A Practical Tool for Assessing Best Value at the Procurement Stage of Public Building Projects in Korea

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Abstract: This paper presents a practical tool for articulating best value criteria during the procurement of public-sector building projects in Korea. Data is obtained from sampling 180 stakeholders drawn mainly from a pool of government construction and project management experts in the Republic of Korea. The Analytical Hierarchy Process (AHP) is employed to rank emergent value criteria. The study finds that best value judgments are (1) multi-faceted assessments of stakeholder most needs, (2) mitigated by project characteristics, and (3) span functional and aesthetic considerations.

Keywords: Best value; Construction management; Analytic hierarchy process; Korea

Introduction

Procurement of public sector construction projects in Korea has traditionally been based on a system of qualification evaluation. Driven mainly by legislation introduced in 2006 and enforced from 2010, all new public sector projects with capital costs exceeding US$30

million in Korea must be procured under the notion of 'best value'. In 2011, with the exception of projects already being procured through the design- and- build (D&B) route, this mandatory threshold was raised to US$100 million. Although being the case, concerns still remains not only about the viability of a procurement philosophy that narrowly emphasises price over overall project characteristics, but also about a lack of appropriate evaluation procedures. There are a number of reasons for this including its vagueness and subjectivity particularly in non-price criteria weighting (Kashiwagi and Byfield 2002) and a limited number of available objective models that are able to inform decision makers on the appropriateness of best value as a procurement philosophy (Yu and Wang 2012). Taking stock of the earlier highlighted challenges with best value evaluation procedures in Korea, a research question is presented: *How can best value be articulated in Korean public-sector building construction?*

Setting out the study

Best value judgements within the public sector are particularly complicated due to the myriad of interest groups and stakeholders involved in public-sector construction projects (Arlbjorn and Freytag 2012). Compared to private sector projects, construction projects in the public sector are also more likely to be subject to multiple objectives, thus the importance of multi-criteria decision analysis and trade-offs amongst various criteria and performance evaluation systems. Arguably we should then look to their aggregation, conceiving this as assessable via specific metrics or models, as key to enhancing best value procurement.

The Study

A total of 6 main needs criteria and 34 sub-criteria relevant to best value judgements in building construction procurement were identified (Table 1). These derive from a synthesis and cross-mapping of key themes that employed text mining (see Salton and McGill 1986), based on extant literature (McDougall et al. 2002; Yu and Wang 2012) and handbooks. These sources included:

- *Building Quality Assessment (BQA),* a tool that assesses against nine categories how the performance of a building meets requirements identified by specific user groups (Clift 1996).
- *Serviceability Tools and Methods (STM),* which serves as a means of assessing both building occupancy needs and serviceability requirements (Davis et al. 1993a, 1993b).This assesses building occupancy needs against 96 sub-criteria and serviceability requirements against 115 sub-criteria.
- *Post-occupancy Review of Buildings and their Engineering (PROBE*), which employs a Building Use Studies (BUS) survey measured against 49 sub-criteria to examine how satisfied building occupants are with internal conditions of buildings (Cohen et al. 2001). Such surveys aim to provide substantial feedback to building services engineers on user satisfaction.
- *Building in Use (BIU),* which evaluates workspace by how occupants perceive the physical environment. Its primary objective is to support the planning and allocation of resources required for building maintenance (Vischer 1996).
- *Total Building Performance (TBP)*, which assesses building performance on criteria including spatial quality, thermal quality and acoustic quality (Hartkopf et al. 1986).

[INSERT TABLE 1 ABOUT HERE]

Pilot study

An initial pilot study was undertaken to check the suitability of the identified needs and criteria. For the pilot study, the identified needs and criteria were presented to a panel selected from the expert pool system of the Korea Institute of Construction & Transportation Technology Evaluation and Planning which supervises construction-related Research & Development programmes in Korea. The respondents were also invited to comment on the relevance, coherence and clarity of a proposed questionnaire developed from criteria and sub-criteria listed in Table 1.

The revised questionnaire

The revised questionnaire that emerged from the pilot study then formed the basis for gathering data to determine the relative importance of each identified need and criterion.

The questionnaire was structured as follows. The first part (questions one to four) consists of general demographic questions. The second part comprising questions examined the significance of the 6 main criteria of best value identified from literature. The results obtained from this section formed the basis for calculating weightings for each criterion. In the last section of the questionnaire, respondents were invited to rank the importance of the 6 main criteria. The response categories for all the questions were assessed against a five-point scale (Likert 1932) scale ranging from '1' = '*Not important at all'* to '5' = '*Very important'*. For the scoring of consistency, a score above '3' on a question

represents a favourable opinion of needs. The higher the score above '3', the more favourable the response was towards each criterion. Conversely, a score below '3' represents a negative opinion of each need.

Obtaining data from the questionnaire

A total of 180 questionnaires were emailed between April and June 2011 to respondents drawn from: (i) the experts' pool system of the Korea Institute of Construction & Transportation Technology Evaluation and Planning, (ii) the staff of the Ministry of Land, Transport, and Maritime of Korea, and (iii) staff from the Korean Government Buildings Management Services. Altogether, 130 completed questionnaires were returned. The relatively high response rate is explained by facilitation of data-gathering by the Board of Audit and Inspection of Korea.

Research Analysis

Treatment of questionnaire data

The five-point scale (Likert 1932) was selected as is easy to interpret. In the survey, all items in Part 2 of the questionnaire were measured ordinally while all criteria were first calculated by mean score ratings.

Data analysis

Questionnaire data was analysed using SPSS/PC+TM version 12 and Microsoft Excel software. Descriptive statistics were used to determine standard deviations, maximum and minimum scores of the sample as a whole, and the mean score. The degree of importance was arranged in descending order in order to determine the criteria that the respondents

deem pivotal in the achievement of best value. In order to extract important criteria and to identify the differences among the respondents, data analysis consisted of the following: (i) selection of important criteria among the identified criteria by *t*-test; (ii) and the application of Mann-Whitney *U* test and Kruskal-Wallis test to examine demographic differences of importance among the respondents. To select the important criteria, a *t*-test analysis was conducted in order to check the mean of selected criteria based on whether the population considers the criteria to be significant or otherwise.

Findings from the questionnaire survey

Respondents were asked to rank the importance of 6 main criteria and 34 sub-criteria. The *t*-test results of the main criteria (Table 2) showed that five criteria ('*serviceability'*, '*safety'*, '*comfort'*, '*environmentally-friendly'* and '*economic-feasibility'*) were considered by the respondents as important best value criteria. However, '*artistry'* which included building appearance and colour, was judged as unimportant at a 5% significance level with a *t*-value (≥ -1.737). A possible explanation for this finding is that while many European countries consider public buildings as cultural assets and elaborate the artistry of such buildings, public buildings in Korea have traditionally been considered simply as functional assets designed to support economic growth. Two of the main criteria, '*serviceability*' and '*safety'*, were considered marginally more important than '*comfort'*, '*environmentally-friendly'*, '*economic-feasibility'* and '*artistry'*. The highest ranking value criterion was '*serviceability'*. Perhaps this finding is not surprising noting that building assessment systems such as POE (Post Occupancy Evaluation) and BQA (Building Quality Assessment) emphasise the functional roles of buildings. From the results of the Mann-Whitney *U* test and Kruskal-

Wallis test, no significant difference was found among various demographic groups for rating main criteria.

[INSERT TABLE 2 ABOUT HERE]

In terms of the 34 sub-criteria, '*fire resistance*' (4.40), '*accessibility*' (4.31), '*operational cost*' (4.28), and '*ventilation*' (4.25) were the four highest ranked sub-criteria. The process of ranking the sub-criteria commenced with an examination of the 6 sub-criteria in the serviceability category and the *t*-test results (refer to Table 3), showing that all sub-criteria except '*flexibility*' were significant since the *t*-values of other sub-criteria were greater than 1.645 ($t \geq 1.645$). The sub-criterion '*accessibility*' was ranked as having highest importance in this category with the highest mean score of 4.31. The result perhaps supports decisions to locate many public buildings within city centres to ensure widespread accessibility.

[INSERT TABLE 3 ABOUT HERE]

In summary, the aim of the first part of the data analysis was to identify criteria for value-based assessments of public building construction in Korea. To determine levels of importance, arithmetic means and rank orders of the identified criteria were extracted from the total sample. Criteria with means exceeding '3.5' were designated as important. The

results show that, from the original 34 sub-criteria, 24 sub-criteria met the 'important' designation; that is, had means greater than 3.5.

AHP analysis

The Analytic Hierarchy Process (AHP)

Next, Analytic Hierarchy Process (AHP) analysis was used to examine and weight the 24 sub-criteria which emerged from the data generated by the questionnaire survey. AHP analysis (Saaty 2008) is a popular means of undertaking multiple criteria decision-making (MCDM). Within the field of project management, MCDM problems are generally of two types: problems of a design nature and problems relating to evaluation (Al Harbi 2001). The focus of this study was to evaluate how the determination of 'best' choice between various alternatives could best be made. In project management, the use of AHP as an evaluation tool is particularly popular during contractor bid selection (Wang et al. 2013). In 2000, AHP was formally adopted by the Korean government as its preferred decision-making tool for pre-feasibility studies in public construction procurement (Park 2000).

The AHP survey

A total of six experts drawn from the Board of Audit and Inspection of Korea were invited to undertake the AHP survey. A nine-point scale proposed by Saaty (2008) was employed in ranking the relative importance of each criterion. The levels of relative importance are represented as equal, moderate, strong, very strong and extreme by the numerals '1', '3', '5', '7', and '9', respectively, while the numerals '2', '4', '6', and '8' represent intermediate values between two adjacent arguments.

Data collection

To undertake the AHP, it became necessary to provide participants with comparators. The decision to employ comparators was influenced by literature on competitive bid decision-making (Hensher et al. 2000). Underpinning this literature is Social Judgment Theory (Sherif and Hovland 1980) which seeks to explain how decision making can be enhanced through the utilisation of experiments that seek to replicate real decision environments. Thus utilising comparators in this study was deliberate in order to incorporate decision conditions observed in real-life decision environments. This also ensured that outcomes of the study were generalisable (Hammond et al. 1986).

To choose comparators, reference was made to earlier work by Kim (2004), who divided public building projects into three categories; (i) national authority buildings, (ii) local government buildings, and (iii) other public buildings. Three completed public building projects in Korea which could be categorised accordingly were selected. The buildings in question are the National Assembly Building, the seat of the legislative arm of the Korean government; Seongnam City Hall, the seat of the tenth largest city in Korea, which was chosen as a representative of a local government office; and the headquarters of the Korean National Police Agency in Seoul which was selected under the 'other' category.

To commence the AHP, a pilot study was conducted with two senior managers from the Ministry of Land, Transportation, and Maritime who revisited the revised sub-criteria. Although, from the data analysis, 24 sub-criteria were considered important in the general survey, three of the discounted criteria from the initial weighting were re-included in the list of important sub-criteria. The inclusion of the previously rejected sub-criteria of '*initial construction cost'* (a sub-criterion of '*economic-feasibility'*), '*flexibility'* (a sub-criterion of

'*serviceability*') and the sub-criterion '*tradition*' (a sub-criterion of '*artistry*') now meant that the AHP exercise was to commence with 27 and not 24 sub-criteria. During the pilot studies, it emerged that, although not meeting the 'important' designation as it scored a mean of less than 3.5, the question of tradition had become a major issue of public debate in Korea during the design of the Seoul City Hall. In 2008, the Architecture Council had rejected the new design of the Hall due to a suggestion that the building did not reflect Korean tradition. Thus '*initial construction cost*' was retained as a sub-criteria because of its crucial role in project decisions (Sonmez 2004). Similarly, '*flexibility*' was retained because buildings when deemed as a functional asset that supports economic growth is designed to be flexible, implying that it should easily be re-purposed to meet customer needs (Arge 2005). The revised AHP questionnaire was then sent to six expert respondents, selected based on more than 15 years of cognitive experience in building construction management. The respondents were chosen randomly from a pool of contacts supplied by the Presidential Commission on Architecture Policy which is responsible for the review of architectural policy in Korea. All respondents had prior experience participating in AHP analysis.

Mechanics of AHP

The AHP process commenced with the establishment of priorities. To identify these, pairwise computed judgement matrices from Microsoft Excel were employed. In total, 21 pairwise comparison matrices were extracted. The pairwise comparison matrix is shown in Table 4.

[INSERT TABLE 4 ABOUT HERE]

The local priority weights of all main criteria and sub-criteria of the three buildings were then calculated, and then combined with all successive hierarchical levels in each matrix to obtain a global priority weight; whereby the higher the mean weight of global priority vector, the greater the relative importance. For each criterion **C,** an *n*-by-*n* matrix **A** of pairwise comparisons was constructed. The components a_{ij} (*i*, *j* = 1, 2, …, *n*) of the matrix **A** are numerical entries, which express (through the pairwise comparison scale) the relative importance of the element *i* over the element *j* with respect to the corresponding element in the next level.

Thus the matrix **A** has the form (De Montis et al., 2000):

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \qquad (1)$$

where: $a_{ii}=1$, $a_{ij}=a_{ji}^{-1}$, $a_{ij}\neq 0$.

In order to calculate relative priorities among the *n* elements of the matrix **A,** the 'principal eigen-vector' of the matrix is computed. Then this eigenvector is normalised by obtaining the 'priority vector' (**v**, with $\sum v_i=1$), which expresses the priorities among the elements belonging to the same node (*local priority*). To obtain an overall priority among options (*global priority*), it is necessary to aggregate all the local priorities. In this way it is possible to obtain a ranking for a discrete number of options (De Montis et al. 2000). Geometric mean is used to incorporate the evaluation of the six respondents.

$$\overline{a_{ij}} = \left(\prod_k^n a_{ijk}\right)^{\frac{1}{n}} \qquad (2)$$

where *: $\overline{a_{ij}}$ is each element of incorporated matrix,* and

a_{ijk} is the evaluation score on a_{ij} of the respondent k.

The final stage of the AHP process involved checking for logical consistency. This stage is as essential feature of the AHP method in that it aims to eliminate any possible inconsistencies revealed in the criteria weights through the computation of the consistency level of each matrix (Cheng and Li 2002). In the AHP approach, the "maximum or principal eigenvalue" (called λ_{max}) of each matrix of pairwise comparisons is computed to check the degree of inconsistency. If inconsistency is too high, it is necessary to reformulate the judgments by means of new pairwise comparisons (De Montis et al. 2000). The inconsistency is measured by first estimating the consistency index (CI). The inconsistency can be represented as the difference between number of criteria (n) and λ_{max}. The CI is defined in Equation (3) (Saaty 2008).

$$CI = \frac{\lambda_{max} - \mathrm{n}}{\mathrm{n}-1} \quad (3)$$

The *CI* was then divided by the random consistency index to obtain the consistency ratio (CR). If the *CR* is greater than a certain value, the pairwise comparison results should be rejected (Saaty 2008). Cheng and Li (2002) set the acceptable CR values for different matrix sizes: (1) the *CR* value is 0.05 for a 3x3 matrix; (2) 0.08 for a 4x4 matrix; and (3) 0.10 for larger matrices. If the *CR* value is lower than the acceptable value, the matrix results are valid and

consistent. In contrast, if the *CR* value is greater than the acceptable value, the matrix results are inconsistent and thus exempt from further analysis.

By evaluating the consistency level of the collected questionnaires in this study, all questionnaires appeared to have acceptable consistency in terms of responses and can be entered into analysis.

Findings

The distributive summary in Table 5 and Table 6 suggests each group of criteria has different priorities according to the mean weight assigned by individual respondents relating to the three different buildings that formed the basis of the AHP.

[INSERT TABLE 5 ABOUT HERE]

[INSERT TABLE 6 ABOUT HERE]

The top five criteria in each building are presented in Table 7. Consistent with the results of the general survey, criteria such as '*fire resistance'*, '*accessibility'*, and '*operational cost'* were ranked as the top three most important sub-criteria across the three buildings, implying that these may be regarded as the most important criteria for the three categories of public building procurement in Korea.

[INSERT TABLE 7 ABOUT HERE]

Conclusion and management implications

A practical tool for articulating best value criteria in public-sector building is of importance to the body of knowledge within engineering management. For one, such a tool will assist in ensuring that building designs are assessed against standardised criteria. The existence of standardised criteria will also facilitate clarity in the communication of needs between for example, clients/customers and projects managers.

The results of the study identified eight criteria for best value in Korea's construction projects: '*fire resistance*', '*operational cost*', '*symbolism*', '*accessibility*', '*security*', '*layout*', '*durability*' and '*safety*'. These results therefore appear to suggest that in in Korean public building projects, practical functional parameters such as safety and operational cost are more important than parameters which are considered more aesthetic or environment-friendly. An important question arising from this study is how these criteria could be best implemented in contractor selection processes and whether the adoption of these criteria could increase the transparency, objectiveness and equitableness of bid selection processes. This question is extremely pertinent because the evaluation of bids based on criteria other than price holds specific implications for the public sector, particularly in terms of trust, integrity and comprehensiveness of the assessment tool. For example, in terms of comprehensiveness, the identified criteria did not include factors such as value ownership. Such a consideration provides an opportunity for future studies which will need to extend the current assessment criteria to a wider construction and project management audience. Future research should therefore be informed by international comparative evaluation and supplemented by examinations of the real outcomes of specific projects where alternative

and more comprehensive evaluative criteria can be tested and developed.

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