obtained for subcontractor selection criteria and stages. In this regard, a three-step conceptual selection procedure with their specific criteria was proposed. As a result, as the first stage, shortlisting is composed of ten criteria such as past experience, past performance, formal relationship, financial strength, workload, safety records, reputation, litigation history, personal relationship, and home office location, respectively. The negotiation stage contains seven criteria such as knowledge of project, reliability, selfless attitudes, ability to solve problems, enthusiasm for the project, quality awareness, and level of communication, respectively. Lastly, the final selection stage includes seven criteria such as price, technical personnel, labor, equipment, payment plan, amount of subcontracting, and amount of compensation for delay, respectively. Consequently, this study has a considerable potential to present research and practical implications from the perspective of researchers, industrial practitioners, and contracting organizations in construction.

Keywords: Construction projects, decision-making, international projects, selection criteria, subcontractor.

Uluslararası İnşaat Projelerinde Taşeron Seçimi İçin Karar Kriterleri

Öz

Düşük kaliteli taşeronlar tarafından yürütülen uluslararası bir inşaat projesi, çoğunlukla zaman ve masraf aşımına, yeniden işlere, çatışmalara ve müşterilerin memnuniyetsizliğine yol açmaktadır. Bu nedenle, bu makale, uluslararası inşaat projelerinde taşeron seçimi kriterleri üzerinde yapılmış bir çalışmayı sunmaktadır. Bu amaca yönelik olarak, Türk Müteahhitler Birliği üyesi olan 96 inşaat firmasına derinlemesine bir anket uygulanmıştır. Sonuçlar, ankete katılan kişilerin algılanan önemini ortaya çıkarmak için kullanılan sıralama yöntemi ile analiz edilmiştir. Tercihleri bir anket ile değerlendirmek üyelik değerlerini bulanık bir değişkene atamak için kullanılabilir olduğundan, alt yüklenici seçim kriterleri ve aşamaları için bulanık önem ağırlıkları ve sıralamaları elde edilmiştir. Bu bağlamda, üç aşamalı kavramsal bir seçim prosedürü, özel ölçütleri ile birlikte, önerilmiştir. Sonuçta, ilk aşama olarak ön-seçim, sırasıyla genel ve benzer proje tecrübesi, geçmişte beraber çalışılması, kişisel ilişkinin varlığı, mevcut ve muhtemel iş yükü, saygınlık, geçmiş projelerdeki hukuki davalar, geçmiş projelerdeki performans düzeyi, finansal kapasite, merkez ofisten uzaklık, geçmişteki iş güvenliği performansı gibi on kriterden oluşur. Müzakere aşaması, iletişim düzeyi, güvenilirlik, sorunlara çabuk yanıt verebilirlik, projeyi kavrama, özverili çalışma, proje için duyulan istek, kalite algılaması gibi yedi kriter içermektedir. Son olarak, son seçim aşaması ödeme planı, teklif fiyatı, işgücü, teknik personel, ekipman, alt yüklenici çalıştırma yüzdesi, gecikme tazminatı miktarı gibi yedi kriteri içerir. Sonuç olarak, bu çalışma, inşaat sektöründeki araştırma ve uygulamaları, araştırmacıların, endüstriyel uygulayıcıların ve müteahhitlik organizasyonlarının bakış açısından sunmak için önemli bir potansiyele sahiptir.

Anahtar Kelimeler: İnşaat projeleri, karar verme, uluslararası projeler, seçim kriterleri, alt yüklenici

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1. Introduction

Subcontracting is a usual practice in the construction industry in most countries. It means that this huge industry relies heavily on subcontracting as a key organizational and commercial device [1]. In addition, subcontracting gains a much more importance while performing works in international projects which are usually executed in inexperienced locations and conditions. In fact, this reality may bring many inherent and unanticipated risks. However, looking at the related academic literature, there seems to be no research that investigates subcontractor selection criteria specifically, to the best of our knowledge. Accordingly, the current study attempts to introduce subcontractor selection criteria in international construction projects. In doing this, all criteria were divided into three different stages as shortlisting, negotiation, and final selection.

2. Material and Methods

The data presented in this study were obtained by a questionnaire survey given to members of Turkish Contractors Association [2]. This sample group is an accepted list of firms within the Turkish construction industry as they perform approximately 70% of total investments made in Turkey and have undertaken 90% of the work done abroad in the field of construction. There are 139 members in total, of which 96 firms (69.06%) positively responded to the survey request. The number of companies interviewed is statistically adequate ($n \geq 30$) to represent the whole. Furthermore, Babbie [3] suggested that any return rate over 50% can be reported, that over 60% is good, and that over 70% is excellent. Respondents were contractors' professional managers who choose subcontractors.

The survey was statistically evaluated by the rank ordering method used for eliciting the respondents' perceived importance. As assessing preferences by a survey can be used to assign membership values to a fuzzy variable, fuzzy importance weights and rankings were obtained for criteria and stages in this study. Preference is determined by pairwise comparisons, and these determine the ordering of the importance or the membership [4]. This method is very similar to a relative preferences method developed by Saaty [5]. In this technique, normalization is employed as well, since more reasonable results can be obtained with normalization than without normalization [6]. Normalization enables the reduction of all fuzzy sets to the same base and ensures that at least one element of the set has a degree of membership of one. This is done by dividing the degree of membership of each element in the set by the maximum degree of membership of any element in the set. If this maximum degree of membership is one, then the set is not modified by this division. If, on the other hand, the maximum degree of membership in the set is a number less than one, then dividing by this maximum will increase the degree of membership of each element and at least one element will have a degree of membership of one after the division.

3. Shortlisting Criteria

As can be seen in Table 1, ten shortlisting criteria that are used for the subcontractor selection in international construction projects were ranked according to their importance levels via the rank ordering method. In the 'number who preferred' column, there are results of pairwise preferences among criteria. For example, out of 96 respondents, 60 preferred K1 to K2, and 84 preferred K2 to K3. Note that criterion

columns represent an ‘antisymmetric’ matrix. In the ‘total’ column, the sum of preferences of each criterion is given. For example, K1 was preferred to other criteria in 810 comparisons. In the ‘total’ row at the bottom, 4320 denotes the total number of comparisons. In other words, 96 participants made 45 different comparisons and this points out 4320 (96x45) comparisons in total. The ‘%’ column indicates percentage values of numbers in the ‘total’ column. The ‘rank order’ column in which the highest percentage value takes the number ‘1’ displays importance rankings of criteria. In the ‘weight’ column, there exist importance weights that were normalized. This means that row sums were normalized to the total number of comparisons and thus a rank ordering was determined. All these explanations are also valid for Table 2 and Table 3. The following ten criteria of the shortlisting stage were clarified in a descending order.

Table 1. Importance weights and rankings of shortlisting criteria

	K1	K2	K3	Number who preferred							Total	%	Rank order	Normalized weight	Fuzzy weight
				K4	K5	K6	K7	K8	K9	K10					
K1	-	60	96	96	96	90	84	96	96	96	810	18.75	1	1.00	EH
K2	36	-	84	66	84	90	48	60	96	66	630	14.58	3	0.78	VH
K3	0	12	-	18	36	42	6	24	90	30	258	5.97	9	0.32	FL
K4	0	30	78	-	66	78	12	36	96	60	456	10.56	5	0.56	H
K5	0	12	60	30	-	60	12	36	96	42	348	8.06	7	0.43	L
K6	6	6	54	18	36	-	6	18	96	48	288	6.67	8	0.36	L
K7	12	48	90	84	84	90	-	90	96	84	678	15.69	2	0.84	VH
K8	0	36	72	60	60	78	6	-	96	66	474	10.97	4	0.58	H
K9	0	0	6	0	0	0	0	0	-	12	18	0.42	10	0.02	EL
K10	0	30	66	36	54	48	12	30	84	-	360	8.33	6	0.44	L
											Total	4320	100		FH

K1: Past experience; K2: Formal relationship; K3: Personal relationship; K4: Workload; K5: Reputation; K6: Litigation history; K7: Past performance; K8: Financial strength; K9: Location of home office; K10: Safety records; EH: Extremely high; VH: Very high; H: High; L: Low; FL: Fairly low; EL: Extremely low.

Past experience (K1)

This criterion includes the firm’s national and international experience in the field of work subcontracted in the past five years. These previous projects undertaken are evaluated by means of the number and scale measured in cost, duration, and square meters. Bidding for specific types of the construction work and thereby having a comparatively low bidding variability relative to other bidders has a vital aspect for candidate subcontractors. With regard to the project type, a subcontractor experienced in undertaking projects of a similar type would seem to require less risk premium, which in turn resulted in less cost, because subcontractor is likely to have greater confidence in completing the project in accordance with the client’s brief. Geographical area experience is also considered in terms of subcontractor’s familiarity with local weather and ground conditions, transportation facilities, cultural habits, and procurement of resources.

Past performance (K7)

Past performance is a guide to likely future performance and illustrates a subcontractor’s ability to execute a contract. It means that subcontractor’s past performance is a good indicator of its technical and managerial abilities. This induces a more disciplined approach towards better subcontractor performance. In addition, if a subcontractor has done good work and knows its customers, it will be able to prove its past performance. Good performance in previous projects can be seen as the sign to improve a subcontractor’s reputation and linked to company image. However, it should be noted that a subcontractor

may show completely different performances in different periods of time even if the conditions are the same. Previous time, cost, and quality performances of subcontractors are evaluated under this criterion. If a subcontractor has been worked together in past projects, the related performance level gains more importance. In this context, differences between estimated and experienced duration and costs in past projects are investigated. Whether a subcontractor is responsible for these variances is also examined, because technical considerations often force modification of contracts during the course of a project. Moreover, quality has a considerable importance in satisfying client's objectives. All of performance information of an organization is obtained via written documents taken from candidates and verified by contacting references of third parties (e.g., contractors who employed that subcontractor in previous projects). However, poorly performing subcontractors would be naturally unable to find any suitable references from the industry.

Formal relationship (K2)

In the industry, subcontractors known from previous projects are preferred, since it is easier to assess the firm's ability within the context of the working attitude and working relationship. There exist some main contractors who make the selection decision solely by considering this criterion. It is also perceived as the first step of establishing a partnering relationship due to the advanced mutual harmonization and addiction. The criterion is evaluated by taking into consideration past business relationships and main contractor's related views.

Financial strength (K8)

When a subcontractor has to carry construction losses in a project or when client- and/or main contractor-based cash flow/progress payment difficulties are the case, financial background and bonding capacity of subcontractor should be adequate. Financial soundness is the basic element of responsibility and risk-sharing behavior which is one of the most important advantages of subcontracting. To this aim, most of general contractors prefer to take securities from subcontractors. There are two types of securities that are commonly used: bank guarantee letter and retention. In 'labor-only' type of projects, the security that is generally taken is the retention type. Main contractor keeps a specified percentage of progress payments until the work is completed. The amount of retention withheld by main contractor in subcontracted work is another way of financing a project by main contractor as well. In 'labor plus material' type of projects, main contractors prefer to take bank guarantee letters from subcontractors. Turnover history, liquidity ratio, net current assets, line of credit, unused portion of a letter of credit, credit reference, credit rating, stockholders' equity portion of the subcontractor's balance sheet, and financing institutions' guarantees/warrantees or letter of consent of surety from the applicant's bank confirming the subcontractor's capacity to carry out the specified range of work are the leading factors that can be considered under this criterion on financial solvency, as cited by Severson et al. [7].

Workload (K4)

Numbers, types, locations, and scales of current/planned projects and completion percentages of current projects are investigated under this criterion. Especially the number and scale of projects should be as small as possible to prevent physical resources of a subcontractor from being divided into many pieces. This also leads subcontractor to be highly willing to get the job and to focus on the project.

Subcontractors with a high work load may submit a high quotation and, if selected, may not fit the main contractor's schedule, causing a delay, particularly if the activity of the subcontracted work is on the critical path. In terms of geographical location, projects should not be too far from each other because of easiness of logistics. In general, this criterion aims to eliminate the risk of subcontractor failure arising out of excessive workloads. It is also intended that the subcontractor capacity is convenient for additional work, because subcontractors' performance levels differ widely under different workloads. Economic theory of the firm suggests that firms are most efficient when they operate just under capacity.

Safety records (K10)

Occupational health and safety performance of subcontractors can block the execution of a project and lead to an additional cost. Therefore, safety precautions and policy should be carefully investigated to understand subcontractor's safety perspective. According to Winch [8], although it is difficult to enforce safety regulations, particularly when dealing with subcontractor workers, they are actually at less risk of death than employees of major contractors. In fact, there is no evidence that labor supplied by subcontractors is any more prone to accidents than people who are directly employed by main contractor itself. However, main contractor can require subcontractor to insure its parts of works. In practice, main contractor is contractually responsible to employer for the whole of works, unless such insurance is taken out by employer for the benefit of main contractor and subcontractors. For instance, FIDIC [9] requires main contractor and subcontractors to acquire certain insurances against loss of or damage to the whole of works. However, it gives a main contractor the option of deciding whether subcontractors should insure their parts of works against loss or damage. It also requires a main contractor and its subcontractors to insure against their liability for injury to their employees. Accordingly, insurance premium is always reflected in the price charged for work. An outline of an accident-prevention program and plan, national and international certificates in this domain, number and qualification of safety officers, and number of employee per personnel are considered in this criterion.

Reputation (K5)

Negative information about a subcontractor's behavior spreads quickly among other parties, including contractors, sureties, material vendors, and even prospective clients, because of the temporary nature of the construction process, where members of the temporary alliance go their own way upon completion of the project. If a subcontractor is not a well-known organization, it is likely to encounter unanticipated problems during construction. On the contrary, positive information about a subcontractor's image distinguishes it from other potential or applied competitors and acts like a catalyst for formation of transactions in the future. There is a logical link between reputation and potential for good performance in that a subcontractor with a 'good' reputation will have earned it and endeavor to uphold it. Often, a main contractor feels more secure if a reputable subcontractor is employed. It also generates main contractors' impression of longer term stability of a subcontractor. The use of qualification restrictions and selection based on reputation for quality allows contracting authorities to effectively screen out potentially underperforming subcontractors. However, subcontractor's superior reputation, if not matched by equally superior performance, may have precisely the opposite effect – it may lead to exaggerated expectations that are less likely to be fulfilled. In this criterion, age of subcontracting firm is taken into account.

Litigation history (K6)

For identifying criminal histories of subcontractors both on failures to complete a subcontract and on terminated works, previous record of jurisdictional claims and convictions in fault are investigated in some prestigious projects from previous main contractors. Number and cause of disputes are considered in the selection process.

Personal relationship (K3)

Both main contractors and subcontractors tend to over-rely on building personal relationships, since they believe that better communication reduces the risk of misunderstanding. In this regard, an informal relationship between parties is perceived as a vital component of establishing and sustaining business partnership in practice. Sometimes, this type of a professional relationship may also be needed to overcome project-based problems arising from external factors such as socio-political constraints especially while working with a local subcontractor in an international project. As a result, managers of a subcontractor are evaluated in terms of whether they have past business relationships with site and head office staff of main contractor.

Location of home office (K9)

Head office location and, if available, local office location of a subcontractor are used as an indication of the ease of mobilization and communication with site office, because the head office normally provides support to each project in administrative issues and sometimes in technical matters. How effectively the main office supports the site and how quickly and effectively information flows between site and main offices are important criteria. A long distance makes a business trip very time-consuming and the time difference severely inhibits communication. However, establishing a local office without having a job is very costly, and more importantly, a local subcontractor has a constant business relationship with local suppliers. In fact, this can bring some advantages in purchasing materials and of timely delivery.

4. Negotiation Criteria

The following seven criteria of the negotiation stage that was tabulated in Table 2 were explained in detail in a descending order.

Table 2. Importance weights and rankings of negotiation criteria

	Number who preferred							Total	%	Rank order	Normalized weight	Fuzzy weight
	K1	K2	K3	K4	K5	K6	K7					
K1	-	6	30	6	12	36	42	132	6.55	7	0.28	FL
K2	90	-	66	36	72	72	78	414	20.54	2	0.88	EH
K3	66	30	-	12	36	60	66	270	13.39	4	0.58	H
K4	90	60	84	-	72	78	84	468	23.21	1	1.00	EH
K5	84	24	60	24	-	78	72	342	16.96	3	0.73	FH
K6	60	24	36	18	18	-	66	222	11.01	5	0.47	A
K7	54	18	30	12	24	30	-	168	8.33	6	0.36	L
								Total	2016	100		FH

K1: Level of communication; K2: Reliability; K3: Ability to solve problems; K4: Knowledge of project; K5: Selfless attitudes; K6: Enthusiasm for the project; K7: Quality awareness; EH: Extremely high; FH: Fairly high; H: High; A: Average; L: Low; FL: Fairly low

Knowledge of project (K4)

Under this criterion, knowledge of a subcontractor about works to be subcontracted and main project are tested. Complete comprehension of a subcontractor on expectations of a main contractor is the most important phase of the negotiation procedure.

Reliability (K2)

Whether trustworthiness, believability, and honesty are established between parties is the focal point of this criterion. How much a subcontractor respects common professional ethics is also paid attention. In this context, communication skill and self-confidence are considerable elements.

Selfless attitudes (K5)

This criterion includes determination of how much a subcontractor can work in a selfless manner in a project. Whether a subcontractor can take the risk of using its extra financial and technical resources to complete a subcontracted work in the event of any problem during construction, such as cash flow difficulties, is revealed. Business customs and culture of subcontractor are also taken into consideration.

Ability to solve problems (K3)

A main contractor tends to work with a responsive and proactive subcontractor who is able to resolve unanticipated problems and conflicts that might occur without delaying the progress of construction works and without requiring any support. Operations of a good organization can be seen through quick responses to actions.

Enthusiasm for the project (K6)

It aims to measure the level of subcontractor's willingness to be awarded. This criterion and 'selfless attitudes' have similarities in some concepts such as willingness and selflessness. The 'workload' criterion also affects it to a certain extent.

Quality awareness (K7)

If a firm subcontracts an activity, it only needs to monitor the quality of the output, whereas if a firm vertically integrates such an activity, it has to know details of the production process. In this regard, problems of coordinating and monitoring the quality of inputs from external sources such as subcontractors, and problems involved in supervising and motivating workers whose relationship with the firm is insecure or merely temporary and who therefore lack a sense of identification with it become more important. As a result, quality certificates and approved quality assurance schemes that subcontractors have are considered in evaluating this criterion. However, the quality of work can suffer when a project team sees achieving shorter completion time as a priority. Moreover, the product itself may lack uniformity and be of unpredictable quality standard. In such a circumstance, warranty period is the point in question. Product warranties furnish information on unobservable product characteristics and they are signals of product quality. The stronger or longer the warranty, then the higher the expected product quality.

Level of communication (K1)

In the communication between a main contractor and a subcontractor, mutual respect and ease of contact are inevitably involved. Subcontractor’s inclination towards team working is another factor constituting this criterion.

5. Final Selection Criteria

Seven criteria of the final selection stage (Table 3) were investigated in a descending order as follows.

Table 3. Importance weights and rankings of final selection criteria

	Number who preferred							Total	%	Rank order	Normalized weight	Fuzzy weight
	K1	K2	K3	K4	K5	K6	K7					
K1	-	18	36	36	36	90	96	312	15.48	4	0.62	H
K2	78	-	78	78	78	96	96	504	25.00	1	1.00	EH
K3	60	18	-	30	66	96	96	366	18.15	3	0.73	FH
K4	60	18	66	-	78	96	96	414	20.54	2	0.82	VH
K5	60	18	30	18	-	96	90	312	15.48	4	0.62	H
K6	6	0	0	0	0	-	72	78	3.87	6	0.15	VL
K7	0	0	0	0	6	24	-	30	1.49	7	0.06	EL
								Total	2016	100		VH

K1: Payment plan; K2: Price; K3: Labor; K4: Technical personnel; K5: Equipment; K6: Amount of subcontracting; K7: Amount of compensation for delay; EH: Extremely high; VH: Very high; FH: Fairly high; H: High; VL: Very low; EL: Extremely low

Price (K2)

A large number of bidders competing for a subcontract can give rise to efficiency in subcontractor selection and negotiation processes and reduce the value of the lowest bid received. This means that the expected bid price falls as the competitors’ number increases, reflecting an advantage of selecting from a larger population of firms. For determining the minimum number of bidders in construction bidding competitions, Ngai et al. [10] employed polynomial regression models while Hiyassat [11] used t-test. However, based on the neo-classical micro-economic theory, more tenders would not necessarily guarantee a lower construction price because price determination is actually based on an interaction of demand and supply, and thus, probably the number of bidders is unlikely have much effect on price. Therefore, the fact that a main contractor individually forces subcontractors to reduce their bid prices regardless of the time of the attempt, either after the award of a main contract or before main contractors submit their bids to the awarding authority, is a usual practice in the industry. If the attempt occurs after the award of main contract, fall amounts are determined in proportion to the reduction that main contractor accepted for main contract. More reasonably, if the attempt occurs before main contractors submit their bids to the awarding authority, then price discounts are decided by negotiation and thus main contractor makes a more realistic plan on how many reduction it can accept during bidding. As a result, under this criterion, a main contractor considers the difference between estimated subcontract budget and bid prices proffered by subcontractors. The criterion ‘price’ is negatively oriented in terms of preference; that is, the lower the price, the better the result is. However, bid prices considered abnormally low or high by main contractor are excluded by giving them very low ratings, and thereby unreasonably inflated proposals can be eliminated. This increases the possibility of selecting ‘the most suitable’ candidate, since subcontractors who always undertake specific trades can submit bid prices that have smaller deviations when compared with other bidders. In other words, with less cost variation across firms, the selection benefit increases. This approach also views cost as an order-

qualifier (i.e., a characteristic that qualifies an item to be considered for selection), not an order-winner (i.e., a characteristic that is the final factor in the selection decision). However, prices submitted by subcontractors on similar projects may show great fluctuations with respect to the general contractor.

Technical Personnel (K4)

General contractors attempt to compose an experienced team to achieve human resources team-working and thus to build the project with acceptable quality and within the project schedule. In this context, elements in this criterion are: (i) the capability of technical staff in terms of the number and skill formation, and (ii) their years with company.

Labor (K3)

The number and quality of subcontractor workers are parameters considered in this criterion. Containing these two factors, man-hour values for unskilled and skilled workers are taken into account as an indicator of productivity. This means that man-hour values of activities on a critical path (such as placing formwork, folding and setting reinforcement steel bars, and earth excavation) are investigated. Here, it is also important that subcontractors use construction planning software packages to assist main contractor's planning efforts.

Equipment (K5)

Similar to 'technical personnel' and 'labor' criteria, construction equipment is examined in terms of the number and quality under this criterion. In this context, model (name of manufacturer) and modernism (year of manufacture) of equipment to be used in a project are important issues. In addition, owned equipment has an advantage over leased or hired equipment, considering potential budgetary difficulties during construction. All these machine-related factors affect on-site productivity indeed.

Payment plan (K1)

In evaluating this criterion, how much project parties reached a compromise on the cost loading distribution per unit time step or cash flow that includes advance payment and progress payments to be paid to a subcontractor is thoroughly considered.

Amount of subcontracting (K6)

Under this criterion, it is required that the amount of work to be performed with own forces of a subcontractor has a greater share in the subcontract package when compared with that to be transferred to sub-subcontractors. The more the number of multi-tier subcontractors, the harder the coordination and the higher the total project cost.

Amount of compensation for delay (K7)

The amount of compensation for delay is one of the most significant indicators of how strong a subcontractor undertakes to successfully deliver subcontracted works without experiencing any time extension. In this context, a main contractor can take into consideration the proportion of the compensation amount for delay per day to the estimated subcontract price in this criterion.

6. Conclusion

In the present research, subcontractor selection criteria that can be considered in international construction projects were presented under a structured selection process with three phases. As a result of the survey conducted, it was found out that the shortlisting stage is composed of a total of ten criteria where past experience is the most important criterion. The negotiation stage was found to contain seven criteria where knowledge of project and reliability are the most significant two criteria. Finally, the final selection stage includes a total of seven criteria where price is in the first rank in terms of importance. Overall, this study can have some implications from the perspective of researchers, industrial practitioners, and every kind of contractors in the construction industry.

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