Regular Article

Performance evaluation for hospital facility management: literature review and a research methodology

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ABSTRACT

Underpinning the quality of health services is a wide range of facilities services that require effective management. With the importance of such facilities management (FM) increasingly recognized, research on healthcare FM has grown, with many that attempted to develop some performance frameworks or key performance indicators (KPIs) for hospital FM. A credible scheme that is tailored for evaluating the holistic FM performance of hospital buildings, however, is yet to be seen. In order to establish such a performance evaluation scheme, a research project was initiated. A review of the literature germane to hospital FM and the groundwork completed by the research team, based on which the project was formulated, is reported in this paper. The research methodology of the project and the five stages of rigorous research work, including a multi-pronged approach to data collection, the method for processing the data with an analytic network process (ANP) and the steps for establishing the intended evaluation scheme, are also described.

Keywords: assessment; healthcare; KPI; performance; scheme

Introduction

Health services in hospitals are underpinned by a wide range of facilities services (BIFM, 2015; IFMA, 2015), which include soft-side services such as reception, catering and cleaning etc. (Whitehead et al, 2007) and various engineering services on the hard side. As identified in a study on hospitals (Yik and Lai, 2009; Yik et al., 2012), there is an array of engineering services such as: electricity supply and lighting systems; steam and hot water systems; heating, ventilating and air-conditioning system; medical gases system; to name but just a few. Their operating expenses, according to the Hospital Authority, are substantial (HA, 2014).

Realizing the importance of quality FM services for hospital buildings, research on the performance of healthcare facilities has grown. But the absence of a credible scheme for systematic assessment of hospital FM performance remains a live issue. In order to address this issue, a research project has commenced. Reported in the next section is a review of the literature germane to hospital FM performance evaluation, including the studies conducted by other researchers and the groundwork completed by the research team of the current project. Based on the literature review, as described in the section after the next, a methodology has been formulated for the five stages of research work required for project.

Literature review: past studies by others

Among the past studies on hospital FM performance assessment, Amaratunga et al. (2002) developed a structured process improvement for construction environments – facilities management (SPICE FM) approach for use on a case study of the National Health Service. Intending to develop a methodology for evaluating healthcare buildings based on performance and economic criteria, 17 public healthcare facilities in Israel were studied and the condition of buildings assessed using a building performance indicator (BPI), which is composed of the weighted average of the scores given to various building systems (Shohet, 2003a). In the extended studies (Shohet, 2003b; Shohet et al., 2003), three more key performance indicators (KPIs): manpower sources diagram (MSD), maintenance efficiency indicator (MEI) and managerial span of control (MSC) were applied to case study analyses. After defining six core healthcare FM domains (Shohet and Lavy, 2004a), Shohet and Lavy (2004b) proposed an integrated healthcare FM model. Further work was carried out to identify the effects of building age and occupancy level on facilities performance (Lavy and Shohet, 2007), and two case studies illustrated the robustness of their model (Lavy and Shohet, 2009).

In an attempt to evaluate the FM performance of public hospitals in Hong Kong, Chan (2004) introduced a facilities performance indicator (FPI). Each component of

TABLE 1.—An integrated process-hierarchy model (with examples of KPIs)

Hierarchical level	Input	Process	Output
Strategic	$\frac{O\ \&\ M\ cost}{Building\ area}$	-	$\frac{Building\ income}{Building\ area}$
Tactical	$\frac{O\ \&\ M\ cost}{Capacity\ of\ installation}$	*% compliance with required response time*	*% users dissatisfied*
Operational	$\frac{No.\ of\ manhours}{Capacity\ of\ installation}$	*No. of equipment faults per month*	*No. of completed work orders per staff*

Facilities services delivery →

the FPI, scored on a 0-100 scale, is weighted according to their life-cycle costs. In Germany, a project named OPIK (Optimisation and Analysis of Processes in Hospitals) was carried out to analyze the interaction between medical and FM business processes in six hospitals (Lennerts et al., 2003).

Aimed at introducing a measure to assess the perceived effectiveness of multi-hospital organizations (MOs), Yavas and Romanova (2005) surveyed top managers of non-profit hospitals in the United States to solicit their perceived importance and performance levels of 11 motives for participating in an MO. In the United Kingdom, Liyanage and Egbu (2008) proposed a framework for the performance management of FM services in hospitals. Using empirical data generation and semi-structured interviews, Madritsch et al. (2008) analyzed the operating costs of 18 long-term care facilities.

In Malaysia, Ali and Mohamad (2009) assessed the performance of a district hospital under five elements: leadership; policies, plans and procedures; training and orientation; monitoring and supervision; and service performance. In Canada, Steinke et al. (2010) developed a 10-step process based on a conceptual model called Building Performance Evaluation Scorecard, which covers four performance dimensions: service, functional, physical and financial. Upon completion of a literature review, Fronczek-Munter (2013) proposed the Evaluation Focus Flower model for the selection of healthcare facilities evaluation methods.

Literature review: groundwork of the research team

The research team of this project has conducted various studies on hospitals, including one that investigates the feasibility of outsourcing hospital engineering services (Yik and Lai, 2009). One of the study's major findings is that the performance of the services was dominated by the nature of different services trades (Yik et al., 2012).

In a bid to develop key performance indicators (KPIs) for building operation and maintenance (O&M), a study was carried out (Lai and Yik, 2006). Based on common examples of KPIs and with due incorporation of two essential facilities services dimensions - delivery process and hierarchical structure of an FM organization, an integrated process-hierarchy (P-H) model (Table 1) was developed to guide the evaluation of input resources, delivery processes and output performance of facilities services by FM practitioners at the strategic, tactical, and operational levels (Lai and Man, 2018a).

Intended to develop a performance evaluation scheme for commercial buildings, a literature review identified over 70 applicable performance indicators (Lai and Man, 2018a). A focus group meeting was then convened, resulting in a shortlist of indicators categorized into five groups: physical, financial, task and equipment related, environmental, and health, safety and legal (Lai and Man, 2018b). A questionnaire survey was made to single out the most important indicators (i.e. KPIs) from the shortlisted indicators and, with the responses from different stake-holder groups (building developer, owner, management company) and FM practitioners at different levels (strategic, tactical, operational), the factors affecting the importance levels of the indicators were analyzed (Man and Lai, 2013). Eventually, the relationships between the final KPIs (4 main categories, 3 subcategories and 11 individuals) were made clear. Afterwards, a series of face-to-face interviews were held with FM experts. Using Saaty's (1996) Analytic Network Process (ANP), a network of interactions between the KPIs was constructed (Figure 1) and their importance weightings were determined for establishing the intended scheme (Man and Lai, 2015). In the final part of that study, the applicability of the scheme was tested using O&M records data of commercial buildings.

Research methodology

In principle, FM operational inputs determine the performance of facilities and hence the quality of facilities services to their end users. Data on FM performance may be collected through: measurement of physical parameters

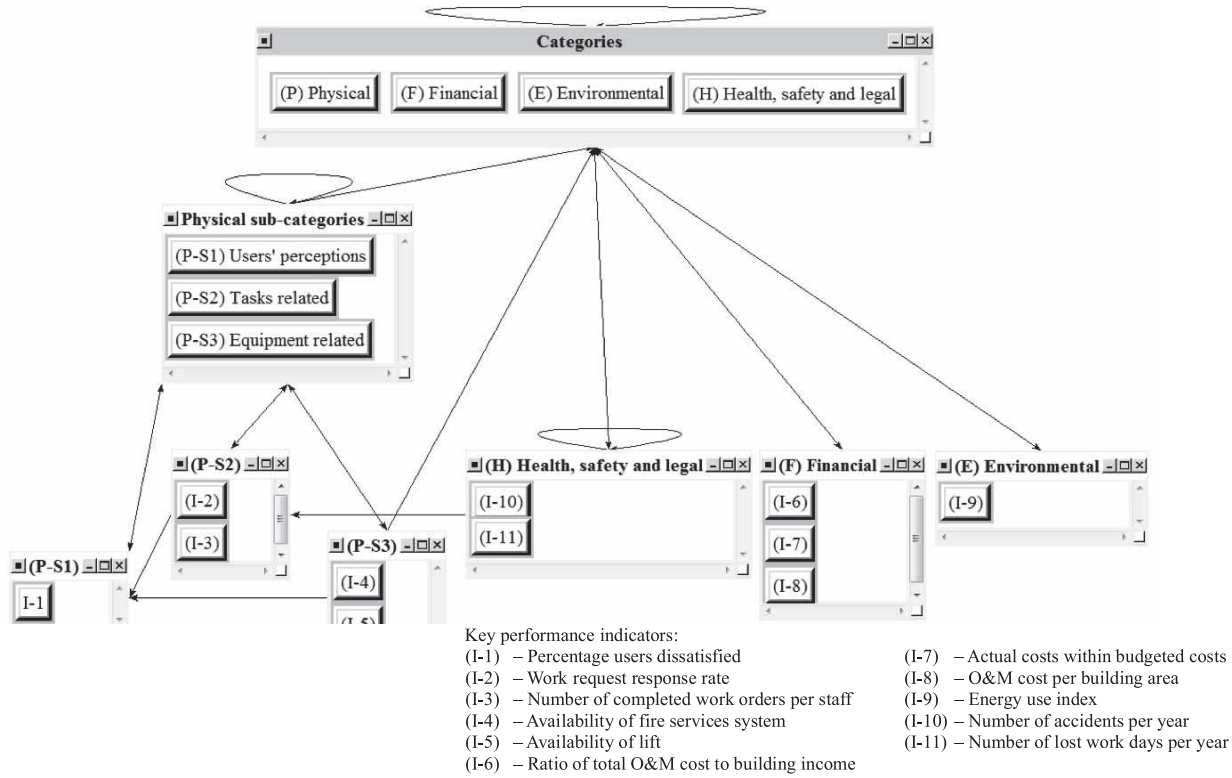


FIGURE 1.—Network constructed for ANP analysis

(e.g. indoor air temperature), collection of end user perceptions (e.g. perceived thermal comfort level), or a combination of both. The data can be processed to evaluate the performance of the facilities, and the resultant findings can serve as valuable feedback information for FM personnel at different levels - strategic (e.g. department head), tactical (e.g. manager) and operational (e.g. technician). Such a performance evaluation schema is depicted as Figure 2 (Lai and Man, 2017).

A model of tendencies between perceived importance (I) and performance (P) of elements being assessed, shown as an I-P matrix in Figure 3, has been developed (Lai and Yik, 2009). The plausible tendencies (arrows A to H) would arise if there are correlations between perceived judgements on performance and importance. Such findings are qualitative. Comparing them with KPIs that are computed from quantitative data (e.g. facility's availability) will unveil if the perceived judgements do also represent actual FM performance levels. In addition to outcome performance, FM costs should also be assessed in order to obtain a holistic evaluation. For this purpose, the FM performance levels need to be plotted against the cost inputs (Figure 4) to determine the performance footprints (Lai and Yik, 2011). Gauging changes in the footprints over time will inform whether: the FM service is value-for-money, the use of resources is ineffective, more resources are needed, or there are factors other than cost that dominate the FM performance.

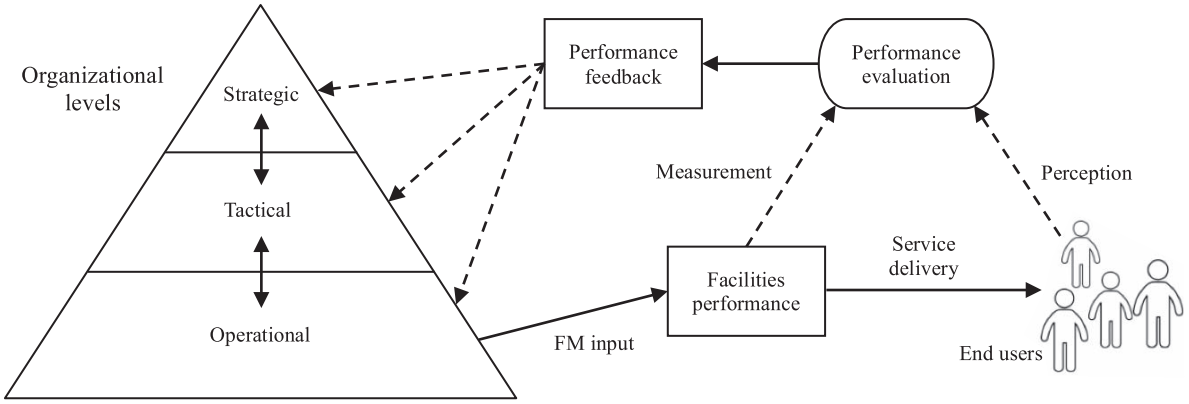
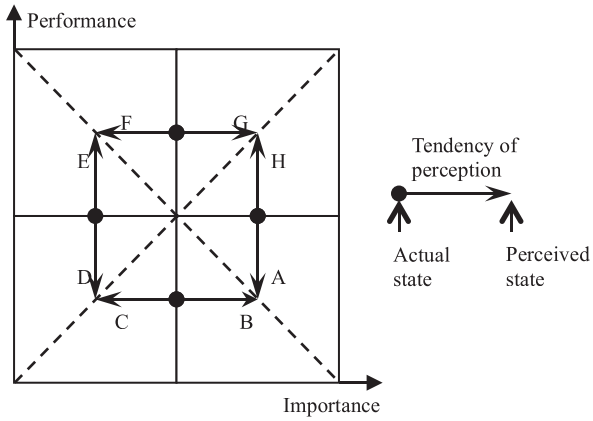


FIGURE 2.—Information and resources flows in facilities services delivery



A: Perceived low performance due to high expectation commensurate with perceived high importance
B: Perceived high importance due to dissatisfaction with poor performance
C: Perceived low importance due to adaptation to poor performance
D: Perceived low performance due to lack of attention given rise by perceived low importance
E: Perceived high performance due to low expectation commensurate with perceived low importance
F: Perceived low importance with good performance taken for granted
G: Perceived high importance due to the desire to strive for even better performance (despite the already good performance perceived)
H: Perceived high performance relative to low performance

FIGURE 3.—Tendencies of perceptions between importance and performance

Research stages

Built upon the above review and groundwork, five stages of work will be carried out for the study.

Stage 1

Adding to the literature search in preparing this proposal, further effort will be made upon the commencement of this study to review any new and relevant publications. The literature review will identify measures that are applicable for assessing the FM performance of hospital buildings. The identified measures will be grouped into different aspects (e.g. safety, financial, environmental, etc.) and with reference to the P-H model in Table 1, they will be classified by FM services delivery process and FM organization hierarchical level.

Stage 2

A series of questions will be designed for use in a focus group meeting in order to examine and confirm the usefulness of the above measures in real-world applications. In particular, healthcare professionals will be invited from among the members of the Hong Kong branch of the Institute of Healthcare Engineering and Estate Management (IHEEM) to join the focus group. Subject to a consensus of the meeting participants, performance measures may be added, modified, and/or removed.

Stage 3

The performance measures refined in Stage 2 will form the basis for designing a survey questionnaire for distribution to the healthcare FM community. Targeting the members of the IHEEM, the survey will solicit opinions on the essential measures that should be included in the intended performance evaluation method. Similar to the approach of an earlier work (Man and Lai, 2013), the respondents will be asked to indicate the importance level of each performance measure. Based on the responses, a Relative Importance Index (*RII*) will be computed for each measure using Equation 1, where I_r is the importance level given by each respondent to a measure, I_m is its maximum importance level, and N is the total number of respondents. The measures will be ranked according to their *RII* values. Those with a relatively high value will be shortlisted as KPIs for use in the evaluation method.

$$RII = \left(\sum_r^N I_r\right) \Big/ (I_m \cdot N) \quad (1)$$

$$S_T = S_1 \cdot W_1 + S_2 \cdot W_2 + S_3 \cdot W_3 + \cdots + S_n \cdot W_n \quad (2)$$

$$P_N = (P_a/P_m) \times 100\% \quad (3)$$

$$\tilde{S}_T = S_T/\tilde{C}_T \quad (4)$$

$$\tilde{C}_T = C_T/A_h \quad (5)$$

Stage 4

A second focus group meeting will be convened during which the research team will show the possible interdependencies and influences between the shortlisted KPIs, and the participating FM experts will be facilitated by the research team to discuss and agree on a network diagram that represents the relationships between the KPIs. Such a diagram (similar to Figure 1) is essential for the next stage of interviews and data analysis under the ANP.

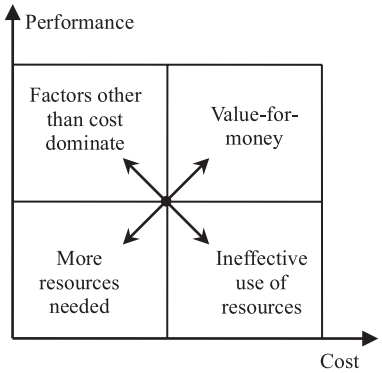


FIGURE 4.—Cost-performance matrix

Stage 5

To complete the method's development, a series of face-to-face interviews - each of which consists of two parts - will be held with FM professionals working on three types of hospital: general (with an emergency department), district (with large numbers of beds for intensive care and long-term care), and specialised (with particular specialties such as rehabilitation, psychiatric treatment, etc.). As the performance of facilities may vary with age, for each hospital type samples of three different age groups (young, middle, old) will be taken and, to examine factors that affect FM performance, a pair of samples will be taken for each of the three groups.

During the first part of each interview (Part A), importance weightings will be solicited from the interviewees by taking the following steps with the use of the SuperDecisions software (Creative Decisions Foundation 2012; Saaty, 2005), similar to those carried out in a previous study (Man and Lai, 2015). Upon determination of the weightings, a performance scoring scheme will be devised for each building being studied, as represented in Equation 2, where S_i is performance score, W_i is importance weighting, and S_T is overall FM performance score.

In the second part of the interview (Part B), data for scoring each performance measure will be collected. To this end, relevant data will be retrieved from the FM records of the buildings. For measures whose possible performance levels lie within a bounded scale of 0-100%, e.g. 'availability of lift service', the actual value in the record will be taken as the performance score. For those with performance levels not bounded by definite limits, e.g. 'number of incidents', their actual performance level (P_a) will be normalized with respect to their maximum performance level (P_m). The normalized values (P_N) of individual measures, as calculated in Equation 3, will be taken as their performance scores (S_i) for input to the performance scoring scheme (Equation 2), thus demonstrating the applicability of the scheme.

The importance weightings and performance levels of the FM services obtained from Parts A and B will be plotted on the I-P matrix (Figure 3) to show if any of the eight perception tendencies exists. The performance levels of individual services trades over different time periods will be plotted against the corresponding input costs to show any changes in the performance footprints of the services. These findings, to be interpreted with the aid of the cost-performance matrix in Figure 4, are useful for internal performance benchmarking. In order to complete the evaluation for the FM services, the overall performance score of the services (S_T) will be processed using Equation 4 to yield a normalized overall performance score ($\mathcal{S}_T$), where ($\mathcal{C}_T$), to be computed using Equation 5, is the total services cost (C_T) normalized by hospital area (A_h). In this way, $\mathcal{S}_T$ can serve as an external performance benchmarking index, enabling fair performance comparisons to be made across the same type of hospitals, even if their scales (areas) are different.

Conclusion

Given the importance of FM and its leverage effect on the functions of healthcare facilities in hospitals, research on performance evaluation for hospital FM has grown. Across the world many studies have attempted to develop some performance frameworks or key performance indicators for hospital FM, but a scheme for evaluating the holistic performance of FM for hospital buildings remains unavailable. After completing the literature review, a research methodology has been formulated for a project to establish the intended hospital FM performance evaluation scheme. Comprising five stages of rigorous research work, the project has been ongoing. Findings of the project, when available, will be reported for sharing with the FM research and professional communities in future.

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