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DETERMINING 'THE MOST ECONOMICALLY ADVANTAGEOUS TENDER' BASED ON CAPABILITY AND FEE-PERCENTAGE CRITERIA

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ABSTRACT. Early involvement of the construction team is increasingly utilized in demanding projects to incorporate versatile expertise in their planning. For public owners this is a challenge since they are obliged to use competitive, transparent team selection based on the 'most economically advantageous' criterion which ensures that both price and quality viewpoints are taken into account. In the case of early involvement, the price component naturally does not include the total price, but may consist only of the fee-percentages of competing service providers. This study examines such a selection situation in project alliancing in the European context and seeks to find a way to integrate the fee component in a multi-criteria selection system and determine reasonable fees for different levels of capabilities. The study builds on the performance difference between different capabilities, derived from a survey of practitioners, and determines an indifference curve arithmetically for the planning of a selection method. The influence of the owner's risk attitude and risk premiums are also considered exploratively based on the pricing methods of the theory of finance.

INTRODUCTION

It has long been the custom in construction to select service providers, especially contractors, solely on the basis of the lowest bid. The practice has led to adversarial relations and created problems in the sector thereby impeding its development. Pressures to renew the implementer selection come also from a broader cultural change: a value-added strategy is now being pursued also in infrastructure

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construction and more collaborative, relational project practices are increasingly applied in various forms (e.g. Lahdenperä, 2012b). A collaborative approach often also means early involvement of the key parties to the building process since traditional, sequential involvement of the parties does not allow mutual exchange of information and collaboration for the benefit of the project. Early involvement has also become part of governments' strategies (Valkenburg et al., 2008; Edwards, 2009; AAA, 2010; Government Construction Strategy, 2012).

As if it were not difficult enough to use price-inclusive multi-criteria selection in the later stages, applying it to early involvement is even more challenging. At that stage, the project is fraught with too much uncertainty which makes it difficult to estimate costs reliably. Due to the resulting risk premiums, it is not sensible to organize normal price-inclusive competition and fix the price in the early stages of project development.

Instead, the solution is to strive for an open process where the price (target cost) of the project is set later after a joint development phase by the owner and the selected team involved. However, it is not reasonable to ignore the cost and price elements totally even then and give the service provider disproportionate power to price the service/project subsequently. Actually, it is necessary especially for public owners to set constraints and/or a mechanism for price formulation also in the case of early involvement in order to comply with procurement directives (e.g. Directive, 2004) and their *most economically advantageous tender* criterion. This leads to a complicated set-up and is surely a challenge when the public bodies are obliged to treat tenderers equally and non-discriminatorily and act in a transparent way. Any failure may lead to laborious court proceedings, stoppage of work and damages to discriminated parties – and even more catastrophically – to a major delay in the start-up of an indispensable facility.

In this respect, the fees of participating companies are in key position. Although the direct costs cannot be estimated yet, it should be relatively easy to agree on percentage (or fixed) fees that include company overheads and profit considering that there is common understanding of which cost items are compensated as direct costs and which are not. The fee can represent the price component in competitive selection. The challenge is, however, that the direct costs

of competing companies or teams cannot be expected to be the same which makes the decision-making situation different from the more usual total price plus quality competition. Yet, the system has to support the maximisation of value for money. For that, it also has to be objective and impartial to entice tenderers and incentivise them to do their best – not only play 'lottery'.

This study aims to respond to the last mentioned challenge by developing a selection system that covers team capability as a qualitative measure and fee percentage only as a price component. The objective is to override the typical problem of approximation by grounding the approach on a strict, reasonable mutual relationship between price and value and keeping the system as simple as possible.

Although the approach under development is aimed to be of general value, the target application as to numbers and adjustment is a *project alliance* team selection (for an infrastructure project in Finland) where the *fee component* covers both *company overhead costs* and *profit* of the service providers. The study skips the examination of the quality/capability/competence assessment system assuming that it can take the form of a multi-criteria evaluation resulting in an overall score that will then be taken in account in the method resulting from this study to combine the fee and quality components.

The paper proceeds as follows. First, it focusses on the research question and determines the specific case for the study in more detail. After a literature review on the service provider selection methods, the study methods are rationalised. Then, the study continues to examine the fee-capability relation arithmetically arriving at formulas based on the figures from a survey of practitioners reported below. Finally, the result will be presented and its application in actual decision making will be pondered before a more general discussion and conclusions.

THE CHALLENGE SET BY THE APPLICATION

There are various forces driving towards further servitization of construction (Leiringer & Bröchner, 2010). Servitization, which means integration of additional services, knowledge and support to the supplier's core product offerings, also puts the firm face-to-face with

its customer (Vandermerwe & Rada, 1988) increasing thereby the importance of the relational mechanisms that supplement the contract (Hartmann et al., 2010). Studies aimed at fostering innovation in construction also stress the need for closer integration and improved collaboration (Blayse & Manley, 2004; Holmen et al., 2005; Rutten et al., 2009). Moreover, performance in demanding, risky projects could obviously be improved by joint risk management (Rahman & Kumaraswamy, 2002; Pishdad & Beliveau, 2010).

This integration of different kinds of competence is most beneficial in the early phases of the project when the potential to influence the design solutions of the project is the biggest and changes will not increase costs by as much as if implemented later in the process (Connaughton & Green, 1996; AIA, 2007). The reported experiences from early involvement are mostly positive (NAO, 2005; Valkenburg et al., 2008; Ballard, 2008; Song et al., 2009; Edwards, 2009; Mosey, 2009) especially when the team is involved with the intention of implementing the project until completion (rationalization for that is given by Lahdenperä [2010]). In such a case the public owner is presented with a major challenge as to the selection method.

The study case adheres to the above practice. More precisely, it is a project alliance for major transport infrastructure in Finland implemented under public procurement regulations (Directive, 2004; Laki, 2007). *Project alliance* is a project delivery method based on a *joint contract* between the key actors to a project (owner, designer, constructor) whereby the parties assume joint responsibility for the design and construction of the project to be implemented through a *joint organisation*, and where the actors *share* both positive and negative *risks* related to the project and observe the principles of information accessibility in pursuing close cooperation (Lahdenperä, 2009; Department of Infrastructure and Transport, 2011). The starting point is that the owner pays the costs as they accrue.

The project alliance system evolved from the need to improve the implementation of demanding and risky investment projects and it has broken through especially in Australia (DTF, 2006; 2009). In a project involving much uncertainty due to, for instance, new technology and project conditions or interfaces, risk premiums and/or adversarial and opportunistic behaviour characteristics of traditional contracting would lead to an uneconomical result from the viewpoint

of the owner (see e.g. Sweeney, 2009; Bajari & Tadelis, 2001; Bajari et al., 2013). On the other hand, the alignment of the parties' objectives by joint risk-sharing in a project alliance arrangement, supplemented by a joint organisation and decision making, is supposed to improve the performance more than early involvement alone.

There are many ways of forming an alliance team: all projects and situations require an individual solution. Yet, the service providers are often selected as a group since the aim is not to find the best players of a category but the best team (DTF, 2006; Department of Infrastructure and Transport, 2011). Thus, any competing team is supposed to have both experienced design and construction resources.

In the process, the competition entrants, who have been selected as tenderers, receive a request for proposal. After tenders have been submitted, the number of tenderers is reduced based on an assessment including interviews. Thereafter, two competing teams usually continue to the stage involving workshop tasks that are evaluated. The cost viewpoint is reflected in the selection primarily through the proposed method for control of the economy, presented budget critique and suggested development possibilities, but the concrete price criterion included is the mean of the percentage fees of the companies of the consortium weighted by work inputs. Selection is then made based on joint assessment of the team's capability and a fee quote. Then, selected service providers develop the project and its designs in cooperation with the owner before the actual target cost is set and the parties are ready to finally commit to the implementation of the project in question. Thus, target cost is agreed prior to the start of construction and termination is possible if the parties are not able to agree on, for instance, the target cost. The target cost is to be based on project/risk- and market-adjusted (or tested), audited direct costs of earlier projects and the fee quote by the selected team. The fee may be fixed (e.g. in Euros) or remain a percentage. After the completion of the project, the owner and service providers share the difference between the target and outturn costs.

Two characteristics of the selection process need to be emphasised. Firstly, evaluation of capability is a very in-depth, stage-wise process (cf. DTF, 2006; Lahdenperä, 2012a). It includes interviews (for shortlisting) and collaborative development workshops

(only for shortlisted candidates) with a psychologist involved in the evaluation – in addition to more usual criteria of past performance, know-how and experience of section managers, and project specific narratives on strategies, approaches and management plans. Secondly, the quote concerns the percentage fee only, not the overall price of the work, since the pricing of the project is not accurate in the early phase. The fee component is supposed to cover both *company overhead* costs and *profit* for the service providers and is based on the team member companies' fees weighted by their anticipated cost shares. The fee component is considered the minimum that satisfies the requirements of European public procurement regulations (Directive 2004).

The European perspective is emphasized in the study since the possibly different constraints in other parts of the world are not examined. It should also be noted that EU Directives are implemented by national laws (e.g. Laki, 2007) which may set stricter terms for public procurement. Therefore, it is not necessarily certain that the practice is applicable as such to all countries within the EU. In terms of public procurement legislation (Directive 2004), the described procurement practice is based on the stage-wise '*negotiated procedure*' where '*the most economically advantageous tender*' is the selection criterion.

In the target market, such a procedure was first applied in the procurement of design and construction services for the renovation of an existing rail section (Lielahti–Kokemäki) in 2011. It is a replacement investment of 90 km of rail transport infrastructure with a budget of about €100 million. Its relevance for this study is based on the fact that the parties involved in the selection process formed the knowledgeable target group of the expert survey carried out as a part of study data acquisition. Some features of the process, like accounting (division between direct and indirect costs, i.e. fee) and subsequent pricing systems, etc. are archetypical of industry-specific solutions and therefore a domestic reference project is of critical value to the study.

STATE OF THE ART AND RESEARCH DESIGN

Review of the Relevant Research

The challenge of selecting the best service providers for a construction project has generated a lot of research. Suggested 'sophisticated' methods range from cluster analysis (e.g. Holt, 1996) to fuzzy logic (e.g. Okoroh & Torrance, 1999) and the analytical hierarchy process (e.g. Fong & Choi, 2000). Beyond the selection methodology qualitative selection criteria and their mutual weighting have also been a topic for numerous studies (e.g. Hatush & Skitmore, 1997; Holt et al., 1994; Watt et al., 2010). Moreover, Sciancalepore et al. (2011) and Holt (1998) classify and introduce alternative methodologies while the author has also tried to do his factual homework (Lahdenperä & Sulankivi, 2001).

Suffice it to say that Holt (2010) has completed a relatively comprehensive review of the multifaceted research on contractor selection. As to the methods of selection, he concludes that in most cases they do not seem to facilitate selection but only replace the challenge of selection with another related to complex methods (cf. 'sophisticated' ones above); the development has been away from the needs of practitioners. Holt (2010) also questions the reliability of various methods while Sciancalepore et al. (2011) illustrate the divergence of the results of different methods in practice. It is clear that the methods may not promote attainment of economic advantageousness in selection while their transparency is also questionable. Thus, the lesson learned so far is to keep the system *as simple as possible*.

Considering the mass of studies on supplier selection, relatively few studies have focussed on the question of how to sensibly combine overall quality assessment and price for the determination of the best option in each case. Yet, the publication by Drew et al. (2001) began an impressive series of research efforts. The publication focussed on collecting, developing and comparing a variety of ('simpler arithmetic') price-quality aggregation formulations that proved to produce different rankings of tenderers. Similar results and/or conclusions have been presented by Dreschler (2009) and Waara and Bröchner (2006), who have examined the methods used with actual construction works. There are also other papers dealing with the challenge in a more general context (Lunander & Andersson, 2004; Bergman and Lundberg, 2013; Mak, 2012). None of them,

however, deal with the situation examined in this study where the fee percentage alone forms the entire price component.

Moreover, the above methods, like many practical guidelines (e.g. DBIA, 2000; Rakli, 2001; Tauriainen, 2007) seem to apply a relative scoring method, i.e. an approach where the tenderer earning the highest total points is selected and the component scores for competitors are calculated in relation to the lowest price or the highest quality tendered. In extreme methods, the lowest price earns maximum points and the highest price earns zero points while the points of other prices are interpolated (c.f. Meland et al., 2011).

A minor experiment with the relative methods illustrates clearly how they make selection sensitive to the lowest fee/price (or highest quality) offered. Even if the tenderer with the lowest fee is not selected due to the relatively fewer quality points he receives, his involvement may cause a situation where other competitors (with higher fee percentages) end up in a reverse order of preference compared to a situation where the tenderer of the lowest fee does not participate in the competition. Yet, this is not logical: the relative advantageousness of two proposals should be the same independent of other proposals if selection is based on economic criteria. The lesson learnt is, thus, to construct a *robust method* that does not change the selection criterion based on tenders.

In fact, Chen (2008) also points out that relative scoring results in serious shortcomings in the system's functioning and calls it a *ranking paradox*. Telgen and Schotanus (2010) state the same in even less uncertain terms: relative scoring methods will never guarantee that the selection is in line with the preferences of the buyer, as their exact form and position depends on the bids coming in; as such, relative scoring methods replace the preference of a buyer by a lottery. Chen (2008) concretizes his presentation by introducing the extra concept of *independence of irrelevant alternatives* reminding that the relative ranking of two alternatives must not be affected by a third alternative. There is also the danger of strategic manipulation involved in relative methods especially if the tenderers are allowed to make alternative proposals (Chen, 2008; Bergman & Lundberg, 2013).

In addition to the notice on diverging results, Drew et al. (2001) also point out that the large difference between price and quality scores in terms of variance is likely to lead to undervalue quality and

promote the influence of the price. Drew et al. (2002) try to find a solution to the problem, but conclude that there seems to be no ideal solution for correcting the price-technical score variability imbalance; therefore Drew et al. (2004) later end up suggesting a situation-related solution on the basis of past, real bidding data.

A sort of general solution to the price-quality score variability imbalance is suggested by Hiltunen (2007), who presents that the variation in price and quality points should be standardised (scaled to the same standard deviation) in each competition prior to summing them up into total scores: this way the impact of weights really remains mathematically as announced in the request for proposals. The problem now is, however, that the method no longer has anything to do with the assessment of the most advantageous tender. Instead – to summarise another lesson – according to economic criteria the method should be based on *value-for-money thinking,* which is not part of most methods of the practice.

Moreover, Waara and Bröchner (2007) state succinctly that proposer incentives should generally be stronger when an owner uses a transparent evaluation model. Telgen and Schotanus (2010) and Chen (2008) look at the issue in more detail and conclude that a fully transparent system is needed by the proposers to optimize their proposals to meet the owner's preferences. That, again, requires that the proposers are able to calculate the points for any level of a (pre-arrangeable) performance at the stage of tender preparation which is not possible with relative scoring or standardisation. Thus, the mutual relationship and scaling of fee and capability levels have to be fixed and unambiguous in the decision formula. In case law, Chen (2008) even found an indication that European procurement directives may not allow the use of relative scoring systems and may require a fully *transparent award system*.

All in all, it is quite clear that literature does not contain relevant, simple and robust awarding systems for the special case of this study, where fee is the only price component taken into account, although such a decision dilemma is nothing new in construction management and partnering projects (cf. ACA, 2008; Mosey, 2009).

Designing the study on the basis of a review

While the value for money approach has generally been neglected, in the case of fee-inclusive competition (excl. total prices)

its application is even more challenging due to the difficulty of price estimation. Here, the remarks by McCall (1970) and Rosenfeld and Geltner (1991) about the need to view the cost plus fee market side-by-side with the more common fixed price (competition) market are appropriate. As a result better players are available to cost plus fee projects only if they can expect to earn the same profit they would make in alternative markets, where the price level is basically the same for efficient and inefficient service providers. This results in fee differences: the best teams tend to use their better capacity to make money allowing the owner to benefit of it only to the degree necessary to ensure the contract. This is simply the result of operating in a market economy.

Therefore, in order to determine the *indifference curve* needed for the design of a selection method, the performance difference between the best imaginable, but realistic, and the weakest qualified performers (market extremities) is traced in an indifference situation. For that, two methods are used to challenge each other and to get a better picture of the dilemma. In the first one the value and price to the owner are both standardized and only direct costs and fees differ due to performance disparity, i.e. *the cost advantage method* from this point forward. In the other method the teams are given an equal sum to cover direct costs whereby the best team is supposed to supply more value to the owner, i.e. *the value advantage method*. Related calculation methods will be developed in the next study stage and presented in the next section.

The performance differences requested as input to the methods cannot, however, be easily measured in the real world of one-off projects where various other factors tend to contribute to any existing data. For that reason, the study is based on a survey of experienced practitioners who were educated for the very same selection situation as in the study in the reference project, i.e. the first of its kind procurement in the target market as explained above. Besides, the owner's preference for competing alternatives needs to be taken into account on a more theoretical basis since the owner may consider the acceptance of a higher fee risky while accurate information on preferences is missing.

The study constrains itself to the examination of a formula for drawing a conclusion based on overall capability evaluation and a fee proposal; it does not focus on detailed examination of capability more

than is necessary to (conceptually) determine the extreme performers. The capability assessment is assumed to be trustworthy as it is based, for instance, on the methods and procedures used in the reference project (see Lahdenperä, 2012a). It is an embodiment of commonly applied simple multi-attribute analysis or weighted grades methods which valid regulations (Directive, 2004) also tend to impose on public procurement. It is, therefore accepted here as a norm as to quality or capability. The qualitative criteria used are numerous, diverse and intangible and would require much more detailed discussion than is possible here.

BASIC FEE ELASTICITY CALCULATIONS

Cost Advantage Method

This section focusses on the performance difference between the supposed extremities, the 'weakest' and 'best' performers: first by the *cost advantage* method and then by the *value advantage* method. The target is to design a calculation model that allows determining a reasonable fee difference to be incorporated in the actual selection model that corresponds to the capability range, i.e. *fee elasticity*. In other words, fee elasticity refers to the change in a fee needed (allowed) to compensate a change in capability required to maintain the same level of overall competitiveness.

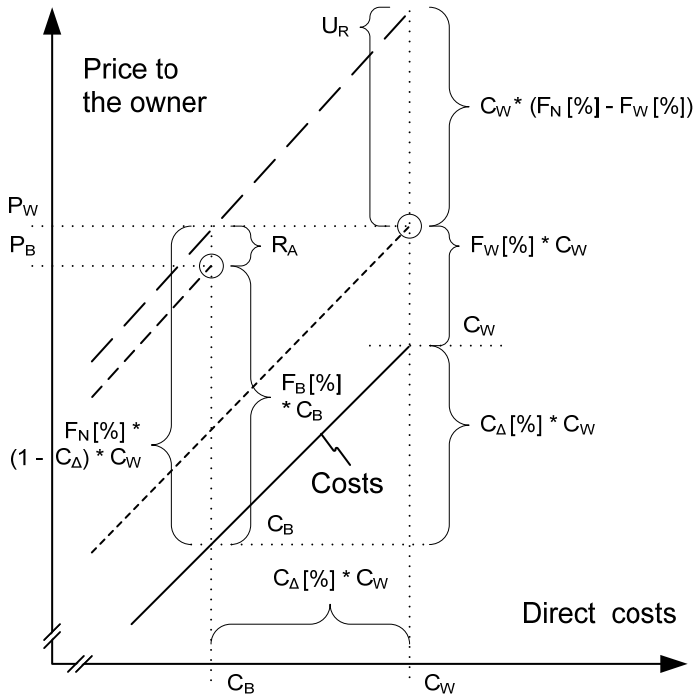
Figure 1 clarifies the presentation as concerns the cost advantage method as follows. A list of symbols is also given in the Appendix to facilitate reading. Let's start by looking at the case where a project is to be implemented by the weakest performer. Then, the direct cost (C_W, at the end of the fixed line in Figure 1) plus the team's fee percentage (F_W) form the price to the owner (P_W, short broken line):

$$P_W = C_W * (1 + F_W) \quad (1)$$

Correspondingly, if the best performing team is able to construct the project at lower cost without compromising quality, it can be said to have an *cost (efficiency) advantage* (C_Δ [%]) over the weakest performer while doing the same work at the price of P_B (medium broken line):

$$P_B = C_W * (1 - C_\Delta) * (1 + F_B) \quad (2)$$

FIGURE 1
Illustration of Calculations by the Cost Advantage Method



If the best performer is allowed to reap the entire cost benefit, its fee can be significantly higher than that of the weakest performer. In such a case the alternatives would also be of the same cost to the owner, i.e. P_W would equal P_B (e.g. P_W level in Figure 1). Since this assumption ignores risk attitude, as will be explained later, the situation is hypothetical – thus, F_B is replaced by F_N in Formula (2) to depict that 'neutral' case:

$$C_W * (1 + F_W) = C_W * (1 - C_\Delta) * (1 + F_N)$$

$$\Rightarrow 1 + F_W = (1 - C_\Delta) + (1 - C_\Delta) * F_N$$

$$\Rightarrow F_W + C_\Delta = (1 - C_\Delta) * F_N$$

$$\Rightarrow F_N = (F_W + C_\Delta) / (1 - C_\Delta) \quad (3)$$

In practice it is, however, unlikely that a conservative (public) owner selects the best performer on paper if it costs relatively as much as another option: the cost-oriented owner is not willing to pay that much for extra value, and moreover, there is no guarantee of better performance – which may require novel, still non-existent innovative approaches – yet the higher fee percentage would be fixed. In other words, the owner carries the risk related to the expected production efficiency. In such a case the owner may well require compensation for doing that in accordance with the general business practice.

A compensation, or absolute risk premium (R_A), means that the expected price of the best performer in the above case has to be lower than that of the weakest alternative (when comparable points are circled in Figure 1) so that:

$$P_W = P_B + R_A \quad (4)$$

Basically, the absolute risk premium is calculated as a share, i.e. relative risk premium (R_R [%]), of the underlying risk (U_R) – which, again, is the price difference (resulting from different fee percentages as also shown at the top of the Figure) when the best performer is no better than the weakest one in terms of direct costs ($C_\Delta = 0$ and C_W is, therefore, valid for both teams):

$$R_A = R_R * U_R = R_R * [C_W * (1 + F_N) - C_W * (1 + F_W)]$$

$$\Rightarrow R_A = R_R * C_W * (F_N - F_W) \quad (5)$$

If we return to Formula (4), and replace its parameters with the equivalents of Formulas (1), (2) and (5) respectively, it rewrites to

$$C_W * (1 + F_W) = C_W * (1 - C_\Delta) * (1 + F_B) + R_R * C_W * (F_N - F_W) \quad (6)$$

By dividing both sides of Formula (6) by C_W and by entering F_N of Formula (3) in it, the following ensues:

$$\Rightarrow 1 + F_W = (1 - C_\Delta) * (1 + F_B) + R_R * [(F_W + C_\Delta) / (1 - C_\Delta) - F_W]$$

$$\Rightarrow 1 + F_W = 1 - C_\Delta + (1 - C_\Delta) * F_B + R_R * [(F_W + C_\Delta) / (1 - C_\Delta) - F_W]$$

$$\Rightarrow F_W = - C_\Delta + (1 - C_\Delta) * F_B + R_R * [(F_W + C_\Delta) / (1 - C_\Delta) - F_W]$$

$$\Rightarrow (1 - C_\Delta) * F_B = C_\Delta + F_W - R_R * [(F_W + C_\Delta) / (1 - C_\Delta) - F_W]$$

$$\Rightarrow \quad F_B = (C_\Delta + F_W - R_R * [(F_W + C_\Delta) / (1 - C_\Delta) - F_W)] / (1 - C_\Delta) \qquad (7)$$

This is the way to determine the reasonable fee for the best performer (F_B) in relation to that of the weakest one (F_W) in an even case when actual estimates of cost advantage (C_Δ) and risk premium (R_R) exist.

Value advantage method

Let's suppose an alternative case where both service providers are given an equal amount of money to cover direct costs. In a competition situation the better performer should be able to provide a more valuable project to the owner. In line with the previous concept, this margin can be called a *value advantage* (V_Δ) describing the added-value (or quality) the best performer provides over the weakest one.

In the pursuit of reasonable fee elasticity, the starting point can be the value for money ratio (*VfM*), the ratio of the value of the team's contribution to the price to the owner. Based on Formula (1) it can be presented for both parties as follows:

$$VfM_W = V_W / P_W = V_W / [C_W * (1 + F_W)] \qquad (8)$$

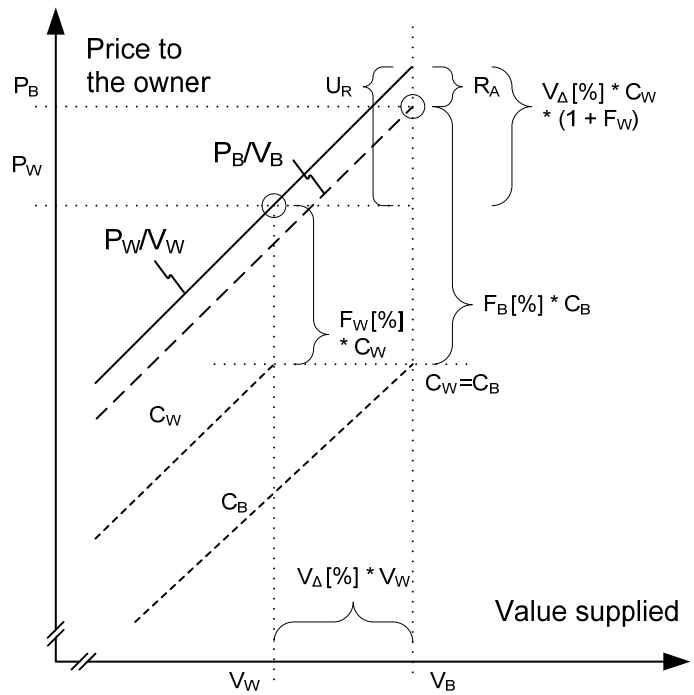
$$VfM_B = V_B / P_B = [V_W * (1 + V_\Delta)] / [C_W * (1 + F_B)] \qquad (9)$$

Should the alternatives be completely equivalent, the *VfM* ratio would be the same for both. Yet, due to the inclusion of the absolute risk premium (R_A) in the calculation, it is expected that the price of the better performer is lower by the amount of the risk premium than in a case where the alternatives actually are equivalent. In other words, the comparative monetary sum in VfM_B should be P_B plus R_A:

$$V_W / P_W = V_B / (P_B + R_A) \qquad (10)$$

In Figure 2 this formula is represented by two uniform triangles bounded by the P_W/V_W line (hypotenuse), the *V*-axis and vertical lines at V_W and V_B, respectively. The inverse of *V/P* is used there to comply with the more usual understanding of price as a function of the value produced.

FIGURE 2
Illustration of Calculations by the Value Advantage Method



In this case the definition of a risk premium is a little more straightforward than in the *cost advantage* approach above. In an equivalent case the relative price increase resulting from a change from party *W* to *B* would equal the relative value-added (V_Δ [%]) that can thus also be used as a measure of relative price increase. Thus, by multiplying the price from Formula (1) by this figure, we get the absolute price increase, i.e. the underlying risk (U_R). The absolute risk premium (R_A) is the product of the relative (percentage) risk premium and underlying risk calculated as follows:

$$R_A = R_R * U_R = R_R * [C_W * (1 + F_W) * V_\Delta] \qquad (11)$$

If the resulting premium (11) is placed in Formula (10) together with the elements of Formula (8) and (9), we can continue as follows.

$$V_W / [C_W * (1 + F_W)] =$$

$$[V_W * (1 + V_\Delta)] / \{C_W * (1 + F_B) + R_R * [C_W * (1 + F_W) * V_\Delta]\}$$

By multiplying both sides by C_W / V_W, etc.

$$\Rightarrow 1 / (1 + F_W) = (1 + V_\Delta) / [1 + F_B + R_R * (1 + F_W) * V_\Delta]$$

$$\Rightarrow [1 + F_B + R_R * (1 + F_W) * V_\Delta] / (1 + F_W) = (1 + V_\Delta)$$

$$\Rightarrow 1 + F_B + R_R * (1 + F_W) * V_\Delta = (1 + V_\Delta) * (1 + F_W)$$

$$\Rightarrow 1 + F_B + R_R * (1 + F_W) * V_\Delta = 1 + F_W + V_\Delta + V_\Delta * F_W$$

$$\Rightarrow F_B = F_W + V_\Delta + V_\Delta * F_W - R_R * (1 + F_W) * V_\Delta \qquad (12)$$

This is the way to determine a reasonable fee for the best performer in relation to a known fee level for the weakest performer when estimates for *value advantage* (V_Δ) and risk premium (R_R) exist.

Defining the risk premium

Although risks are project-specific, information on the nature and extent of cost uncertainty in a construction project is provided by studies that compare actualised project costs to budgets (Flyvbjerg et al., 2002; Cantarelli et al. 2012; Love et al, 2012b) or contracted costs (Love et al. 2012a) in a number of projects. Yet, even studies that examine the impact of various project features on uncertainty (e.g. Flyvbjerg et al, 2004; Odeck, 2004; Aibinu & Pasco, 2008; Creedy et al. 2010; Bhargava et al. 2010; Park & Papadopoulou, 2012) do not assess the related role of varying capability. Moreover, the price increase mechanism triggered by design deficiencies and opportunistic behaviour in traditional competitive award projects (cf. Bajari et al., 2013; Chong et al., 2010) may hinder the use of these results in risk-sharing projects making this line of research of little use here. Neither is it necessary since possible deviations in uncertainties are already included in the expected performance differences between capabilities.

The risk notion referred to and needed here is, instead, related to the parties' risk attitude. According to decision theory a risk adverse decision maker expects a risky option to produce a bigger benefit than its certainty equivalent; this difference is called a risk premium (Keeney & Raiffa, 1993; Clemen, 1996). The theory of finance is in agreement: the bigger the business risk, the larger the compensation

expected by the party assuming the risk. Here, underlying price risk (U_R) is considered the incremental amount the owner has at stake when selecting the potentially best performer, i.e. a sum the owner expects to receive a return on. In finance, the capital asset pricing model (*CAPM*), obviously the most used valuation method, is used to determine the required rate of return on an asset (e.g. Fama & French, 2004; Damodaran, 2009). It determines the expected rate of return as the sum of a risk-free rate of interest and the product of systematic risk and the difference between the expected market rate of return and the risk-free rate of return:

$$E(R_i) = R_f + [E(R_M) - R_f] * \beta_{iM} \qquad (13)$$

where $E(R_i)$ = the expected return on asset *i* [%]

R_f = the risk-free interest rate [%]

$E(R_M)$ = the expected market rate of return [%]

β_{iM} = the market *beta* of asset *i*

$E(R_M) - R_f$ = the equity risk premium (*ERP*), i.e. expected market rate of return in excess of the risk-free rate [%]

In other words, the expected return on any asset is the risk-free borrowing rate plus a specific risk premium. In this work we are not interested in pricing assets but only in finding a relative, industry-related estimate for operation risk which is (tentatively) given by the product of *beta* and the market risk premium in Formula (8) above. The risk-free component can be ignored since the time-value of money as such has no meaning here: the owner does not make an actual deposit and the payment to an alternative service provider actualizes according to the same schedule. Moreover, the uncertainties of individual years make up overall uncertainty.

Therefore, in terms of the above parameters, the relative risk premium is simply as follows:

$$R_R = ERP * \beta_{iM} \qquad (9)$$

It should, however, be noted that although the study is grounded in the CAPM, the above approach is only made reasonable by a more recent approach to company-specific risk determination that has evolved from the CAPM community as explained in the section on initial data below. The degree of risk refers to that carried by 'an

average' company of the industry. Otherwise, the application of the method here is based on certain assumptions whose applicability is explained in more detail in Discussion to keep the presentation simple and understandable.

ACQUISITION OF INITIAL DATA

Questionnaire Survey for Determining Performance Levels

A questionnaire survey was conducted to gather the practitioners' views on the estimates on the cost and value advantages (C_Δ, V_Δ) of the above formulas and the likely actual range of fees. The target group consisted of the key personnel involved in the first ever project alliance competition in Finland which used the type of selection criteria that are the subject of the study. Thus, the respondents can be considered to be familiar with the subject and the decision making situation in general. A survey was carried out just after the completion of the team selection process when the respondents could still remember the essentials (pricing issues, cost structures, etc.). Altogether 74 owner's representatives, owner's consultants, and competing designers and contractors were sent a link to an Internet questionnaire. A total of 32 responses were received.

The overall survey covered a considerably broader field than is dealt with here (see Lahdenperä, 2012a), but the questions relevant to this study were the following (in condensed form):

- *Question 1a*. If the goal was to reap the added value generated by the best team only in the form of project cost savings (excluding implementer fees) with quality and other benefits remaining the same, how much lower would the costs [%] of the best, but realistic, implementation team be compared to the weakest possible one that nevertheless meets the minimum suitability criteria of a demanding project?
- *Question 1b*. If the goal was to reap the added value generated by the best team only in the form of better quality and other benefits than lower investment costs (yet incl. lower life-cycle costs) with allowance for direct costs remaining the same, how much higher would the value [%] of the best, but realistic, implementation team be compared to the weakest possible one that nevertheless meets the minimum suitability criteria of a demanding project?

- *Question 2a–b*. In the case of a typical project suitable for delivery under an alliance contract in a normal economic situation, what is the broadest realistic average range of fee percentages [a%–b%] for different bidding consortia (considering that a quote is requested at the end of a laborious selection phase when polite and test bids are unlikely)?

Table 1 presents the results of the survey. As to cost advantage (C_{Δ}), for instance, 17% is a reasonable basic value for the analysis based on the survey. Yet, the calculated margin of error (for 95% confidence level) makes it necessary to extend the analysis to include also the extremity values of 13% and 21% (i.e. basic value ± margin of error). The suggested fee range is from 10% to 20% in the studied case.

TABLE 1
The Results of the Survey

Question	1a	1b	2a	2b
Parameter	Cost advantage	Value advantage	Lowest fee%	Highest fee%
Number of responses	26	26	24	24
Average response	16.84	18.54	10.21	20.25
Standard deviation	10.02	12.95	5.45	8.58
Margin of error	3.85	4.98	2.18	3.43

Interestingly, the representatives of public owners (4 persons) estimated both advantage differences to be clearly larger than private service providers. Especially the contractors, the biggest group (12), made lower estimates while owner's advisors (3) and designers (7), in general, fell between these two groups.

Literature survey for determining risk premium

There seems to be no unanimity about how risk premiums should be determined. Moreover, there are significant differences between time periods, sectors, sizes of business, and geographical areas and/or countries. While detailed discussion on the topic is beyond the scope of this summary, the study rests on the following findings:

- Historical data over a century or so indicates that enterprise risk premiums (*ERP*) have typically been around 6–10% globally (Damodaran, 2011; Nyberg & Vaihekoski, 2011). Limiting the review to recent decades, however, reduces the figures significantly, typically by half. Correspondingly, those recommending their use tend to consider lower rates reasonable. For instance, the average view of chief financial officers (over a 10 year investment period) has typically remained within 3−4% in recent years (Graham and Harvey, 2010).
- *Beta* varies between businesses significantly and, thus, it is reasonable to look at the figures of the engineering and construction, and, especially, heavy construction sectors when the target is to develop practices for the infrastructure sector. As most economic key figures, (unlevered) *betas* (β) fluctuate over the years and vary between markets: the range has been from ½ to 1½ (Damodaran, 2012). However, it has been suggested that the so-called *total beta* be used for undiversified owners of businesses, which would give us approximate *total beta* values from 1 to 4, respectively (Damodaran, 2012).

Considering expert opinions and the recent trends against the long-term historical trend, the average range of *ERP* is 3−5%. The relatively short duration of the typical construction project for which the risk premium is defined would suggest a lower figure – the longer the period, the higher the premium. Moreover, contracted work does not involve the risk of getting deals which is built in *CAPM* pricing. On the other hand, an individual project is subject to significantly bigger risk than a portfolio of projects where the projects tend to vary in terms of success; their successes and failures often roughly offset each other. The initial range can thus be considered appropriate.

As concerns the value of *beta*, here we deal with a stand-alone asset, to which *total betas* are applied, i.e. 'standard' beta divided by the correlation of volatilities of the stock and the market (Tofallis, 2008; Butler and Pinkerton, 2008; Damodaran,2009; Butler et al. 2011). This way the total risk related to a company working in the said industry can be estimated and valued, including idiosyncratic risk. Similarly, we are not dealing with traditional CAPM and related systematic risk and diversification issues. From the owner's viewpoint, it is reasonable to focus on total company risk as the best,

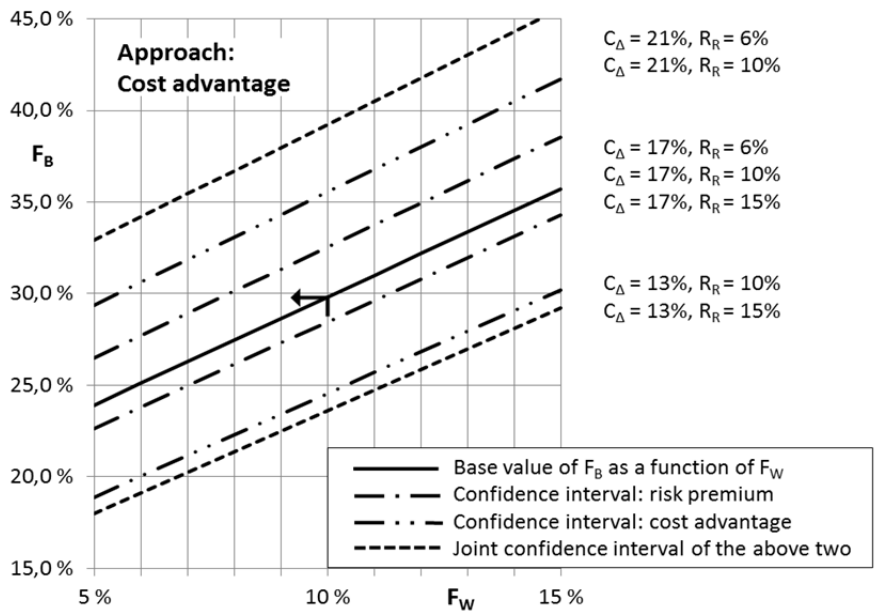
rough estimate of the risk related to its operation. Values 2−3 tend to be reasonable for the sector.

In summary, multiplication of the extreme *total beta* (2–3) and equity risk premium values (3%−5%) according to Formula (9) produces a wide range (6%−15%) while the middle values yield a basic value of 10% for further calculations.

RESULTS OF THE STUDY

By using the above determined Formulas (7) and (12) together with estimates for *cost advantage* (C_Δ) and *value advantage* (V_Δ) derived from the survey (basic values of 17% and 19%, respectively) and the relative risk premium (R_R) produced by the theoretical examination (10%), a reasonable F_B´s can be calculated as a function of F_W as presented by the solid lines in Figures 3 and 4.

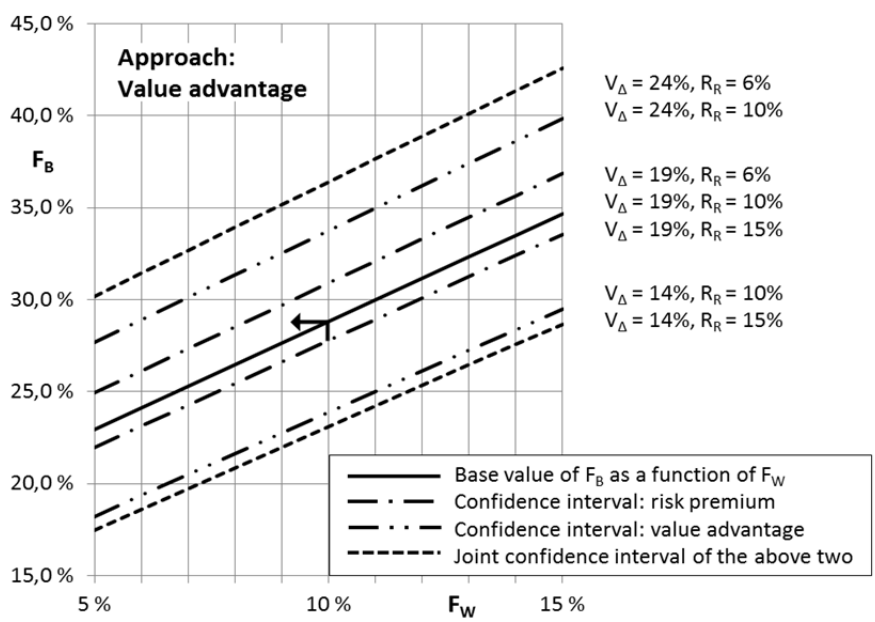
FIGURE 3
Fee Ranges Equivalent to Capability Variation Based on the Cost Advantage Method



The figures show how the difference between F_B and F_W in an indifference case – or *fee elasticity* (E_F) in terms of the study – is nearly a constant 20 percentage units across the scale irrespective of the magnitude of F_W, which is an important observation from the viewpoint of the development of the selection method. At the obvious lower limit (F_W) of 10% (see Table 1) the range is 19.8 units in case of the *cost advantage* approach and 18.8 units with the *value advantage* approach (as illustrated by arrows in the figures). Also at the extreme F_W values of Figures 3 and 4 (5%, 15%) the range deviated from the said basic range less than 1 percentage unit in both cases.

Varying of the parameters (C_Δ, V_Δ, R_R) between the extreme values (as a consequence of the margins of error of the survey and the ambiguousness of the risk premium examination) provided other estimates for F_B as illustrated by the broken lines of the figures. Confidence intervals are given separately for risk premium and

FIGURE 4
Fee Ranges Equivalent to Capability Variation Based on the Value Advantage Method



efficiency advantage while the extreme lines illustrate their joint intervals. Due to the explorative nature of the risk premium examination (explained in detail in Discussion), the 0% (or 'no-premium') option is presented as a minimum value to describe a situation where the owner does not oppose a higher fee.

Thus, fee elasticity could be lower or higher than the later suggested basic 20 percentage units. Sensitivity analysis shows that the reliability of the study is not excellent and much room for speculation still remains as becomes obvious in the next section.

Correspondingly, the *indifference curve* is any line from a point defined by the lowest performance level and a certain fee to a point defined by the highest performance level and a fee that equal to the former fee plus the fee elasticity. Thus, application of the research result is basically very simple. For instance, if the competing teams are evaluated based on their capability on a scale from 0 to 100 (S_C) depicting relevant industry extremities (not extreme tenderers), the same scale is used for scoring the fee (S_F) as follows:

$$S_F = 100 - 100 * (F_I - F_L) / E_F \qquad (16)$$

where F_I = the fee (of tenderer I) to be scored
F_L = the lowest fee tendered
E_F = fee elasticity

Fee elasticity has to be decided project-specifically based on the above numbers (and considering the comments below). The highest total score ($S_T = S_C + S_F$) determines the best option.

DISCUSSION

The respondents to the survey were experienced professionals and obviously also aware of the targeted decision situation where their views would be made use of since they had just participated in a similar competition. They obviously also had the experience demanded for a valuable view: 81% of the respondents had at least ten years and 32% at least 20 years of experience from practical construction projects. Yet, the relatively wide deviation in efficiency advantage views resulting in a wide margin of error in the combined estimate tends to lower the reliability of the study.

And verification of the estimate is not easy due to the lack of relevant comparison views and/or data. Yet, there is at least one

work that has traced the efficiency difference between extreme performers for compiling a contractor selection system (Rakli, 2001). It suggests that the capability/risk range is equal to a 16% cost difference; the range is based on a joint estimate by a group of construction clients. The estimate concerns, however, the traditional design-bid-build contract whereas in project alliance the team has considerably more leeway to influence the success of the project. Therefore the efficiency advantage should basically also be much bigger. Yet, the relatively higher standard of prequalification is likely to even out the difference by and large (as the surveyed 17% and 19% advantages indicate).

On the other hand, the owners' own views did support even larger elasticity figures than those of the entire group of respondents – and owners especially should be in a position to know the performance differences best. It may be, however, that their estimates are based on bid prices which are affected by other pricing factors besides the actual performance difference. Thus, estimates based on the responses of the entire group are considered more appropriate, especially due to the small number of respondents from the owner category.

As concerns owner's risk aversion, practical examples of such behaviour exist: price is often valued over quality (e.g. Drew et al., 2001; Waara & Bröchner, 2006; cf. also Tversky & Kahneman, 1991) and teams asking a high fee tend to be excluded from the actual tendering stage in alliancing (e.g. VicRoads, 2012). The owner may also argue for low fees in the request for proposal documents (e.g. RMS, 2012). The world of fees and parties' risk attitude is, however, unexplored which favours the exploratory method used.

This way, however, the equity/debt ratio typical to the industry transfers to the risk valuation of the study. Correspondingly, the method also overestimates the premium (by increasing equity beta significantly due to leveraging). This means that the premium yielded by the approach (R_R = 10%) is more of a theoretical maximum limit than a likely value. This is why the other limit of the confidence interval was calculated without a premium (R_R = 0%): the 'truth' is expected to lie somewhere between these limits (i.e. 19.8…22.5 by the cost advantage method and 18.8…20.9 by the value advantage method).

All in all, we are dealing with a tentative, exploratory way of estimating the magnitude of the owner's premium and discussing its role in bridging the gap of missing information. The estimate of the risk premium was also based on business risk instead of operational risk which is naturally an approximation. However, so many variables are open to interpretation that chasing a more exact figure for the premium would be nonsensical without thorough investigation of project risks and, especially, the owner's risk attitude, besides the cost and value advantages.

Even the variation of the owner's risk premium by the used method shows, however, that the significance of risk attitude usually remains relatively small compared to the performance difference between the extreme performers. It can also be expected based on the study that the magnitude of the premium or advantage has no impact on the structure of the grading method of the fee percentage.

It is also possible that the respondents are not able to distinguish a team-related performance variation from other accidental or project-related variations whereby the estimated cost efficiency advantage becomes unreasonably large. This being the case, public owners may well prefer lower fee elasticity than suggested by the basic value since they tend to be conservative considering the tradition of price-oriented selection and public accountability. In other words, the owner may undervalue the anticipated better performance itself since it is not guaranteed while the possibility of financial loss, once the fee (percentage) has been accepted, becomes irreversible. Even then the owner should not, however, lower fee elasticity substantially: the calculations have already taken the risk into account and anyway the owners' view suggests even larger fee elasticity values.

The review of actual fee percentages on a theoretical basis would be too speculative due to the different cost structures of types of business and alliance and other project delivery systems. Yet, the first two transport infrastructure alliance competitions yielded four fee proposals varying from10–15% though most were in the upper end of the range because the proposers were best in their class (only two finalists per competition submitted fee quotes; Finnish Transport Agency, 2011b; 2012). This gives no reason to suspect the level of the lower limit in the current market situation but indicates that a project-specific range may not be as wide as thought by the respondents, i.e. from 10–20 percentage units.

Since the fee range indicated by the proposals is narrower than that suggested by the survey, the latter can be considered a tentative one within which fee elasticity must normally remain. Based on this fact and the above arguments, fee elasticity of about 0.20 can be considered an appropriate basic value based on the study. However, it must be noted that in order to use such fee elasticity figures, the capability scale has to be extended to cover innovation potential not yet realized or even considered feasible. Thus, top capability points, which only could justify the highest fees, are extremely rarely, if ever, earned. On the other hand, the shortlisting to two (or three) candidate teams usually means that teams with relatively low capability scores are not among those quoting a fee. For instance, in the mentioned two alliance competitions the differences between summed up raw capability scores were 4 and 14 points (Finnish Transport Agency, 2011b; 2012). These figures would correspond to only 0.8 and 2.8 percentage unit differences in team fees in a case where a fee elasticity figure of 0.20 is used.

Fee elasticity (E_F) forms the denominator of Formula (*16*) and hence substitutes the lowest fee (F_L), which was used in the otherwise identical formula for scoring in the reference project (Finnish, 2011a). It is easy to notice that the team making the lowest fee quote earns 100 points in both cases while the scores for the other teams differ (excl. special cases).

Thus, the original method imitates those referred to earlier (Drew et al., 2001; Dreschler, 2009; etc.) where a component grade for competitors is calculated in relation to the lowest price. These methods are generally questionable due to the critique presented above (see Chen, 2008; Telgen and Schotanus, 2010), and even more so in determining the scores for the fee-percentage. Firstly, the method makes scoring unreasonably sensitive to 'suicide' pricing when a small decrease in the lowest fee makes the scores of other quote(s) much lower: not only by moving it (them) further away from the lowest fee but also by narrowing the scoring range at the same time. Such a double loss would most likely prevent attracting the best teams to tender considering the above presented ideas of Rosenfeld and Geltner (1991) concerning the other options in the market. The fee percentage already constitutes a share of the overall price and relating the fee differences to this small, coincidental figure makes the system unreasonably sensitive to accidental errors. The scoring

method of the reference project also illustrates why the owner's risk attitude in the study was based on a theoretical construction instead of a survey: a biased foundation cannot be built on. The decision-making situation may be so demanding that it can lead to totally illogical responses.

Secondly, there seems to be no indication that varying fee levels (due to economic fluctuation and different cost structures of projects, etc.) have any substantial influence on the fee elasticity reflecting varying capability levels. Therefore, the grading system should primarily be based on a constant range (i.e. E_F) instead of, for instance, one changing according to the economic situation. Correspondingly, no weighting is needed with capability and fee scores, which ensures the targeted *simplicity*. When the formulas are revealed in a request for proposals document, the model is *transparent* and allows tenderers to calculate the score for any potential performance combination in relation to other options thereby avoiding the *reference paradox*. Moreover, the method as an entity is based on *value for money* thinking.

CONCLUSIONS

There seem to be strong indications that early involvement of the key players of a construction project is often worthwhile in case of large, highly complicated and risky projects. There the candidate teams' capability and potential are subjected to a thorough review. Performance in reference projects, skills and the chemistry within the project team, management and development approaches and the ideas for improvement and cost savings will be examined thoroughly. Only then can a reasonable, knowledgeable decision on the service providers be made.

Yet, that it is not enough. If early involvement is chosen, it is certainly better to fix the fee than leave all price components open to negotiation with selected service providers. Therefore, both capability and the fee become criteria for competitive selection. In fact, that is the only way public owners usually are able to apply early involvement in major projects due to procurement rules and/or probity auditing.

Such a competition scheme has not been actively discussed, but one guide (Department of Infrastructure and Transport, 2011) states clearly that selection that is biased towards competition on proposed

fees is not recommended. The used argument is that the fee is only a small component in creating the potential to satisfy the owner's needs and that simply reducing profit and/or margins is counterproductive to optimising actual out-turn cost outcomes: it discourages proponents from applying their best resources and/or service providers may be incentivised to develop and implement a suboptimal project solution that reflects their lower indirect overhead rather than a lower total cost.

Although the argument as such is indisputable, it should not be considered a valid reason to kill off capability plus fee competition, but a reason to avoid assigning an unreasonably big weight to fee variation in the selection. This being the case, a balance has to be found between the fee and capability components in an award system so that any change in them impacts the overall score in proportion to its real impact on the owner's value for money ratio – a fact forgotten in many academic and practical 'lottery' applications. Only then, however, the system can truly serve decision making based on the *most economically advantageous* criterion, incentivise the industry for better performance and enhance the actualization of the owner's objectives. And this is where the study at hand steps in with its relatively simple method, aimed to be easily understood and accepted by practitioners. To the best of my knowledge, a similar systematic effort has not been made before.

The results, or actually the numeric values for fee elasticity, are not definitive or universal solutions, but have been shown to be reasonable for the selection of an alliance team for the design and construction of Finnish transport infrastructure projects. Yet, we are talking of an initial solution which deserves to be developed as knowledge and experience accumulates. For other projects, market areas and industries, the figures may have to be adjusted to start with, but the developed approach is assumed to work also there. The evaluation and scoring system for capability must also be developed very carefully.

The survey completed as a part of the study also indicates that practical fee variation may not be as wide as could be justified by the variation in the team performance. That leads to capability being the primary means of competition and key determinant of awarding the contract when the method of this study is used in selection. That, again, means that the owner can expect to attract highly competent

teams for his/her projects and benefit from the procurement system. This being the case, use of the system indirectly fosters also development of the sector. This, again, would be very welcome and support the expedient of the approach.

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APPENDIX: NOTATION

C_B = Direct costs for the best performer
C_W = Direct costs for the weakest performer
C_Δ = Cost advantage of the best performer [calculated from the cost of the weakest performer; %]
$E(R_i)$ = The expected return on asset *i* [%]
$E(R_M)$ = The expected market return [%]
E_F = Fee elasticity
ERP = Equity risk premium
F_B = Fee of the best (assumed) performer [share of the direct costs; %]
F_I = Fee of the tenderer in question at the time [share of the direct costs; %]
FL = Fee of the lowest (actual) tenderer [share of the direct costs; %]
F_N = Fee of the best performer in a notational case all the cost efficiency advantage is given to it [share of the direct costs; %]
F_W = Fee of the weakest (assumed) performer [share of the direct costs; %]
P_B = Price to the owner in case of the best performer
P_W = Price to the owner in case of the weakest performer
R_A = Absolute risk premium
R_f = The risk-free interest rate [%]
R_R = Relative risk premium [%]
S_C = Score of the capability component of a proposal
S_F = Score of the fee component of a proposal
S_T = Total score (sum of capability and fee scores)

U_R = Underlying risk
V_B = Value supplied by the best performer
VfM_B = Value for money ratio reached by the best performer
VfM_W = Value for money ratio reached by the weakest performer
V_W = Value supplied by the weakest performer
V_Δ = Value advantage [calculated from the value supplied by the weakest performer; %]
β_{iM} = The market *beta* of asset *i*