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Identifying Key Performance Indicators for Facilities Management in Hospital Buildings

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Abstract

Quality health services entail not only competent healthcare professionals but also effective management of the underpinning facilities. Realizing the importance of quality facilities management (FM) services for hospital buildings, research in this area has grown. But the absence of a credible, scientific method for systematic evaluation of hospital FM performance remains a live issue. Intended to develop such a method, a multi-stage research project has commenced. At the first stage of the project, as reported in this article, a review of relevant literature was conducted to identify indicators that are applicable to assessing hospital FM performance. The 61 indicators identified fall into 6 aspects: financial, physical, safety, patience experience, environmental, and functional. Using the phase-hierarchy (P-H) model, which is a 2-dimensional matrix comprising three phases (input, process and output) of facilities services delivery and three hierarchical FM levels (operational, tactical and strategic), the safety indicators were systematically classified. The majority of them, for measuring the output of a facilities services delivery process, are useful to FM practitioners at the strategic and tactical levels. This method, to be used for classifying the indicators in the remaining aspects, can also be applied to similar future studies on key performance indicators (KPIs).

Keywords: facility, healthcare, hospital, KPI, performance

1. Introduction

Facilities in hospital buildings need to be properly managed in order to perform their intended functions. Performance evaluation, which is a facilities management (FM) tool, is essential for ensuring effective operation of facilities. Without a proper performance evaluation, it is not possible to know how well the facilities have been managed. Underperformance of facilities, if undetected, undermines hospital operations, resulting in operational standstills or even fatalities (O' Mahony et al, 1990; The Telegraph, 2015).

Realizing the importance of quality FM services for hospital buildings, research in this area has grown in recent years. But a credible method developed on a scientific basis for systematic assessment of hospital FM performance remains unavailable. Healthcare FM professionals are, therefore, confronted with the difficulty of providing concise yet holistic reports on the performance of the facilities they manage. Aiming to tackle this problem, a research study has commenced.

Given that Hong Kong is built with hospitals that are under intense demand from its large population (Hospital Authority, 2014), the city serves as a suitable place for the study. To enable performance measurement of the most essential hospital FM services, the fundamental part of the study is to identify performance indicators that are applicable to the services.

As reported in the next section, a review has been made on the major studies on FM performance indicators in the past. Then, the research process of the current study and the model developed earlier for systematic classification of performance indicators are described in Section 3. In Section 4, the performance indicators found to be applicable to hospital buildings are reported and how the above-mentioned model was used to classify such indicators is illustrated. After discussing the findings, the final part (Section 5) provides the conclusions drawn from the work completed and the work needed in future.

2. Major past studies

Key performance indicator (KPI) is a widely adopted model for measuring FM performance (Meng and Minogue, 2011). Over the years, in fact, many attempts have been made to identify performance indicators for managing facilities in existing buildings. For example, Hinks and McNay (1999) found that FM performance could be measured by as many as 172 indicators, which can be grouped into 8 dimensions: business benefit, equipment, space, environment, change, maintenance/service, consultancy, and general.

In the study of Shohet (2003a), the condition of the buildings in 17 public healthcare facilities in Israel was assessed using a building performance indicator (BPI). Afterwards, 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 (Shohet, 2003b; Shohet et al., 2003).

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 the FPI, scored on a 0-100 scale, is weighted according to their life-cycle costs. This scoring system, as the author remarked, was in its infancy and required further improvement.

A review on the estate performance measurement for nine international healthcare organisations, which identifies the attributes and KPIs in use, shows that there is a common set of attributes and KPIs adopted

by the majority of the organisations (Rodriguez-Labajos et al., 2016). The large number of KPIs identified were grouped into different attributes and then different dominions; in total, there are 7 dominions: financial, physical, safety, functional, patient experience, environment, and others.

Aimed at developing KPIs for building operation and maintenance (O&M), a study was conducted by Lai and Yik (2006). In that study, some common examples of KPIs were given to illustrate that the performance of O&M services can be assessed by referring to the different stages of a facilities services delivery process and the different hierarchical levels of an FM organization.

Forming part of a comprehensive study that purports to develop a scheme for evaluating the O&M performance of commercial buildings (Lai and Man, 2017), a literature review, which found over 70 applicable performance indicators and presented a model for classifying the indicators systematically (Lai and Man, 2018a), addressed the need of proper categorization for performance metrics (Lavy et al., 2010). Through a further focus group study, a shortlist of 17 indicators, belonging to 5 categories (physical; financial; task and equipment related; environmental; and health, safety and legal) were identified (Lai and Man, 2018b). Such indicators, after refinements, became 11 KPIs in 4 main categories (Lai, 2016): (1) physical (sub-categories: (1a) user perception, (1b) tasks related, and (1c) equipment related), (2) financial, (3) environmental, and (4) health, safety and legal.

3. Research process and the P-H model

As described in Lai and Yuen (2018), a research project for developing an analytic FM performance evaluation method for hospital buildings has commenced. It comprises five stages of work:

Stage 1 - Literature review (extended)
- Identify measures (performance indicators) that are applicable for assessing the FM performance of hospital buildings
- Group the performance indicators into different aspects
- Classify the performance indicators in a systematic manner

Stage 2 - Focus group meeting (1^{st})
- Convene a meeting for the focus group participants to examine and confirm the usefulness of the above-identified performance indicators in real-world applications
- Refine (add, modify and/or remove) the performance indicators subject to a consensus of the participants

Stage 3 - Questionnaire survey
- Design a survey questionnaire based on the performance indicators refined in Stage 2
- Distribute the questionnaire to the healthcare FM community
- Shortlist the key performance indicators (KPIs) based on the survey result

Stage 4 - Focus group meeting (2^{nd})
- Convene a second focus group meeting for participants to discuss and agree on a network diagram that represents the relationships between the KPIs (the network diagram is essential for the next stage of interviews and data analysis using the Analytic Network Process (ANP))

Stage 5 - Interviews
- Conduct face-to-face interviews with hospital FM professionals to collect their opinions and facilities performance data

- Determine importance weights of the KPIs based on the opinions and data collected

Requiring an extensive review of the relevant literature, Stage 1 as a key part of the project is reported in the subsequent sections of the current article. This stage of work is to answer the following questions: What elements of hospital FM performance should be measured? For each element, are there any applicable performance indicators? If so, which are useful for performance measurement?

When the applicable performance indicators are made known, they need to be classified systematically (Lai and Man, 2018a). For this purpose, an initial step is to examine the meanings of the indicators and group them into different aspects (e.g. financial, safety, etc.) and sub-divided aspects (i.e. facets). Using the result of this step, the indicator will be further classified in the next step by referring to the phase-hierarchy (P-H) model (Figure 1) of Lai and Man (2018a). Developed based on the performance evaluation schema of Lai and Man (2017), the P-H model enables systematic classification of FM performance indicators and it integrates two performance evaluation dimensions:

(i) the horizontal dimension covers the different phases (input, process and output) of facilities services delivery
(ii) the vertical dimension refers to the hierarchical levels (operational, tactical and strategic) of an FM organization

Hierarchical level ↑

Strategic (S)	I, S	P, S	U, S
Tactical (T)	I, T	P, T	U, T
Operational (O)	I, O	P, O	U, O
	Input (I)	**Process (P)**	**Output (U)**

Facilities services delivery (phase) →

Figure 1: The P-H model for classifying performance indicators (Lai and Man, 2018a)

According to the P-H model, performance indicators can be classified with respect to the phase (horizontal) dimension and the hierarchy (vertical) dimension. With three classes on each of the two dimensions, there are nine possible classes of performance indicators: input-operational (I, O); input-tactical (I, T); input-strategic (I, S); process-operational (P, O); process-tactical (P, T); process-strategic (P, S); output-operational (U, O); output-tactical (U, T); and output-strategic (U, S).

4. Findings and discussion

From the preceding literature review, two studies are particularly useful for identifying FM performance indicators applicable to hospitals in Hong Kong. The first one is Rodriguez-Labajos et al. (2016), which reviewed the performance measurement for international healthcare organisations. The other one is Lai (2016), from which 11 KPIs were identified. While the latter study was based on commercial buildings, the KPIs identified are fit for the O&M practice in Hong Kong. The total number of performance indicators, combined from these studies, is 61. Such indicators fall into 6 aspects.

As shown in Table 1, the first aspect is "financial", of which the 21 indicators belong to 5 facets: operational cost, maintenance cost, backlog maintenance cost, resource allocation, and productivity. The second aspect is "physical", under which there are 5 facets covering 9 indicators. The last aspect in Table 1 is "safety". The seven safety indicators fall into 4 facets: accident/injury, statutory compliance, risk associated with backlog maintenance, and fire incident.

Table 1: Financial, physical and safety indicators

Aspect	**Facet**	**Performance indicator**
Financial	Operational cost	(F1) Ratio of total O&M cost to building income; (F2) Actual costs within budgeted costs; (F3) O&M cost per building area; (F4) Annual operation cost; (F5) Total operating cost; (F6) Cleaning cost; (F7) Rates cost; (F8) Catering cost; (F9) Pottering cost per consumer week; (F10) Laundry and linen cost per consumer week; (F11) Energy cost; (F12) Waste cost per consumer week; (F13) Facilities management cost; (F14) Cost efficiency score
	Maintenance cost	(F15) Maintenance cost per sq.m.; (F16) Total maintenance expenditure by functional area
	Backlog maintenance cost	(F17) Backlog maintenance cost per sq.m.; (F18) Total maintenance backlog cost / gross internal area (GIA)
	Resource allocation	(F19) Annual maintenance expenditure as a % total replacement value; (F20) Sustain rate
	Productivity	(F21) Adjust treatment index (ATI)
Physical	User perception	(P1) % users dissatisfied
	Tasks related	(P2) Work request response rate; (P3) Number of completed work orders per staff
	Equipment related	(P4) Availability of fire services system; (P5) Availability of lift
	Physical condition	(P6) Percentage of the estate to be in excellent or satisfactory condition with evidence of only minor deterioration or above; (P7) Facility condition index (FCI) or Condition index (CI); (P8) Physical condition index
	Age	(P9) Percentage of properties less than 50 years old; (P10) Percentage of the estate built since 1948; (P11) Average age
Safety	Accident/injury	(S1) Number of accidents per year; (S2) Number of lost work days per year
	Statutory compliance	(S3) Overall percentage compliance score from Statutory Compliance Audit and Risk Tool (SCART); (S4) percentage of the estate that is required to take action in the current plan to comply with relevant guidance and statutory requirements
	Risk associated with backlog maintenance	(S5) Significant and high risk backlog maintenance as percentage of total backlog expenditure requirement; (S6) Total risk adjusted backlog maintenance
	Fire incident	(S7) Number of unwanted (false) fire incident calls/ GIA; (S8) Number of fire incidents/ GIA

The remaining indicators, as summarized in Table 2, are in three other aspects. The first of such aspects is "patience experience", which comprises 3 facets, embracing 6 indicators. Some of these indicators (e.g. Pa 3), which seem to share some coverage with, for example physical indicator P1, would be reviewed in a later stage. The second aspect in Table 2 is "environmental", where there are 7 indicators grouped into 3

facets: energy performance, water and waste, and sustainability. Comprising also 3 facets (utilization, available capacity, functional suitability), the final aspect is “functional”, which covers a total of 8 indicators.

Table 2: Patient experience, environmental and functional indicators

Aspect	**Facet**	**Performance indicator**
Patience experience	Quality of the building	(Pa 1) Percentage of properties categorised as excellent or satisfactory quality in terms of amenity, comfort engineering and design
	Single bedrooms	(Pa 2) Percentage of single bedrooms for patients
	Patient feedback	(Pa 3) Positive response to patient questionnaire on patient rating of hospital environment; (Pa 4) Percentage of positive response for privacy and dignity; (Pa 5) Percentage of positive response for cleanness and tidiness; (Pa 6) Percentage for positive response for food services
Environmental	Energy performance	(En 1) Energy use index; (En 2) Total site energy consumed/heated; (En 3) Net energy consumption; (En 4) Carbon dioxide emissions/ occupied floor area; (En 5) % of the estate with an energy consumption of 410kWh/m2 or less
	Water and waste	(En 6) Water, sewage and waste carbon indicator
	Sustainability	(En 7) Sustainability index (SI)
Functional	Utilisation	(Fn 1) Space utilisation (percentage of properties categorised as fully utilised; building area sq.m. per consumer week; % of occupied floor area; percentage of space utilisation; required program space vs. the existing space); (Fn 2) Utilisation index; (Fn 3) Usage (Total replacement value/ weighted separation; weighted separation per sq.m.; asset depreciation/ weighted output measure of service)
	Available capacity	(Fn 4) Beds per 1,000 people; (Fn 5) Theatres per 10,000 people
	Functional suitability	(Fn 6) Percentage of properties classified as ideal accommodation or very satisfactory; (Fn 7) Functional unsuitability (% of occupied floor); (Fn 8) Functional performance index

To further classify which hierarchical level of an FM organization and which phase of a facilities services delivery process the above performance indicators belong to, the P-H model was used. As an example, the indicators in the “safety” aspect were taken to illustrate how the classifications were made (Figure 2).

For indicators (S1) Number of accidents per year and (S2) Number of lost work days per year, they reflect the outcome performance of the FM team in preventing the occurrence of accidents or the consequence of lost work days (e.g. resultant from occupational injuries). Such “output” indicators are useful to both the strategic and tactical management levels of an FM organization.

For reflecting the outcome performance in complying with statutory requirements, two indicators, namely, (S3) Overall percentage compliance score from SCART and (S4) percentage of the estate that is required to take action in the current plan to comply with relevant guidance and statutory requirements, are useful. These two indicators, same as the preceding two - (S1) and (S2), can help the strategic and tactical levels of staff manage the output of FM services.

Phase / Level	Input	Process	Output	More than one phase
Strategic	**0** -	**2** (*S5*, *S6*)	**7** (*S1*, *S2*, *S3*, *S4*, *S5*, *S6*, *S8*)	**2** (*S5*, *S6*)
Tactical	**0** -	**2** (*S5*, S6)	**8** (*S1*, *S2*, *S3*, *S4*, *S5*, *S6*, *S7*, *S8*)	**2** (*S5*, *S6*)
Operational	**0** -	**0** -	**0** -	**0** -
More than one level	**0** -	**2** (*S5*, *S6*)	**7** (*S1*, *S2*, *S3*, *S4*, *S5*, *S6*, *S8*)	

Notes: 1) **Boldfaced numbers** denote quantities of indicators in the respective phase-level classes. 2) *Italicised texts* denote indicators applicable to more than one level. 3) Underlined texts denote indicators applicable to more than one phase.

Figure 2: Mapping of the safety indicators

The size of backlog maintenance, which is the ratio of the number of overdue maintenance tasks to the number of maintenance, can help tactical staff measure the maintenance process (Lai and Man, 2018a). Here, indicator (S5) denotes significant and high risk backlog maintenance as percentage of total backlog expenditure requirement and indicator (S6) denotes total risk adjusted backlog maintenance. When calculated on a monetary (cost) basis (NHS Estates, 2004), this pair of indicators is not only useful tactical measures for the maintenance process but also useful for assessing the maintenance output and the strategic maintenance investment of an FM organization.

The last pair of safety indicators, belonging to the "fire incident" facet, are (S7) Number of unwanted (false) fire incident calls/ GIA and (S8) Number of fire incidents/ GIA. Representing how well the facility services are delivered to prevent fire incidents, they both are "output" indicators. Indicator (S7) is useful for tactical staff to assess the extent of nuisance resultant from unwanted fire alarms whereas indicator (S8), which shows the actual number of fire incidents occurred, is also important in the eyes of senior management at the strategic level.

As far as the safety indicators are concerned, as shown in Figure 2, none of them falls into the operational level of the P-H model. All the 8 safety indicators are useful to the tactical staff, and 7 of them are also useful for strategic management purposes. Viewing from the horizontal dimension of the P-H model, there is no safety indicator in the input phase. While only 2 safety indicators are "process" measures, all the 8 indicators are "output" measures. Overall, 7 of all the safety indicators lie across two hierarchical levels – tactical and strategic, and 2 indicators are applicable to both the "process" and "output" phases.

5. Conclusions and future work

Forming the fundamental part of a multi-stage research project, the study reported above, through a literature review, identified 61 indicators that are applicable to assessing the FM performance of hospital buildings. The 6 aspects of such indicators are: financial, physical, safety, patience experience, environmental, and functional. In each aspect, there are 3 to 5 sub-divided facets. In terms of quantity of indicators, the financial aspect, with 21 indicators, prevails over the other aspects.

The P-H model, which had been used to classify O&M performance indicators for commercial buildings

(Lai and Man, 2018a), is also useful for classifying the FM performance indicators for hospital buildings. As illustrated, the majority of the safety indicators, which are useful to FM practitioners at the strategic and tactical levels, measure the output of a facilities services delivery process. Following this method, further effort will be made to systematically classify the remaining hospital FM performance indicators along the phase and hierarchy dimensions of the P-H model.

As it is neither practicable nor effective to use a large number of indicators to measure FM performance in practice, the next stage of work is to shortlist the most essential indicators for use in real-world hospitals. For this purpose, the opinions of FM experts in the hospital sector will be solicited through a focus group meeting. Findings of such shortlisted indicators and the remaining stages of the research project will be reported in future.

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