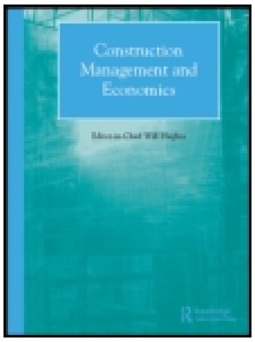

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NOTE
Service quality performance of design/build contractors using quality function deployment

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This note describes a model that measures the quality of the *project* service of a D/B firm using quality function deployment (QFD). This model is an add-on to a model developed previously by the authors to measure the *corporate* service quality performance of D/B firms. The project service quality performance model makes use of 10 service quality factors and their relative weights (transferred from the corporate service quality performance model), three components of quality management systems in place in D/B projects (ranked by senior managers in D/B firms) and the relationships between service quality factors and quality system requirements (established by a professional quality system assessor). It uses QFD to calculate a quality performance index. The combined corporate and project service quality performance index can be used by D/B firms to benchmark themselves against their competitors or to monitor their own performance. It can also be used by owners to rank D/B firms relative to their service quality performance.

Keywords: Project service quality, design/build construction, quality function deployment

Introduction

If a project can be defined as a temporary endeavour undertaken to create a unique product, the project that is delivered by a D/B firm can be considered to be a unique entity consisting of product (e.g. building, cement plant, etc.) and service (at corporate and project levels). Previous research focused on measuring the service quality performance of D/B firms at the corporate level (Arditi and Lee, 2003), whereas this research focuses on measuring the service quality performance at the project level. The outcome of these two studies is a tool that measures the service quality performance (at the corporate *and* project levels) of D/B firms.

The tool combines experience captured from three expert pools that consist of construction owners, senior managers in D/B firms and a quality system assessor who has extensive experience with D/B firms and projects. The measurement is conducted by performing QFD on data that measure: (1) the needs and expectations of construction owners as transferred from a model developed in previous research, (2) the strength of the relationship between service quality factors and quality management system components at the project level, and (3) the pursued and implemented quality management system in place in D/B projects.

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Measuring project service quality performance

The model developed to measure service quality performance at the project level makes use of ten service quality factors and three quality management system components (see the right most data matrix in Figure 1). The ten service quality factors used in this study were adapted from the original ten dimensions identified by Parasuraman *et al.* (1985). These factors

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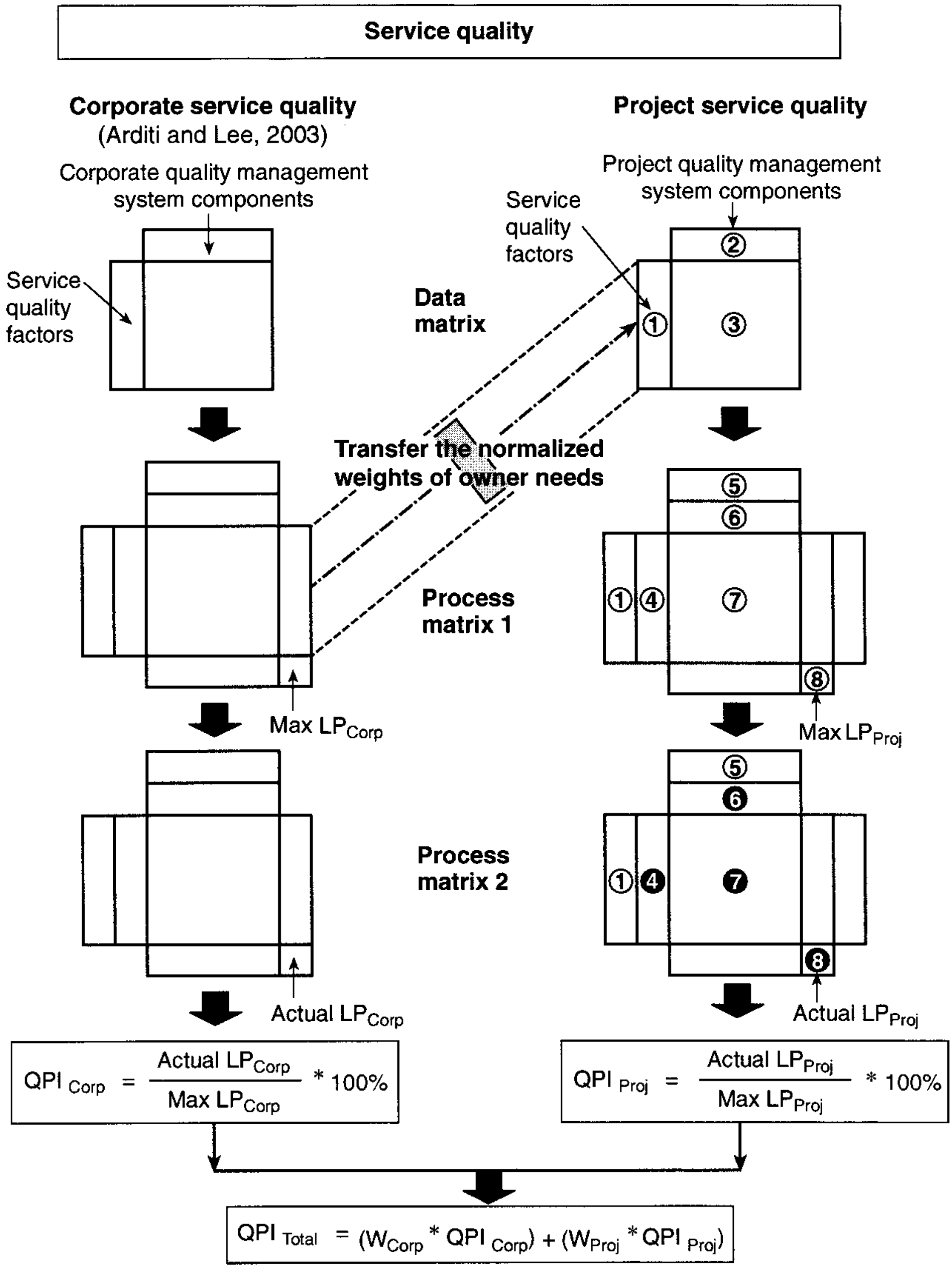

Figure 1 Service quality performance measurement model

Table 1 Project quality management system components (modified from PMI standards)

Components	Definitions
Quality planning	Identifying which quality standards are relevant to the project and determining how to satisfy them
Quality assurance	Evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards
Quality control	Monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate the causes of unsatisfactory performance

are defined and discussed in detail by Arditi and Lee (2003).

The quality management system components at the project level are identified from criteria used in Project Management Institute (PMI) standards and include quality planning, quality assurance, and quality control (PMI, 2000). A list of the project quality management system components and their definitions are presented in Table 1.

The quality of a project is measured by its conformance to a *quality plan* (QP) that is designed to satisfy a customer. *Quality assurance* (QA) in a construction project involves establishing a programme that will maintain effective quality procedures for the entire duration of the construction project to prevent, correct, identify, segregate and control non-conformities whether they are procedure-related, service-related or product-related. A QA programme includes deciding what has to be measured and who measures it (Kagan, 1989). *Quality control* (QC), on the other hand, involves the actual measuring of the conformance of activities to standards previously set in the quality plan. Therefore, the effectiveness of the QP, QA and QC programmes in a project will reflect on the entire project quality performance as defined by PMI (2000). The project service quality performance is associated with the level of proficiency with which the project quality management system processes – QP, QA and QC – are carried out in the project. Although these processes interact and at times overlap with each other, they consist of and include all activities required to ensure that the project will satisfy the quality requirements (PMI, 2000).

Methodology

QFD is defined as ‘a technique to deploy customer requirements into design characteristics and deploy them into subsystems, components, materials and production processes’ (Hoyle, 1998). The senior executives of D/B firms and an independent assessor of quality systems contributed to the research as these parties are directly involved in administering and assessing corporate quality in D/B firms. The elements of QFD are discussed in a systematic way by Arditi and Lee (2003).

The project service quality performance measurement model shown in Figure 1 uses QFD. The details related to the left part of the model that corresponds to the measurement of service quality performance at the *corporate* level are described by Arditi and Lee (2003). The details of the attributes and the data processing for the right part of the model that corresponds to the measurement of service quality at the *project* level are as follows:

- Column ①: this column includes 10 ‘service quality factors’ that were modified from the 10 dimensions identified in Parasuraman *et al.*’s (1985) conceptual model developed after an extensive study of service industries. These factors represent customers’ quality requirements, and their brief descriptions are presented by Arditi and Lee (2003). The relative importance rates of service quality factors were reported by construction owners in a questionnaire survey on a scale of 1 to 10, where 1 represents ‘not important’ and 10 ‘extremely important’, and then the normalized weights of these service quality factors were calculated (Arditi and Lee, 2003) and transferred to Column ① in this model.
- Row ②: this row includes three ‘quality management system components at the project level’, which were adapted from the project quality management system provided by PMI (PMI, 2000). They represent the technical characteristics with which D/B projects’ activities are expected to meet D/B construction owners’ requirements at the project level. Their brief descriptions are presented in Table 1. The relative importance of quality management system components in place at the project level of D/B firms, was reported by senior executives in D/B firms in a questionnaire survey on a scale of 1 to 10, where 1 represents ‘not important’ and 10 ‘extremely important’.
- Matrix ③: this matrix represents the strength of the relationships between the construction owner’s needs and expectations with respect to service quality factors (column ①) and the quality management system components in place at the project level of D/B firms (row ②). This information was obtained from a quality management system assessor (i.e. an independent third party)

by means of a survey instrument on a scale of 0 to 5 where 0 represents 'no relationship' and 5 'perfect (one-on-one) relationship'.

- Column ④: this column represents the status of service quality factors under perfect conditions (i.e. they all score a maximum 5).
- Row ⑤: this row features normalized importance weights for quality management system components at the project level.
- Row ⑥: this row represents the status of project quality management system components under perfect conditions (i.e. they all score a maximum 5).
- Matrix ⑦: the point scores (R_{ij}) were calculated by the synthesis of the information in attributes ①,③,④,⑤ and ⑥.
- Cell ⑧: the maximum level of service quality performance at the project level under perfect conditions is calculated using the procedure defined by Arditi and Lee (2003).
- Column ❹: this column represents the status of service quality factors under actual conditions in a particular D/B project, as assigned by construction owners.
- Row ❻: this row represents the status of project quality management system components under actual conditions in a particular D/B project, as reported by a quality management system assessor.
- Matrix ❼: the point scores (R_{ij}) were calculated by the synthesis of the information in attributes ①,③,⑤,❹ and ❻.
- Cell ❽: the actual level of service quality performance at the project level under actual conditions is calculated using the procedure defined by Arditi and Lee (2003).

Questionnaire surveys were conducted of 126 senior executives of D/B firms listed in the database of the Design Build Institute of America (DBIA), and a quality system assessor. The details of these surveys are reported by Arditi and Lee (2003).

The relative importance of quality performance at the corporate and project levels were prioritized by the three parties, construction owners, senior managers in D/B firms and the quality management system assessor. The score ranged from 1 to 10, where 1 is 'not important' and 10 'very important'.

Findings

The data collected through the two surveys administered to senior executives of D/B firms and the quality management system assessor with experience in D/B projects (corresponding to the top-right matrix in Figure 1) were processed to get Process Matrix 1 (corresponding to the middle-right matrix in Figure 1). Given the data collected in the three surveys described earlier, the maximum level of performance (Max LP) expected in the D/B industry is calculated as 23.00 (bottom right corner cell ⑧ in Process Matrix 1).

As an example, let us now assume that a construction owner who engages a D/B firm wants to assess the service quality performance in this project. If the quality system assessors hired by the D/B construction owner rate the status of the quality management system components in place in the D/B project being investigated (recorded in the status row ❻ of Process Matrix 2 in Figure 1) and the D/B construction owner defines his/her needs by assigning ratings (recorded in the status column ❹ of Process Matrix 2 in Figure 1) based on the particular project's requirements, it is possible to calculate the actual level of performance (Actual LP) expected in the case of the D/B project in question as 20.92 (bottom right corner cell ❽ in Process Matrix 2 in Figure 1). The quality performance index (QPI) of the project in this example is obtained as follows (last step in the right column of Figure 1).

$$
\begin{aligned}
QPI_{Proj} &= \frac{\text{Actual LP}}{\text{Max LP}} \times 100\% \\
&= \frac{\text{Value in right bottom cell in Process Matrix 2}}{\text{Value in right bottom cell in Process Matrix 1}} \\
&\quad \times 100\% \\
&= \frac{20.9233}{23.0040} \times 100 \\
&= 90.95\%
\end{aligned}
$$

In the example presented by Arditi and Lee (2003), the corporate service quality performance was measured for a D/B firm and QPI_{Corp} was found to be 93.68%. If the example project described above is carried out by the very same D/B firm, then the combined service quality performance (at the corporate *and* project levels) can be calculated by making use of the average weights specified in the surveys by owners, D/B executives and the quality system assessor (W_{Corp} = 49.52% and W_{Proj} = 50.48%).

$$
\begin{aligned}
QPI_{Service} &= \left(W_{Corp} \times QPI_{Corp}\right) + \left(W_{Proj} \times QPI_{Proj}\right) \\
&= \left(49.52\% \times 93.68\right) + \left(50.48\% \times 90.95\right) \\
&= 92.30\%
\end{aligned}
$$

It is desirable for the performance index to be as close to 100% as possible. The real benefit of the $QPI_{Service}$ becomes apparent when a construction owner compares the $QPI_{Service}$ of different D/B firms. The

QPI_{Proj} is of value to individual D/B firms who can use it to compare their performance in different projects and take measures to maximize their $QPI_{Service}$ in future projects. They can also benchmark themselves against their competitors.

The project and corporate service quality performance measurement tools are designed as a relational database system using quality function deployment (Doukas *et al.*, 1995; Sriraman *et al.*, 1990). The process matrices 1 and 2 described in Figure 1 are calculated by means of an integrated system designed as an Excel spreadsheet.

Conclusion

The service quality performance measurement model reported in this note was developed as an answer to the need for better quality monitoring in D/B projects. The first step in this study was a service quality performance measurement model that works at the corporate level (Arditi and Lee, 2003). The add-on step involves a service quality performance measurement tool for the D/B project and is reported in the preceding sections. The service quality performance measurement model can be used by a construction owner as a part of a qualification system to rank D/B firms in terms of their service quality performance.

The quality audits and assessments conducted by D/B firms, the owner and third parties such as ISO 9000 quality management system auditing and consulting firms can have greater impact when used in association with the tool described in this note, which in turn is expected to lead to higher efficiency levels of quality management in D/B construction. Furthermore, the systematization of service quality performance measurement on an industry-wide basis facilitates the diffusion of quality management information among the parties involved in construction.

This quality performance measurement tool is applicable only to D/B firms and projects, since the surveys that investigate owners' needs and expectations and construction executives' views have been conducted only for this type of organization. Future research should include the development of a tool that measures the quality performance of the constructed facility.

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