Evaluation and analysis of criteria and sub-criteria of a construction excellence model

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Abstract
Purpose – The purpose of this paper is to evaluate and analyse the criteria and sub-criteria of an excellence model for construction that would aid construction contractors in measuring and improving their business performance.

Design/methodology/approach – The methodology of evaluation was based on similar evaluations of total quality management frameworks and excellence models in the literature. The developed model was measured via a questionnaire survey. The questionnaire as a measuring instrument was evaluated in terms of reliability and validity using techniques such as factor analysis, multiple correlation, and Cronbach’s alpha. The weights of the criteria were empirically calculated using factor regression coefficients.

Findings – The criteria and sub-criteria of the proposed construction excellence model were confirmed using empirical data, and the criterion weights were suggested on an empirical / scientific basis.

Research limitations/implications – The model is limited as a managerial tool: it can increase the chances of success, but not guarantee it. The model was evaluated on, and therefore limited to, large construction contracting organisations.

Originality/value – The main benefit of the construction excellence model is that it provides criteria and sub-criteria for an excellence model developed for and evaluated by construction companies. It has a more comprehensive and wider coverage of performance criteria relevant to the construction industry than other excellence models.

Keywords Construction industry, Factor analysis, Business performance, Modelling, Quality

Paper type Research paper

Introduction
Over the last few decades, many quality management models have been adopted for improving performance. The most utilised models are the European Foundation for Quality Management (EFQM) Award and Excellence Model in Europe (EFQM, 2007), the Baldrige Award and Excellence Model in the USA (NIST, 2007), and the Deming Prize and Model in Japan (Tan, 2002). The EFQM and Baldrige models have gained much popularity in the last two decades. Beatham et al. (2002) reported different uses of the EFQM model applied to construction. The implementation of total quality
management (TQM) has traditionally been faced with problems in construction, due to its contrasts with manufacturing, where TQM originated (Ahmad and Sein, 1997; Stockdale, 1997). However, the EFQM model, unlike its TQM parent, is a well-defined model, and has been reported to be easier in understanding and implementation to construction companies (Watson and Seng, 2001). Nevertheless, some implementation problems exist, and can be summarised as resistance to change, inexperience with the model, documentation difficulties and insufficient time and funds allocation (Watson and Seng, 2001). Additionally, Robinson et al. (2005) reported that construction firms considered the EFQM model less difficult than Balanced Scorecard (Kaplan and Norton, 1992, 1993, 1996) in terms of determining and monitoring indicators. They regard this to the presence of enabling criteria in the EFQM model, which are not clear or comprehensive in the balanced scorecard.

The need for adapting/modifying management techniques applied to construction but originating from other industries has been discussed by Ahmad and Sein (1997). This has been evident in the adaptation of performance measurement frameworks when applied to construction, such as that of the balanced scorecard (Kagioglou et al., 2001). Furthermore, expert interviews and case studies reported in Bassioni et al. (2005) demonstrated the need for excellence models and performance frameworks to be adapted to construction. The construction excellence model in this paper was developed based on widely accepted excellence and business performance models in previous research (Bassioni et al., 2004a, 2005). The objective of this paper is to evaluate and analyse the criteria and sub-criteria of the construction excellence model. Consequently, the following research questions can be articulated:

1. The evaluation/analysis of the criteria of the model.
2. The evaluation/analysis of the sub-criteria of the model.
3. The calculation of the criterion weights on an empirical basis.

The evaluation and analysis of the criteria and sub-criteria is conducted in line with the evaluation of excellence models and TQM frameworks in the literature, and data are gathered through a questionnaire survey on UK construction contracting organisations. The paper is divided into ten further sections. The following section discusses the research methodology. Then the excellence model is described. The measurement of the model’s criteria and sub-criteria via a questionnaire survey is discussed. The preparation of data and the evaluation of the measuring instrument are overviewed. Then the model criteria and sub-criteria are evaluated and the criterion weights are calculated. Benefits and limitations of the model are discussed. Finally, a conclusion is presented with recommendations for industry and further research.

**Research methodology**

The methodology used to evaluate the excellence model is shown in Figure 1. Different elements of this evaluation have been used in literature to evaluate excellence models and TQM frameworks (Ahire et al., 1996; Anderson et al., 1995; Black and Porter, 1996; Eskildsen et al., 2001; Saraph et al., 1989; Wilson and Collier, 2000). First, the construction excellence model resulting from previous research undertaken by the authors and reported in Bassioni (2004a, 2005) is described. Second, the criteria and
Figure 1. Evaluation of construction excellence model

Construction Excellence Model
Developed from widely accepted Excellence and business performance models

Measurement of Criteria & Sub-Criteria
Questionnaire survey

Data Preparation
Coding, missing data and data exploration

Evaluation of Measuring Instrument
Reliability and validity

Evaluation of Model Criteria
Criteria importance and factor analysis

Evaluation of Model Sub-Criteria
Sub-criteria importance and factor analysis

Computation of Criterion Weights
Factor regression coefficients
sub-criteria of the model were measured in the analytical part of a questionnaire survey. The criteria and sub-criteria were measured for both their importance and actual performance within the company of the respondent. Third, the data collected was prepared for further analysis through coding, missing data analysis, and data exploration. Fourth, the questionnaire was evaluated as a measuring instrument in terms of reliability and validity. Fifth, the criteria and sub-criteria were evaluated through their importance measurement, via factor analysis, and through their effectiveness measurement. Finally, weights of the model criteria were computed on an empirical basis using factor regression coefficients. The steps of evaluation are discussed in the sections to follow.

The proposed construction excellence model
The construction excellence model under evaluation was developed and described in Bassioni et al. (2004a, 2005) and is illustrated in Figure 2. The model is divided into enabling and results criteria. The enabling criteria include: leadership; customers and stakeholder focus; strategic management; information and analysis; people, partnerships, suppliers, physical resources, intellectual capital, risk, work culture, and process management. The results criteria include: internal stakeholder; project, external stakeholder; and organisational business results. The logic of the model starts with leadership as the main driver for change and improvement in organisations. Leadership should guide the focus on customers, people and other relevant stakeholders, which in turn should guide the development of strategic plans. The strategic plans are further detailed into functional or programmatic business plans that are translated into processes for implementation. Once implemented on projects and throughout the organisation, improved internal stakeholder results should start to appear (internal in terms of being under direct influence of management), such as that of employees, suppliers and other internal stakeholders. This will reflect on project results that would further affect customer and external stakeholder results not under the direct management influence of the organisation. The outcome is business results being achieved on the organisational level. Work culture is seen to be driven by leadership, and affecting other enabling criteria, whereas information and analysis is also driven by leadership and supports all other criteria throughout the model. The bi-directional relationships between information and analysis and other criteria provide forward and backward loops of information among criteria.

Measurement of model criteria and sub-criteria
The measurement of the model’s criteria and sub-criteria was conducted through a questionnaire survey. This section discusses the design of the questionnaire showing how the criteria and sub-criteria were measured, and the sampling approach of the survey.

Questionnaire design
The questionnaire is divided into three questions, as can be seen in the Appendix (Figure A1). The first question aims to identify the importance of each criterion in improving organisational business performance results. It uses a five-point Likert scale
The suggested construction excellence model
with 1 being “Not important” and 5 being “Extremely important”. It should be noted that the terms: factor and sub-factor, used in the questionnaire, resemble the criterion and sub-criteria of the model. The second question addresses the enabling criteria and their operational definitions. Each operational definition is rated on how well it defines its overarching enabling criterion on a five-point Likert scale with 1 being “Not important” and 5 being “Extremely important”. Each operational definition is also rated on how effective it is in the organisation on a five-point Likert scale with 1 being “Not effective” and 5 being “Extremely effective”. The third question addresses the results criteria and their operational definitions. Each operational definition is rated on how well it represents its overarching results criteria on a five-point Likert scale with 1 being “Not important” and 5 being “Extremely important”. Each operational definition is also rated on its actual performance in the organisation on a five-point Likert scale with 1 being “Very weak performance” and 5 being “Very strong performance”. In order to verify and improve the questionnaire design, a pilot survey of six questionnaires was sent to three professionals and three academicians for review. The model itself, in its diagram form, was not included with the questionnaire, as its logic was evaluated in previous research (Bassioni et al., 2005), and the objective is to evaluate and analyse the criteria and sub-criteria.

**Sampling approach**

It is often not possible to survey an entire population for practical and cost reasons, and therefore a sub-set or sample of the population is more suitable for study (Brewerton and Millward, 2001). The sample targeted in this research consisted of construction contractors having a turnover of more than £10 million. The reason for this selection is that companies of a smaller size might not have used some of the advanced methods entailed in the questionnaire. The sampling frame, which is a list of members of the research population (Gill and Johnson, 2002) was obtained from the New Civil Engineer Contractor File (New Civil Engineer, 2003), the FAME database (FAME, 2003) and web searches. The questionnaire was sent out to 120 construction contractors. The total responses and sample size was 50 and the total response rate was 41.7 per cent. This high response rate can be possibly attributed to the interest in the topic of study and to adopting some of the “improving returns” techniques suggested in Cooper and Emory (1995) such as personalised approach, follow-ups, questionnaire length, anonymity, and final report incentive.

**Data preparation**

In order to prepare the data for the data analysis, the data were coded and missing data analysed. Furthermore, the data were explored for basic descriptive statistics, normality of distributions and correlations, as shown in the following sub-sections.

**Coding and missing data**

To facilitate the analysis and handling of data through specialised computer programmes, the data variables require coding (Hussey and Hussey, 1997). Consequently, the variables of the questionnaire concerned in this research were coded. New variables were computed for each criterion by summating the actual
effectiveness scores of their underlying sub-criteria, thus giving an indication of the actual performance of each criterion.

Missing values can cause problems with some statistical techniques and could be resolved by either deletion or replacement methods (Hair et al., 1998). A missing value analysis was conducted on the Statistical Package for Social Sciences (SPSS) software to evaluate the magnitude of missing data before deciding how best to handle them in statistical techniques. A maximum of two missing values were found in less than 3 per cent of variables, which indicates a low percentage of missing values. The mean of the variable was used to replace missing data (Hair et al., 1998). One respondent did not answer any of the “sub-criterion importance” questions, and was therefore discarded from the analysis, thus leaving the sample of sub-criteria importance variables being 49 responses.

Data exploration
The mean and standard deviation of each observed variable were computed in the missing value analysis. The normality of the distribution of each variable was assessed, where the skewness and kurtosis values were computed. The assessment of normality was initially based on the values of \( Z_{\text{skewness}} \) and \( Z_{\text{kurtosis}} \) that were calculated from the following equations, as expressed by Hair et al. (1998, p. 72), in terms of the sample size \( N \):

\[
Z_{\text{skewness}} = \frac{\text{skewness}}{\sqrt{\frac{6}{N}}} \quad Z_{\text{kurtosis}} = \frac{\text{kurtosis}}{\sqrt{\frac{24}{N}}}
\]

These values were compared to 2.58 to assess the significance of the normality assumption at the 0.01 level (Hair et al., 1998, p. 73). If the variable was found to be non-normal, it was further assessed for the degree of non-normality according to the criteria of Curran et al. (1996 in Byrne, 1998). Curran et al.’s criteria considered distributions with skewness between 2 and 3 and kurtosis in the range of 7 to 21 to be moderately non-normal, whereas skewness of above 3 and kurtosis of above 21 were considered extremely non-normal. The reason for this assessment of degree of non-normality is that many statistical techniques are robust and can withhold deviations from the normality assumption (Stevens, 2002, p. 263). The only variable that has shown extreme non-normality was the importance of leadership in determining business performance (Question 1-a). It should be noted though that the variables showing moderate or extreme deviation from normality are all negatively peaked, which means they have higher concentrations towards their maximum values.

Evaluation of measuring instrument
The measurement of variables in a theoretical framework is an integral part of research, and abstract concepts should be measured through physical/actual measurement of their operational definitions (Sekaran, 2003). This concept of developing a measuring instrument in quality management research has been used to confirm the abstract constructs/criteria of Excellence Models (Wilson and Collier, 2000) and TQM frameworks (Ahire et al., 1996; Anderson et al., 1995; Black and Porter, 1996;
Similarly, the actual effectiveness measurement of the sub-criteria in Questions 2 and 3 are used to measure the abstract criteria and are termed as the “measuring instrument”.

To evaluate the characteristics of the questionnaire as a measuring instrument the issues of reliability and validity are key considerations (Brewerton and Millward, 2001). Reliability indicates the extent to which the measurement instrument is without bias, i.e. produces stable and consistent data in measuring concepts (Sekaran, 2003). Validity, on the other hand, gives an indication of the certainty of the instrument in actually measuring the concepts it is intended to measure (Brewerton and Millward, 2001). The following discussion overviews an analysis of both issues in the measuring instrument. Reliability is a necessary but not sufficient condition to validity (Cooper and Emory, 1995), and is therefore discussed first.

Reliability of measuring instrument
As explained above, reliability addresses the consistency of results. It is mostly measured by Cronbach’s alpha, which is an indication of internal consistency and the degree to which items are homogeneous (Cooper and Emory, 1995; Saraph et al., 1989). The value of Cronbach’s alpha was computed for each criterion, or in more technical words, for the construct or abstract concept. Computations were carried out on the SPSS software. Table I shows these values, the number of items (sub-criteria) of each construct (criterion) and the 95 per cent lower and upper confidence limits based on tables in Duhacheck and Iacobucci (2004).

The acceptable value of Cronbach’s alpha is recommended to be 0.6 for new scales, such as the one used in this study (Flynn et al., 1994; Hair et al., 1998). Of the 16 criteria, 14 had values that exceeded this recommended level and ranged from 0.71 up to 0.92. The “project performance” criterion had an alpha of 0.5886. However, in order to

<table>
<thead>
<tr>
<th>Criterion (construct or abstract concept)</th>
<th>Number of items</th>
<th>Cronbach’s alpha</th>
<th>Lower 95 per cent confidence limit</th>
<th>Upper 95 per cent confidence limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>6</td>
<td>0.8132</td>
<td>0.7281</td>
<td>0.8983</td>
</tr>
<tr>
<td>Customer focus</td>
<td>3</td>
<td>0.7067</td>
<td>0.6471</td>
<td>0.7663</td>
</tr>
<tr>
<td>Other stakeholder focus</td>
<td>3</td>
<td>0.8468</td>
<td>0.7772</td>
<td>0.9164</td>
</tr>
<tr>
<td>Information and analysis</td>
<td>4</td>
<td>0.8348</td>
<td>0.7535</td>
<td>0.9161</td>
</tr>
<tr>
<td>Strategic management</td>
<td>5</td>
<td>0.8546</td>
<td>0.7929</td>
<td>0.9163</td>
</tr>
<tr>
<td>Intellectual capital management</td>
<td>3</td>
<td>0.8659</td>
<td>0.8004</td>
<td>0.9314</td>
</tr>
<tr>
<td>People management</td>
<td>5</td>
<td>0.8694</td>
<td>0.8112</td>
<td>0.9276</td>
</tr>
<tr>
<td>Partnerships and supplier management</td>
<td>3</td>
<td>0.9044</td>
<td>0.8581</td>
<td>0.9507</td>
</tr>
<tr>
<td>Resource management</td>
<td>3</td>
<td>0.8606</td>
<td>0.7127</td>
<td>0.8993</td>
</tr>
<tr>
<td>Risk management</td>
<td>4</td>
<td>0.8911</td>
<td>0.8468</td>
<td>0.9354</td>
</tr>
<tr>
<td>Process management</td>
<td>5</td>
<td>0.9189</td>
<td>0.8828</td>
<td>0.9550</td>
</tr>
<tr>
<td>Work culture management</td>
<td>4</td>
<td>0.9027</td>
<td>0.8627</td>
<td>0.9427</td>
</tr>
<tr>
<td>Project performance</td>
<td>4</td>
<td>0.6406</td>
<td>0.4730</td>
<td>0.8082</td>
</tr>
<tr>
<td>Organisational business performance</td>
<td>2</td>
<td>0.5702</td>
<td>0.3350</td>
<td>0.8054</td>
</tr>
<tr>
<td>Internal stakeholder performance</td>
<td>2</td>
<td>0.7900</td>
<td>0.6765</td>
<td>0.9035</td>
</tr>
<tr>
<td>External stakeholder performance</td>
<td>4</td>
<td>0.7969</td>
<td>0.6999</td>
<td>0.8939</td>
</tr>
</tbody>
</table>

Table I.
Cronbach’s alpha and 95 per cent confidence limits for each construct
improve reliability, SPSS provides an expected value of alpha if a certain item were to be deleted. Item (sub-criterion) “d. Society and environmental impact of projects” was found to have the largest impact on reliability improvement and was, thus, deleted to improve the reliability of the measuring instrument. The resulting Cronbach’s alpha became 0.6406 as indicated in Table I. The deletion of this item is acceptable from a computational standpoint since five items were used to express the underlying construct, and the deletion of one would leave four items to express the criterion. However, in the case of the construct “organisational business performance”, Cronbach’s alpha was found to be 0.5702, but this criterion was defined by only two items and deletion of an item would essentially separate the concept between financial and non-financial performance. Moreover, the alpha value is quite close to the acceptable value of 0.6. Accordingly, and in order to represent the concept in its entirety, both items are retained.

**Validity of measuring instrument**

As previously discussed, validity indicates that the instrument is measuring what it is supposed to measure. Three types of validity are most common in business and organisational research: content validity; construct validity and criterion-related validity (Brewerton and Millward, 2001; Sekaran, 2003).

**Content validity.** Defined as “the extent to which it provides adequate coverage of the topic under study” (Cooper and Emory, 1995, p. 149). This type of validity is mostly based on the analysis of the target domain required, and drawn on expert judgement (Brewerton and Millward, 2001). Content validity is demonstrated in this instrument in two ways. First, the “analysis of the target domain” was achieved through the literature review conducted in previous papers, and the theoretical development of the model based on well-established models (Bassioni et al., 2004a, b). Second, the “expert judgement” was based on the empirical evaluation of expert interviews and case studies (Bassioni et al., 2005), and the evaluation of the questionnaire in the pilot study.

**Construct validity.** Shows the extent to which items of a construct measure the same construct (Flynn et al., 1994), i.e. do not measure multiple constructs. Construct validity can be demonstrated by a factor analysis on the items of each construct (Cooper and Emory, 1995; Flynn et al., 1994). Table II and Figure 3 show the factor analysis and associated Scree plot conducted on the sub-criteria of leadership using SPSS software.

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues total</th>
<th>Per cent of variance</th>
<th>Cumulative %</th>
<th>Extraction sums of squared loadings total</th>
<th>Per cent of variance</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.138</td>
<td>52.298</td>
<td>52.298</td>
<td>3.138</td>
<td>52.298</td>
<td>52.298</td>
</tr>
<tr>
<td>2</td>
<td>0.964</td>
<td>16.071</td>
<td>68.369</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.728</td>
<td>12.141</td>
<td>80.510</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.542</td>
<td>9.027</td>
<td>89.537</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.361</td>
<td>6.015</td>
<td>95.552</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.267</td>
<td>4.448</td>
<td>100.000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table II. Factor analysis of leadership sub-criteria
The extraction method used was “principal component analysis”. It can be seen that only one factor was extracted in Table II, as its Eigen value is larger than 1, and the slope in the Scree plot of Figure 2 changes after this first factor (Hair et al., 1998; Tabachnick and Fidell, 2001). Similar factor analyses were conducted on the remaining 15 constructs of the measuring instrument and each resulted in the extraction of a single factor, thus reflecting the construct validity of the measuring instrument.

**Criterion-related validity.** This type of validity reflects the ability of measures/variables to predict or estimate a certain criterion (Cooper and Emory, 1995). The criterion used in this analysis is the organisational performance criterion, as it encompasses the final goal of the organisation. The multiple correlation of this factor against all other factors was computed using SPSS and was found to be 0.831. This figure exceeds the acceptable level expressed by Makin et al. (1996) of 0.5 for excellent criterion-related validity, and is in line with the result of 0.8 reported by Saraph et al. (1989) to demonstrate criterion-related validity.

**Evaluation of model criteria**
The confirmation of the model’s criteria is achieved in two ways. First the importance of the criteria is evaluated in determining business performance. Second, the actual effectiveness of the criteria is analysed using factor analysis. The two following sub-sections discuss each method of criteria confirmation.
Importance of criteria in determining business performance
Respondents of the survey were asked to rate the importance of each criterion in determining organisational business performance in Question 1 of the questionnaire. The results of this question are summarised in terms of the mean and lower 5 per cent confidence limit of each criterion, and illustrated in Figure 4. These results were computed on an Excel spreadsheet using its embedded functions. The line chart shows an above average rating of importance for all criteria and close to maximum rating for many of them. Leadership, customer focus and people management showed the highest relevance, among all criteria, to improving organisational business performance. The only criterion having extreme non-normality (leadership), as discussed in the data exploration sub-section was negatively peaked. Its computed confidence limit based on normality is expected to provide an understatement of the actual lower confidence limits.

Factor analysis of excellence criteria
Confirmatory factor analysis differs than exploratory factor analysis in the postulation of a factor structure, whereas in exploratory factor analysis the factor structure is determined within the analysis (Cramer, 2003). To ensure that the items load on only one variable a preliminary “exploratory factor analysis” is conducted on SPSS, then a confirmatory factor analysis (CFA) is conducted using a specialised statistical software LISREL (LInear Structural RELationships).

In the exploratory factor analysis, the method of principle component analysis was used on SPSS and the scree plot of eigen values is illustrated in Figure 5. The scree plot indicates a single variable to be extracted as the eigen value of the first factor is 8.557 and the second is 1.308. The difference between both factors is rather large and the change in direction of the scree plot occurs after the first factor, thus indicating the appropriateness of extracting the first factor only.
Confirmatory factor analysis is used to reassure the single factor structure as expressed by the CFA Model in Figure 6, where the criteria of the Construction Excellence Model are related to a latent variable that is assumed to be “excellence”. The term “latent” refers to a variable that is not directly measured or is unobserved (Loehlin, 1998, p. 1). The CFA Model is expressed in the form of a path diagram with the rectangles resembling items of the CFA Model and the latent variable portrayed as an ellipse. The arrows point from the latent variable to the items of the CFA Model indicating that it is expressed in terms of the items (Cramer, 2003). A similar manifestation of the EFQM Excellence Model as a CFA Model has been described in the literature (Eskildsen et al., 2001, p. 788).

The computations of the confirmatory factor analysis were conducted on the LISREL software. The observed variables (criteria) were obtained by the summated scores of sub-criteria effectiveness. A program written in the SIMPLIS language was developed and the covariance matrix was prepared as input to the program using the PRELIS program that accompanies the LISREL package. The appropriateness of the CFA Model is determined by goodness-of-fit indices that indicate how well the data fit the model. A large number of indices exist in the literature and there is little agreement as to which one is appropriate (Cramer, 2003). Of these indices, the root mean squared error of approximation (RMSEA) is gaining popularity (Loehlin, 1998, p. 76) and is considered the only index to satisfy the ideal properties described by Gerbing and
Anderson (1992) of indicating the degree of fit along a continuum with bounded values; being independent of sample size; and having known distributional characteristics. The value of RMSEA in the LISREL output for the CFA Model is 0.099, which indicates a good fit since it is below the acceptable threshold of 0.1 (Cramer, 2003, p. 34; Loehlin, 1998, p. 77). Therefore, the empirical data confirm the CFA model in Figure 6, which illustrates the expression of the latent variable “excellence” in terms of the model criteria.

**Evaluation of model sub-criteria**

The sub-criteria of the Construction Excellence Model as developed from previous research are depicted in the sub-criteria of the questionnaire. These sub-criteria were
assessed in the Questions 2 and 3 of the questionnaire as to their importance in defining their underlying criterion, and their actual effectiveness in the companies of the respondents, as can be seen in the Appendix (Figure A1). The sub-criteria of the model are confirmed in a manner very much similar to that of the model criteria, through assessing their importance and through a factor analysis to ensure the single construct structure.

Importance of sub-criteria in defining underlying criterion
The results of the importance of each sub-criterion in defining its criterion in the form of the means, standard deviations and 5 per cent lower confidence limits were computed on an Excel spreadsheet, using its built-in functions in a similar manner to the model criteria. The results show that the mean and lower confidence limits of sub-criteria were all above average and inclined towards the scale maximum of five points, hence confirming the importance of each sub-criterion in defining its underlying criterion. Furthermore, the negative skewness of these items indicate that even if a few of these distributions are not normal, they are nevertheless peaked and negatively concentrated towards the upper end of the scale, as explained with the importance of the criteria previously. Thus, the actual confidence limits are expected to be higher than those reported.

Factor analysis of sub-criteria underlying a criterion
The results of the effectiveness assessment of each sub-criterion were used in factor analysis to determine the single factor structure, which was previously conducted in the discussion of the content validity and was demonstrated in Table II and Figure 3 for the Leadership criterion. The factor analysis in all other criteria showed only one factor is to be extracted and thus confirms the single factor structure assumed in the criteria of the model.

Calculation of model criterion weights
The scoring system of the EFQM Excellence Model has been shown to vary across industries and has been criticised as not corresponding to the way companies are working (Eskildsen et al., 2001). Different methods for assessing the actual weights of the model’s criteria have been reported in literature. For example, Eskildsen et al. (2001) used factor regression coefficients. Cheng and Li (2001) used the analytic hierarchy process (AHP) to determine the weights of performance measures of a business process. It is difficult to assess which method is more accurate. Nevertheless, any of the empirical approaches mentioned would be preferred to “an arbitrary weight structure, which has never been empirically tested” (Eskildsen et al., 2001, p. 783), as with the case of EFQM. Furthermore, a method that has been previously applied to excellence models would be preferred. The factor regression coefficients method was chosen in this research because it assesses the actual impact of each criterion on the organisation’s performance, whereas with AHP requires expert judgement data that can be obtained from the importance rating of each criterion, but might affect the accuracy of outcomes in the paired comparisons process, as well as reflecting the importance perception rather than actual impact.
To compute the regression coefficients of the criteria relevant to one another, they need to be loaded on a single factor. Hence, the CFA Model of Figure 6, was used to reflect such a single factor structure. In this model, each of the criteria is loaded on a latent variable termed “excellence”. The regression coefficients are computed for each criterion in predicting the latent variable “excellence”. The computations were carried out on SPSS, and the results are illustrated in Table III. Moreover, the coefficients in their crude format might not be suitable for excellence scoring calculations and need to be presented in a more workable format. Therefore, weights for each criterion were calculated on an Excel spreadsheet such that the total weight of all criteria is 1,000. This was achieved by dividing the coefficient of each criterion by the total of all coefficients and multiplying the result by 1,000.

**Benefits and limitations**

The main benefit of the Construction Excellence Model is that it provides an excellence model developed for and evaluated by construction companies. It has a more comprehensive and wider coverage of performance criteria than other excellence models. Its underlying logic is also easier to understand and more user friendly. The limitation of the suggested model is that, as in all other models, it is only as good as whoever uses it. Thus, the model is merely a tool that clarifies what needs to be measured/improved, but in no way can guarantee success of the organisation. For example, if management pursues an inappropriate strategy or the economy takes a downturn, the organisation’s performance would most certainly be affected, no matter how efficient the business models it uses. However, the use of the suggested model is expected to raise the chances of success and increase organisational performance in relation to competitors. Furthermore, the use of the Construction Excellence Model, by its nature, is targeted towards project-based industries, specifically construction, and

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<thead>
<tr>
<th>Score coefficients</th>
<th>Criterion weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>0.0967</td>
</tr>
<tr>
<td>Customer focus</td>
<td>0.0928</td>
</tr>
<tr>
<td>Other stakeholder focus</td>
<td>0.0738</td>
</tr>
<tr>
<td>Information and analysis</td>
<td>0.0877</td>
</tr>
<tr>
<td>Strategic management</td>
<td>0.0939</td>
</tr>
<tr>
<td>Intellectual capital management</td>
<td>0.0914</td>
</tr>
<tr>
<td>People management</td>
<td>0.0903</td>
</tr>
<tr>
<td>Partnership and supplier management</td>
<td>0.0952</td>
</tr>
<tr>
<td>Resource management</td>
<td>0.0779</td>
</tr>
<tr>
<td>Risk management</td>
<td>0.0890</td>
</tr>
<tr>
<td>Process management</td>
<td>0.0712</td>
</tr>
<tr>
<td>Work culture</td>
<td>0.0610</td>
</tr>
<tr>
<td>Project performance</td>
<td>0.0833</td>
</tr>
<tr>
<td>Organisational performance</td>
<td>0.0833</td>
</tr>
<tr>
<td>Internal stakeholder performance</td>
<td>0.0778</td>
</tr>
<tr>
<td>External stakeholder performance</td>
<td>0.0931</td>
</tr>
<tr>
<td>Total</td>
<td>1.3584</td>
</tr>
</tbody>
</table>

**Table III.** Component score coefficients and criterion weights
might not be applicable in other industries. This might limit the ability of organisations to benchmark across industries.

Conclusion and further work
The evaluation and analysis of the criteria and sub-criteria of a Construction Excellence Model was presented in this paper. The evaluation and analysis was based on similar evaluations and analyses of TQM frameworks and excellence models in quality management literature. The analysis addressed the issue of data preparation, where missing data were analysed and appropriate data replacement methods used to complete the data set. The questionnaire as a measuring instrument was evaluated in terms of reliability using Cronbach’s alpha, which resulted in the omission of the “Society and environmental impact of projects” sub-criterion from the “Project performance” criterion. Reliability of the measuring instrument is a necessary but not sufficient condition for validity. The validity of the measuring instrument is further evaluated in terms of content, construct and criterion-related validity using techniques as factor analysis, multiple correlation. The criteria and sub-criteria were confirmed through their importance ratings and actual effectiveness ratings employing confidence intervals and exploratory and confirmatory factor analysis. The evaluation and analysis of the model’s criteria and sub-criteria strengthens the model’s validity. The weights of the criteria were calculated using empirical data and the method of factor regression coefficients.

A number of future researches can be conducted in continuation of this research paper. The scope of the model could be expanded to suit the needs of other types of construction organisations, such as consultants and owner organisations. Modifications could include, for example, modifying the relative criterion weights in the Construction Excellence Model, for different types of organisations. The consideration of organisation size is another area of possible research, where spin-off models could be developed for small and medium enterprises. In addition, the criterion weights of national Excellence Models such as EFQM and Baldrige require empirical justification. Finally, within the Construction Excellence Model, alternative methods for computing criterion weights can be applied such as the analytic hierarchy process.

References


Further reading

Appendix.

Q1. Please rate the importance of the following performance factors in improving organisational business performance results (e.g. financial and market results). If you feel any further performance factors need to be added please specify below.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Not Important</th>
<th>Moderately Important</th>
<th>Extremely Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Leadership</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>b. Customer focus</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>c. Other stakeholder focus</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>d. Information and analysis</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>e. Strategic management</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>f. Intellectual capital management</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>g. People management</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>h. Partnership and supplier management</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>i. Resource management</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>k. Risk management</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>l. Process management</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>m. Work culture management</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>n. Project results</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>o. Internal stakeholder performance (i.e. under the direct influence of the organisation, for example, employees and suppliers)</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>p. External stakeholder performance (i.e. not under the direct influence of the organisation, for example, customers and society)</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

Q2. Please rate the definitions (Q2-A) of the following performance factors and their actual effectiveness in your organisation (Q2-B). If you feel any item is missing, please add below.

<table>
<thead>
<tr>
<th>Q2-A. Definition of performance factors in defining leadership</th>
<th>Q2-B. Actual Effectiveness in your organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td></td>
</tr>
<tr>
<td>a. Leaders develop and communicate mission, vision, and values.</td>
<td>Not important</td>
</tr>
<tr>
<td>b. Leaders are actively involved in ensuring management systems are developed, implemented and continuously improved.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>c. Leaders measure organisational performance and translate results into improvements.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>d. Leaders are actively involved with customers.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>e. Leaders are actively involved with stakeholders.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>f. Leaders create an environment for empowerment, innovation, learning and support.</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

| Customer Focus               |                                               |
| a. Systematic identification and monitoring of customer requirements and needs. | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| b. Translation of customer requirements and needs into actions and expressed in organisation’s products/services. | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| c. Organisation staff are actively involved with customers. | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |

| Other Stakeholders’ Focus     |                                               |
| a. Systematic identification and monitoring of stakeholder requirements and needs. | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| b. Translation of stakeholder requirements and needs into actions and expressed in organisation’s products/services. | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |
| e. Organisation staff are actively involved with stakeholders. | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 | 1 2 3 4 5 |

Figure A1. Questionnaire

(continued)
**Information and Analysis**

<table>
<thead>
<tr>
<th></th>
<th>Q2-A, Definition</th>
<th>Q2-B, Actual Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Importance in defining information &amp; analysis</td>
<td>Actual effectiveness in your organisation</td>
</tr>
<tr>
<td></td>
<td>Not important</td>
<td>Extremely important</td>
</tr>
<tr>
<td>a.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>b.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>c.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>d.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

**Strategic Management**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Presence of strategic planning or thinking.</td>
</tr>
<tr>
<td>b.</td>
<td>Strategic planning is a systematic process.</td>
</tr>
<tr>
<td>c.</td>
<td>Strategic planning is based on gathering of data and information and reflects customer and stakeholder needs and requirements.</td>
</tr>
<tr>
<td>d.</td>
<td>Strategic plans and objectives are communicated throughout the organisation.</td>
</tr>
<tr>
<td>e.</td>
<td>Monitoring mechanisms and/or measures exist to track strategic deployment at corporate and operational levels.</td>
</tr>
</tbody>
</table>

**Intellectual Capital Management**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Innovation is encouraged and managed.</td>
</tr>
<tr>
<td>b.</td>
<td>Technology (e.g. techniques, methods, inventions) is planned and managed.</td>
</tr>
<tr>
<td>c.</td>
<td>Knowledge and organisational learning are planned and managed.</td>
</tr>
</tbody>
</table>

**People Management**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>People resources and capabilities are planned, managed, and improved.</td>
</tr>
<tr>
<td>b.</td>
<td>A healthy and safe work environment exists.</td>
</tr>
<tr>
<td>c.</td>
<td>People are communicated with, involved, and empowered.</td>
</tr>
<tr>
<td>d.</td>
<td>People are motivated, rewarded, and recognised.</td>
</tr>
<tr>
<td>e.</td>
<td>Teamwork is encouraged and enabled.</td>
</tr>
</tbody>
</table>

**Partnerships & Supplier Management**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Partnerships &amp; supplier relations are planned.</td>
</tr>
<tr>
<td>b.</td>
<td>Partnerships &amp; supplier plans are controlled and managed.</td>
</tr>
<tr>
<td>c.</td>
<td>Partnerships &amp; suppliers are planned based on their needs, contributions, and a teamwork culture.</td>
</tr>
</tbody>
</table>

**Resource Management**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Financial resources are planned and managed.</td>
</tr>
<tr>
<td>b.</td>
<td>Physical operational resources (e.g. material and equipment) are planned and managed.</td>
</tr>
<tr>
<td>c.</td>
<td>Physical long-term resources (e.g. building and land) are planned and managed.</td>
</tr>
</tbody>
</table>

Figure A1.
A construction excellence model

Q2-A.

<table>
<thead>
<tr>
<th>Risk Management</th>
<th>Definition Importance in defining risk management</th>
<th>Q2-B. Actual Effectiveness Actual effectiveness in your organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Project and organisation risks are identified and evaluated.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>b. Plans are set to mitigate relevant risks.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>c. Effects of risk management plans are evaluated and controlled.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>d. Actions are taken to improve the risk management programme.</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

Process Management

| a. Processes are identified and designed. | 1 2 3 4 5 | 1 2 3 4 5 |
| b. Processes are clearly communicated to staff and stakeholders. | 1 2 3 4 5 | 1 2 3 4 5 |
| c. Processes are implemented and controlled. | 1 2 3 4 5 | 1 2 3 4 5 |
| d. Processes are updated and improved. | 1 2 3 4 5 | 1 2 3 4 5 |
| e. Process design is based on customer and stakeholder needs and requirements. | 1 2 3 4 5 | 1 2 3 4 5 |

Work Culture Management

| a. Existing behavioural norms and organisational values are identified. | 1 2 3 4 5 | 1 2 3 4 5 |
| b. Desired behavioural norms and organisational values are planned for. | 1 2 3 4 5 | 1 2 3 4 5 |
| c. Behavioural norms and organisational values are measured to control plans. | 1 2 3 4 5 | 1 2 3 4 5 |
| d. Work culture programme is improved. | 1 2 3 4 5 | 1 2 3 4 5 |

Q3. Please rate how well the following performance factors are represented by indicators (Q3-A), and actual performance of each indicator in your organisation (Q3-B). If you feel an indicator is missing, please add below.

Q3-A.

<table>
<thead>
<tr>
<th>Project Performance</th>
<th>Representation Suitability in measuring Project performance</th>
<th>Actual Performance Actual performance in your organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Project predictability/variance of costs and time.</td>
<td>Not important 1 2 3 4 5</td>
<td>Extremely important 1 2 3 4 5</td>
</tr>
<tr>
<td>b. Project safety.</td>
<td>Not important 1 2 3 4 5</td>
<td>Extremely important 1 2 3 4 5</td>
</tr>
<tr>
<td>c. Project teamwork and harmony.</td>
<td>Not important 1 2 3 4 5</td>
<td>Extremely important 1 2 3 4 5</td>
</tr>
<tr>
<td>d. Society and environmental impact of projects.</td>
<td>Not important 1 2 3 4 5</td>
<td>Extremely important 1 2 3 4 5</td>
</tr>
<tr>
<td>e. Quality of the constructed facility, as per specifications.</td>
<td>Not important 1 2 3 4 5</td>
<td>Extremely important 1 2 3 4 5</td>
</tr>
</tbody>
</table>

Organisational Business Performance

| a. Financial performance (e.g. profits, sales, liquidity). | Not important 1 2 3 4 5 | Extremely important 1 2 3 4 5 |
| b. Non-financial performance (e.g. market performance, organisation image, flexibility). | Not important 1 2 3 4 5 | Extremely important 1 2 3 4 5 |

Internal Stakeholder Performance (i.e. directly under organisation's influence)

| a. Employee satisfaction. | Not important 1 2 3 4 5 | Extremely important 1 2 3 4 5 |
| b. Partner and supplier satisfaction. | Not important 1 2 3 4 5 | Extremely important 1 2 3 4 5 |

External Stakeholder Performance (i.e. not directly under organisation’s influence)

| a. Direct customer satisfaction. | Not important 1 2 3 4 5 | Extremely important 1 2 3 4 5 |
| b. End user of facility satisfaction. | Not important 1 2 3 4 5 | Extremely important 1 2 3 4 5 |
| c. Impact on society. | Not important 1 2 3 4 5 | Extremely important 1 2 3 4 5 |
| d. Impact on environment. | Not important 1 2 3 4 5 | Extremely important 1 2 3 4 5 |

Figure A1.

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