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Performance indicators for facilities operation and maintenance (Part 2): shortlisting through a focus group study

Structured abstract

Purpose
The study reported in this paper (Part 2 of 2) aims to shortlist performance indicators for use in evaluating facilities operation and maintenance (O&M) in commercial buildings.

Methodology/approach
A three-session focus group meeting, with the use of a customised questionnaire and audio-recording, was convened to solicit opinions from O&M experts. Their quantitative responses (ratings on the importance of the indicators) and the qualitative ones (reasons for having the indicators selected or excluded) were taken for analysis, followed by mapping the shortlisted indicators based on the phase-hierarchy (P-H) model for facilities management (FM).

Findings
From a total of 74 performance indicators (71 identified from the literature and three added by the focus group), 17 indicators were shortlisted, and time constraint was the most common reason for having those indicators excluded from the shortlist. Mapping the shortlisted indicators with the P-H model revealed that the performance evaluation focus of the experts was at the tactical level, on the output phase of facilities services delivery.

Research implications
The shortlisted indicators serve as a keystone for establishing a performance evaluation scheme for engineering facilities in commercial buildings. Research on other areas may follow the approach of this study to shortlist key performance indicators (KPIs).

Practical implications
Professionals of the other building types (e.g. residential, industrial, healthcare, etc.) or sectors with diverse FM organizations may conduct a similar study to identify indicators for performance evaluation purposes. In particular, the process of shortlisting the O&M KPIs may be used to shortlist KPIs for the other FM services.

Originality/value
The focus group study demonstrates how to rigorously select KPIs for use in managing facilities.

Paper type
Research paper

Keywords
Assessment, commercial properties, facilities, KPI, maintenance, performance

Performance indicators for facilities operation and maintenance (Part 2): shortlisting through a focus group study

Introduction

As the preceding, companion article (Part 1) shows, a total of 71 indicators were found from the literature as applicable for evaluating the operation and maintenance (O&M) performance of engineering facilities in commercial buildings. These indicators fall into five groups: six in the physical group; 22 in the financial group; 30 in the financial group; six in the environmental group; and seven in the health, safety and legal group. As reviewed earlier (Lai and Man, 2017), the physical indicators can reflect how well the builder's work (e.g. walls, windows) and building services systems (e.g. air-conditioning, lighting) have performed. The financial indicators are related to expenditure and revenues of a building. Performance levels associated with matters like maintenance response, efficiency and availability of facilities can refer to the technical indicators. The environmental indicators, measuring energy use, greenhouse gas emissions and so on, are conducive to attaining a sustainable built environment. Indicators in the health, safety and legal group can show how well the O&M team have done in safeguarding the health and safety of building occupants and avoiding mishaps (e.g. power outage leading to business loss) that result in legal claims.

Despite the applicability of all the 71 indicators, using such a long list of indicators to evaluate the facilities' performance, in practice, would require a great deal of effort for recording, retrieving and processing the needed data, rendering the evaluation ineffective. And before an industry-wide survey could be devised to investigate the opinions of a large number of O&M practitioners on the indicators, it is necessary to shortlist the indicators, with the non-essential ones removed. For this purpose, a focus group meeting, which serves as an effective platform for soliciting the opinions of experts in the respective field (Ritchie and Lewis, 2003; Bryman and Bell, 2011), is helpful.

In the next section of this article (Part 2), the preparation works made for the focus group meeting under the study, the activities conducted during the meeting and how the data were collected are recounted. Then, the data analysis method and the analysed findings including the backgrounds of the focus group participants, and the importance levels and ranks of the performance indicators are reported. Furthermore, the considerations taken in shortlisting the indicators, including the reasons for excluding the applicable yet non-essential indicators and the reasons for including those indicators in the shortlist, are explained. After illustrating how the shortlisted indicators were mapped with the three phases (input, process and output) of facilities services delivery and the three hierarchical levels (operational, tactical and strategic) of a facilities management (FM) organization, the implications drawn from the results are concluded.

Data Collection

A focus group meeting, with an ideal size of not more than 10 participants (Krueger and Casey, 2008), enables direct interactions between the participants and the meeting facilitator, and the participants can realize the reasons of each other for holding certain views on issues being discussed, qualify or modify their views, or agree to suggestions made by the others. A flowchart showing the process of the focus group study is shown in Figure 1.

"Insert Figure 1 here"

Given that the target participants of the meeting are experienced O&M professionals, invitations were sent to the executive committee board of the Building Services Operation and Maintenance Executives Society (BSOMES), which is the leading professional body in Hong Kong with a mission of promoting the development of the O&M profession. Meanwhile, it was necessary to set some questions to solicit the needed opinions of the focus group participants. With the applicable performance indicators taken into account, a questionnaire was devised for the focus group meeting. Because of the limited duration of the meeting, and in order to make the meeting discussion fruitful and smooth, the questionnaire was provided to the participants before the meeting. This allowed the participants to preview the questions and get their responses ready for discussion.

During the focus group meeting, the facilitator guided the participants to complete the questionnaire, share their views and opinions, and brainstorm any relevant issues not yet covered by the questions. The questionnaire, with its abridged version shown in Appendix A, comprises three sections. Section 1 contains questions on the personal particulars of the participants, such as work experience, employer type, job title and qualifications. In Section 2, there are two subsections: Section 2A requests the participants to indicate on a five-point scale (1: very low; 2: low; 3: moderate; 4: high; 5: very high) the importance levels of the listed indicators for evaluating the O&M performance of engineering facilities in commercial buildings; Section 2B asks whether the listed indicators are key indicators that should be shortlisted for use and, the participants were requested to express their reasons for shortlisting or excluding the indicators. Section 3 allows the participants to state any other comments they may have.

With the unanimous consent of the participants, the meeting was proceeded with audio recording. This allows cross examination between the recorded verbal discussion and the responses stated by the participants on the questionnaire. In the first of the three sessions of the meeting, the facilitator briefed about the purpose of the study, the meeting rundown and the planned activities. Then, the facilitator requested the participants to fill in their personal particulars in Section 1 of the questionnaire, followed by providing to each of them a set of handout showing the definitions of the 71 performance inductors.

In the second session of the meeting, the following activities were conducted for each of the indicators:

(1) The facilitator explained the definition of the indicator.
(2) The participants were facilitated to discuss the usefulness of the indicator; they were asked to share any experience in using the indicator, including any problems with recording or retrieving the required performance data.
(3) After the discussion and experience sharing, the participants rated the importance level of the indicator.
(4) The participants were asked to indicate whether the indicator should be shortlisted. To this end, indicators supported by over half of the participants were shortlisted and the reasons for support or opposition were recorded.

At the end of this session, the participants were allowed to suggest any useful indicators not yet listed in the handout. For each indicator suggested, the grounds for its usefulness were deliberated before the participants voted to decide whether to add it to the list. Afterwards, the

participants referred to the above-mentioned five-point scale and rated the importance level of each of the added indicators.

In the final session, the major findings, including the indicators eventually shortlisted, were reviewed collectively by the participants. Sufficient time was also allowed for the participants to provide any other comments in Section 3 of the questionnaire, before the facilitator collected all the completed questionnaires.

Analysis and Discussion

Of the 15 board members of the executive committee invited, seven agreed to participate in the focus group. Five of them worked in the private sector and the other two worked for some non-government organizations. With the same job nature - management of engineering facilities in buildings, the participants were highly experienced; their work experiences ranged between 14 and 31 years. In terms of job titles, two were directors and the rest were chief engineer, manager, etc. The types of commercial premises they looked after include office, retail, hotel and restaurant. The responses of the participants were analysed, as in the following.

Original and additional performance indicators

On top of the 71 indicators identified before, three indicators were suggested by the participants. The first one is "(F0) ratio of total O&M cost to building income". Referring to the focus group discussion, the major grounds for adding this indicator are: it takes into account not only the input to O&M works (cost) but also the output of the works (income resultant from O&M services provided to building users), and the numerator of this indicator (i.e. total O&M cost) embraces the constituent O&M cost elements.

In lieu of the generic indicator "(T28) availability", "(T28a) availability of fire services system" and "(T28b) availability of lift" were two specific indicators suggested as useful for representing the performances of two critical facilities - fire services system and lift. According to the participants, these two indicators can assist practitioners at both the strategic and tactical levels to evaluate the facilities' output performance, in particular their safety performance, which is a common concern of building users. In line with this concern, the government specifies that the monthly availability of lift should be not lower than 99% (Electrical and Mechanical Services Department, 2009), and this is the reference level for lift owners in setting specifications for the procurement of lift maintenance services.

Importance levels and ranks of indicators

With the above three indicators added, the total number of indicators became 74. Using the importance ratings given by the participants, the mean importance levels of all the indicators were calculated. Referring to the values of such importance levels, the importance ranks of the indicators were determined: one set for their corresponding group (group rank) and the other set for all the indicators (overall rank). The results are summarised in Tables 1 to 5 (where tied ranks are denoted by "="); for example, the importance level of indicator P1 "thermal comfort", being 4.29, is the highest among the group of physical indictors (i.e. group rank is 1) and the seventh highest (with the same level as those of indicators T1, T25 and H1) among all the indicators (i.e. overall rank is 7).

Among the group of physical indicators (Table 1), four were found with an importance level of not less than 4 (i.e. "high" importance on the five-point scale). Two equally rated indicators - "(P2) visual comfort" and "(P4) indoor air quality" share the same rank of 3. "(P1) thermal comfort" recorded the highest importance level (4.29), while the level of "(P6) number of users' complaints per year" is the lowest (3.14). The importance ranks of these two indicators, among all the 74 indicators, are 7 and 26 respectively.

"Insert Table 1 here"

As regards the financial performance indicators (Table 2), three of them, namely "(F0) ratio of total O&M cost to building income", "(F4) actual costs within budgeted costs" and "(F13) O&M cost per building area", recorded an importance value at the "high" level or above.

"Insert Table 2 here"

Indicator F0, the top-rated indicator in the financial group, recorded a very high importance level. This result was not unexpected given that the addition of this indicator was suggested by the participants. As total O&M cost is the amount of money spent on the O&M works for a building while the outcome performance of the works affects the building value and hence the rental income of the building, "(F0) ratio of total O&M cost to building income" is the only financial indicator that measures parameters in both the input and output phases of facilities services delivery.

Sharing the same rank of indicator F0, indicator F13 measures O&M resources deployed per unit building area. At the opposite end of the ranking table is "(F18) total safety and security expenditure", which has the lowest importance level (1.71).

In Table 3, the top two indicators are "(T28a) availability of fire services system" and "(T28b) availability of lift"; they recorded an importance value above the "high" level. Three other technical indicators, which were also regarded as of high importance, are "(T1) work request response rate", "(T25) failure/breakdown frequency" and "(T12) number of completed work orders per staff". With an level of 1.86, "(T15) schedule realization rate" is the least important indicator in the technical group.

"Insert Table 3 here"

"(E1) energy use index", with an importance level of 4.71, ranked top of all the indicators (Table 4). This is justifiable because energy use, especially electricity consumption for operation of facilities, is substantial in commercial buildings. In fact, about 42% of the total energy (or 65% of the total electricity) in Hong Kong was used in the commercial sector (Electrical and Mechanical Services Department, 2016). Although indicator E2 also measures the use of energy, it is hard to accurately determine the number of users, who include not only regular workers but also ad-hoc workers and visitors of commercial buildings.

"Insert Table 4 here"

The problem of growing greenhouse gas (GHG) emissions has been well recognised (International Energy Agency, 2009). Since the Hong Kong government issued a set of guidelines to help facilities managers account and report on GHG emissions of buildings (Environmental Protection Department and Electrical and Mechanical Services Department,

2010), measurement of GHG emissions has started to draw the attention of building stakeholders (Lai, 2014). This supports the high importance level of "(E3) greenhouse gas emission per building area".

After the launch of the Buildings Energy Efficiency Funding Schemes for subsidizing building owners to conduct energy-cum-carbon audits and energy improvement projects (Environment and Conservation Fund, 2013), the Hong Kong government has enacted the Building Energy Efficiency Ordinance (Cap. 610), which stipulates the mandatory conduction of energy audits for commercial buildings (Department of Justice, 2017). But indicator E4, with an importance value below the 'high' level, only reflects whether an energy audit has been conducted over the assessment period. It does not lead to any particular energy performance figures. This applies to both indicators E5 and E6, which recorded similar importance levels. They show whether a carbon audit or an environmental assessment has been conducted instead of measuring carbon emission or environmental performance. Conduction of environmental assessment (E6) for buildings, in fact, has long been encouraged in Hong Kong (Man et al., 2012). As participation in the assessment remains voluntary, the number of buildings certified is not high (Construction Industry Council and Hong Kong Green Building Council, 2017).

In Table 5, the two indicators with importance levels above 4 are "(H1) number of accidents per year" and "(H6) number of lost work days per year". The importance levels of the remaining five indicators in the health, safety and legal group are significantly below the "high" level. Indicator H4, i.e. amount of compensation paid per year, is the least important within the group. It ranks 61th among all the indicators.

"Insert Table 5 here"

Altogether 16 of the indicators, each with an importance level of not less than 4, were regarded as highly important. They are: four physical indicators (25.0%), three financial indicators (18.8%), five technical indicators (31.3%), two environmental indicators (12.5%), and two indicators (12.5%) in the health, safety and legal group.

Shortlisting the indictors

Reasons for exclusion

In shortlisting the indicators, those regarded as non-essential were first eliminated. Referring to the focus group discussion, the various factors taken to judge an indicator as non-essential include: unavailability of record data for working out the indicator, time constraint of the practitioners in the field, difficulties in working out the indicator, high consultant fee or internal staff cost needed for working out the indicator, and low importance level of the indicator. To some extent, these factors are interrelated. For instance, the amount of time or cost required for working out an indicator may depend on how difficult it is to work out the indicator. For an indicator that is complicated (i.e. difficult) to work out, considerable time is required to log, retrieve, organise and compile the needed data for computing the value of the indicator, thus incurring additional cost.

The above factors were consolidated to three common reasons that rendered the indicators excluded. The first reason is that it is too time consuming to work out the indicators. Because O&M practitioners are often fully, if not overly, loaded, it is infeasible for them to deal with indicators that require a long time to work out. The second reason is that it is too costly to work

out the indicators. Given that O&M budgets are typically limited (Lai, 2010), it is seldom possible to get extra resources to work out the indicators for performance evaluation purposes. For indicators that are covered or should be better represented by the other applicable indicators (i.e. the third reason), they should be removed from the shortlist.

For the sake of visualising the interactions between the above three reasons, Figure 2 was prepared. Indicators in the overlapping regions are those excluded for more than one of the reasons. For example, indicator E2 (energy consumption per person) was excluded because it is too time consuming and too costly to work it out, and it is should be better represented by a substitute indicator - "(E1) energy use index". Likewise, indicator F12 was substituted by indicator F0.

"Insert Figure 2 here"

On the whole, the most common reason for having the indicators excluded is it is too time consuming to work them out. For this reason alone, 22 of the indicators were excluded. As the participants pointed out, the biggest hurdle to figuring out the indicators is the substantial amount of time required to record and retrieve the data needed.

There are some indicators that were excluded not because of the three most common reasons, but for some other reasons. For example, "(F7) equipment replacement value" was excluded because the number of equipment in a building is too many. For "(F15) cost of equipment added or replaced", the participants opined that its usefulness in performance evaluation is doubtful as it could not reflect the reason for equipment addition or replacement, and there is normalisation denominator for this indicator. The latter reason also applies to "(F19) security expenditure per building area" and, because expenditure on security services for commercial building is typically small when compare with other O&M costs, the participants considered it niggling to use indicators F19 and F20.

Referring to their mean importance levels (see Tables 1 to 5), 16 of the indicators with a value of 4 (i.e. 'high' importance) or above were shortlisted. In addition to such importance levels, as discussed among the focus group, whether a performance indicator should be shortlisted also hinges on how feasible it is to work it out and its usefulness in practice. As such, "(P2) visual comfort" was excluded. The reason is that it is difficult to carry out all the necessary field measurements, e.g. identification of glare at different times in different building areas, especially areas affected by daylight. The resources needed for such measurements, according to the participants, would outweigh the benefit obtainable from using the indicator for performance evaluation.

Reasons for inclusion

Among the 15 indicators remained, three belong to the physical group. The first one is "(P1) thermal comfort". As discussed at the meeting, the main reason for having it shortlisted is that it reflects how well the indoor environment is maintained, which is critical to the productivity of workers (e.g. office) and satisfaction of customers (e.g. shop) in commercial buildings. Another physical indicator on the shortlist is "(P4) indoor air quality". The participants mentioned that indoor air quality certification (Indoor Air Quality Management Group, 2003), which is useful for marketing purposes, is increasingly popular. Nowadays, users of commercial buildings, who are more and more health-conscious, have a high expectation on indoor air quality. As regards the last physical indicator - "(P5) percentage users dissatisfied",

it is useful for revealing the overall satisfaction of building users, which often links to occupancy rate and hence building income.

Three other shortlisted indicators belong to the financial group. Indicator F0, as reported earlier, was an additional indicator suggested by the participants. Measuring the ratio of total O&M cost to building income, it is not only useful to the senior management who make strategic decisions for the O&M team but is also needed for tactical staff who manage the performance of O&M works. The second financial indicator is "(F4) actual costs within budgeted costs", which enables practitioners to detect if the O&M expenditure is over or under the planned budget. As the participants pointed out, it is definitely unacceptable if the actual costs exceed the budget. But if the actual costs are significantly below the projected expenditure, especially in the middle of a financial year, the indicator can alert the team to speed up any works that are behind schedule. The last financial indicator, "(F13) O&M cost per building area", can keep track of the O&M cost, which is a common task in budget estimation, control and review (Lai, 2010). This indicator is useful for evaluating the effectiveness of the team in monitoring and minimizing the use of budget. Normalization of the cost by building area can facilitate benchmarking to be made between buildings of the same type, even if they are of different scales.

Given the generally high demand of users of commercial buildings, it is crucial to have short response time to maintenance work request. This is why the focus group considered it essential to have "(T1) work request response rate" on list. To ensure that the O&M operatives are productive enough, the participants opined that indicator T12, which measures the number of completed work orders per staff, is useful. For indicator T25, i.e. failure frequency or breakdown frequency, it reflects both the seriousness of facilities aging and the quality of maintenance works provided for the facilities. The main reason for including "(T28a) availability of fire services system" and "(T28b) availability of lift", as mentioned earlier, is that they can help address the common safety concern on fire services and lift installations.

Following the requirements of the Building Energy Efficiency Ordinance (Cap. 610), for buildings completed with an energy audit, the energy use index of the respective building shall be stated in the prescribed energy audit form. Therefore, the participants highly recognized the need of including indicator E1, i.e. energy use index, in the shortlist. Apart from the fact that the government has provided guidelines on quantification of greenhouse gas emissions from buildings (Environmental Protection Department and Electrical and Mechanical Services Department, 2010), the participants realised that the use of resources other than energy, e.g. water, paper, etc., need to be measured by carbon audits. This is the major reason why they considered "(E3) greenhouse gas emission per building area" an essential indicator.

From the health, safety and legal perspective, the focus group regarded two indicators, namely "(H1) number of accidents per year" and "(H6) number of lost work days per year", as highly important. The main reason for having indicator H1 shortlisted is the increasing health and safety concern of employees in the built environment. For indicator H6, it is useful for showing the consequences of incidents (e.g. injuries at work) or illnesses (e.g. diseases due to poor air-conditioning) that arise from poor O&M works.

In addition, the participants regarded two other indicators, "(T13) area maintained per maintenance staff" and "(T18) backlog size", as useful even though they were not rated as important as the preceding 16 indicators. Indicator T13 enables FM practitioners to check if the manpower (e.g. technicians) is sufficient to carry out regular maintenance work. It is a

useful reference when the manpower is found insufficient and a request for more resources is needed. Indicator T18, which shows the percentage of overdue work orders, is useful for reflecting the work efficiency of the operatives.

The shortlisted indictors

Referring to the rationales and justifications elaborated above, the indicators fall into four categories, as shown in the grid matrix in Figure 3: Category A – important and included; Category B - less important but included; Category C - important but excluded; and Category D - less important and excluded.

"Insert Figure 3 here"

Eventually, the shortlist comprises the following 17 indicators:

- (P1) Thermal comfort
- (P4) Indoor air quality
- (P5) Percentage users dissatisfied
- (F0) Ratio of total O&M cost to building income
- (F4) Actual costs within budgeted costs
- (F13) O&M cost per building area
- (T1) Work request response rate
- (T12) Number of completed work orders per staff
- (T13) Area maintained per maintenance staff
- (T18) Backlog size
- (T25) Failure/breakdown frequency
- (T28a) Availability of fire services system
- (T28b) Availability of lift
- (E1) Energy use index
- (E3) Greenhouse gas emission per building area
- (H1) Number of accidents per year
- (H6) Number of lost work days per year

With reference to the work of Lai and Man (2017) where a schema of information and resources flows in facilities services delivery is illustrated, the performance of facilities can be assessed by measurement, perception, or both of them. Thus, there are three ways in which the above-shortlisted indicators can be obtained. First, indicators P1 and P4 can be obtained by physical measurement and/or perception. Second, gauging the perception of the building users can give indicator P5. Third, managerial measurement, i.e. recording and analysing O&M data of building facilities, can reveal indicators F0, F4, F13, T1, T12, T13, T18, T25, T28a, T28b, E1, E3, H1 and H6.

As explained in Part 1 (i.e. the preceding, companion article of the current one), there are two essential dimensions in evaluating facilities performance: the first covers the different phases (input, process and output) of facilities services delivery; the second refers to the hierarchical levels (operational, tactical and strategic) of an FM organization. With these two dimensions integrated (Lai and Man, 2017), a phase-hierarchy (P-H) mode has been developed for classifying performance indicators.

Based on the P-H model and the same method used for mapping the applicable performance indicators in Part 1, the shortlisted 17 indicators were grouped with respect to the three phases of facilities services delivery and the three hierarchical levels of an FM organization, as displayed in Table 6. It shows that some of the indictors are applicable to more than one of the hierarchical levels and some involve both the input and output phases of facilities services delivery. In principle, it is possible that some of the indicators could be combined to further reduce the number of indicators, e.g. combining indicators P1, P4 and P5 which belong to the same physical group. Likewise, the financial indicators (F0, F4 and F13) could be combined. But as mentioned in Part 1, many commercial buildings in metropolises like Hong Kong are massive developments equipped with sophisticated engineering facilities (e.g. high-speed lifts, automated air-conditioning systems, etc.) that need to be managed by a dedicated O&M team. The three different levels (strategic, tactical and operational) of practitioners in the team would require specific, rather than combined, indicators to gauge the performance of their facilities at the different phases of facilities services delivery. While the O&M team plays a critical function in such commercial buildings, the O&M performance of the facilities need to be connected to the overall goal of the organisation. To this end, the indicators at the strategic level are particularly useful.

Of all the indicators, the majority (11 of them) belong to the output-tactical class. This implies that the focus group placed a great emphasis on evaluating the output performance of facilities from the managerial perspective. Two of these indicators, namely "(F0) ratio of total O&M cost to building income" and "(T12) number of completed work orders per staff", which involve both the input and output phases, are applicable to more than one hierarchy level. Whereas indicator T12 is useful for evaluating performance at the operational and tactical levels, indicator F0 enables practitioners at the strategic and tactical levels to monitor the performance of facilities.

"Insert Table 6 here"

In contrast, the total number of indicators that are applicable to the input phase of facilities services delivery is significantly smaller than the counterpart of the output phase. This suggests that the experts of the focus group, in managing facilities of commercial buildings, are output-oriented. For those at the strategic level, the process during which facilities services are delivered is of little concern. This is reflected by the result that none of the shortlisted indicators lies in the process-strategic class.

Conclusions

The large number of performance indicators identified as applicable for evaluating the O&M performance of engineering facilities in commercial buildings, as reported in the preceding article (Part 1), are too voluminous for use in practice. The foregoing sections of the current article (Part 2) show that through a rigorous three-session focus group meeting, the participants, who are experts in the O&M field, provided useful responses for the selection of appropriate O&M performance indicators.

On top of the 71 applicable performance indicators identified from the literature (see Part 1), the focus group suggested three additional indicators. In addition to the quantitative responses on the importance levels of the indicators, the qualitative opinions of the focus group were taken for analysis. For the 57 indicators that were excluded from the shortlist, it is often too time consuming or too costly to work them out, or, they are covered or should be better

represented by the other applicable indicators. Besides the diagrammatic interactions between these common reasons that rendered the indicators excluded, the main reasons for having the 17 indicators shortlisted were revealed.

The P-H model of Lai and Man (2017) is useful for mapping the shortlisted indicators with the three phases of facilities services delivery and the three hierarchical levels of an FM organization in a systematic manner. On the basis of the mapping result, the performance evaluation focus of the O&M experts was at the tactical level, on the output phase of facilities services delivery.

The shortlisted indicators serve as a keystone for further works to be carried out to establish a performance evaluation scheme for engineering facilities in commercial buildings. Such works include a survey on the opinions of more O&M practitioners on the shortlisted indicators, which will enhance the representativeness of the indicators.

Research on buildings of the other types (e.g. residential, industrial, healthcare, etc.) or sectors with diverse FM organizations may follow the approach of this study to shortlist indicators for performance evaluation purposes. In particular, the process of shortlisting the O&M KPIs may be used to shortlist KPIs for the other FM services such as cleaning, catering, security control and so on.

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Appendix A – Abridged sample of the focus group questionnaire

Section 1

1.1 Gender (□ Male / □ Female)

1.2 Work experience (_____ years)

1.3 Employer (□ Government /□ Non-government public organization / □ Private company)

1.4 Job title (_____)

1.5 Building premises you have looked after (□ Office / □ Retail / □ Hotel / □ Hostel / □ Restaurant/ □ Others, please specify: _____)

1.6 Professional qualification (_____)

1.7 Highest academic qualification (_____)

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Section 2

(A) Please circle on a five-point scale the importance level of each indicator.

(B) For each indicator, please tick the appropriate box (Yes or No) to indicate whether it should be shortlisted. Please also state the reason(s) for indicators that should not be shortlisted.

Performance indicators	**(A) How important is the indicator?**					**(B) Should the indicator be shortlisted?**					
								Reason(s) for not shortlisted			
	Very low	Low	Moderate	High	Very high	Yes	No	Too time consuming	Too costly	No record data	Others (Please specify)
Physical											
(P1) Thermal comfort	1	2	3	4	5	□	□	□	□	□	□ _____
…	1	2	3	4	5	□	□	□	□	□	□ _____
(P6) Number of users' complaints per year	1	2	3	4	5	□	□	□	□	□	□ _____
Financial											
(F1) Percentage of personnel cost	1	2	3	4	5	□	□	□	□	□	□ _____
…	1	2	3	4	5	□	□	□	□	□	□ _____
(F22) Total rentable value of the building	1	2	3	4	5	□	□	□	□	□	□ _____
Technical											
(T1) Work request response rate	1	2	3	4	5	□	□	□	□	□	□ _____
…	1	2	3	4	5	□	□	□	□	□	□ _____
(T30) Gross floor area under safety and security patrol	1	2	3	4	5	□	□	□	□	□	□ _____
Environmental											
(E1) Energy use index	1	2	3	4	5	□	□	□	□	□	□ _____
…	1	2	3	4	5	□	□	□	□	□	□ _____
(E6) Conduction of environmental assessment	1	2	3	4	5	□	□	□	□	□	□ _____
Health, safety and legal											
(H1) Number of accidents per year	1	2	3	4	5	□	□	□	□	□	□ _____
…	1	2	3	4	5	□	□	□	□	□	□ _____
(H7) Number of incidents of specific diseases per year	1	2	3	4	5	□	□	□	□	□	□ _____
Any other indicators you suggest											
…	1	2	3	4	5	□	□	□	□	□	□ _____

Section 3

Any other comments: _____

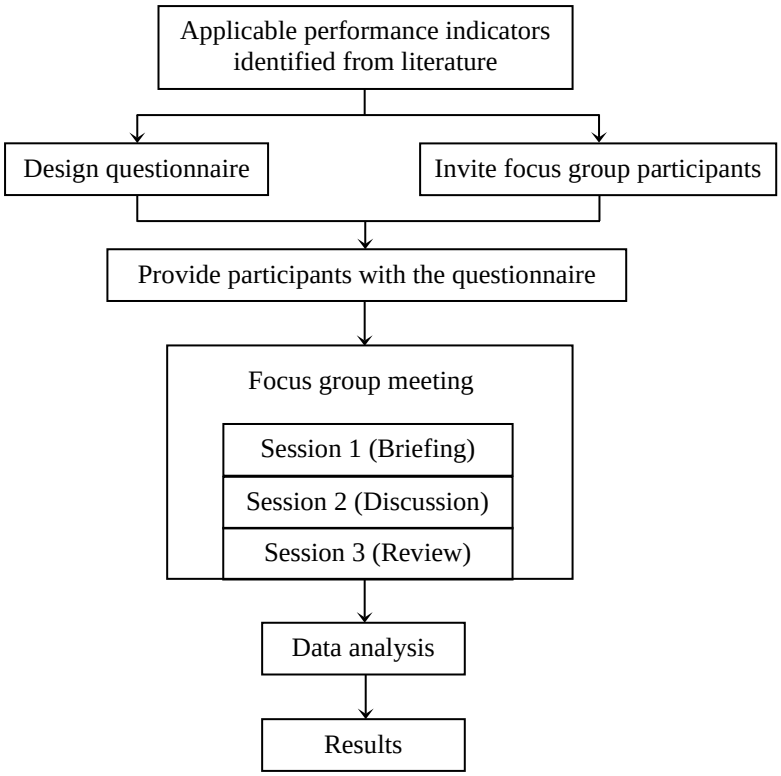

Figure 1 The process of the focus group study

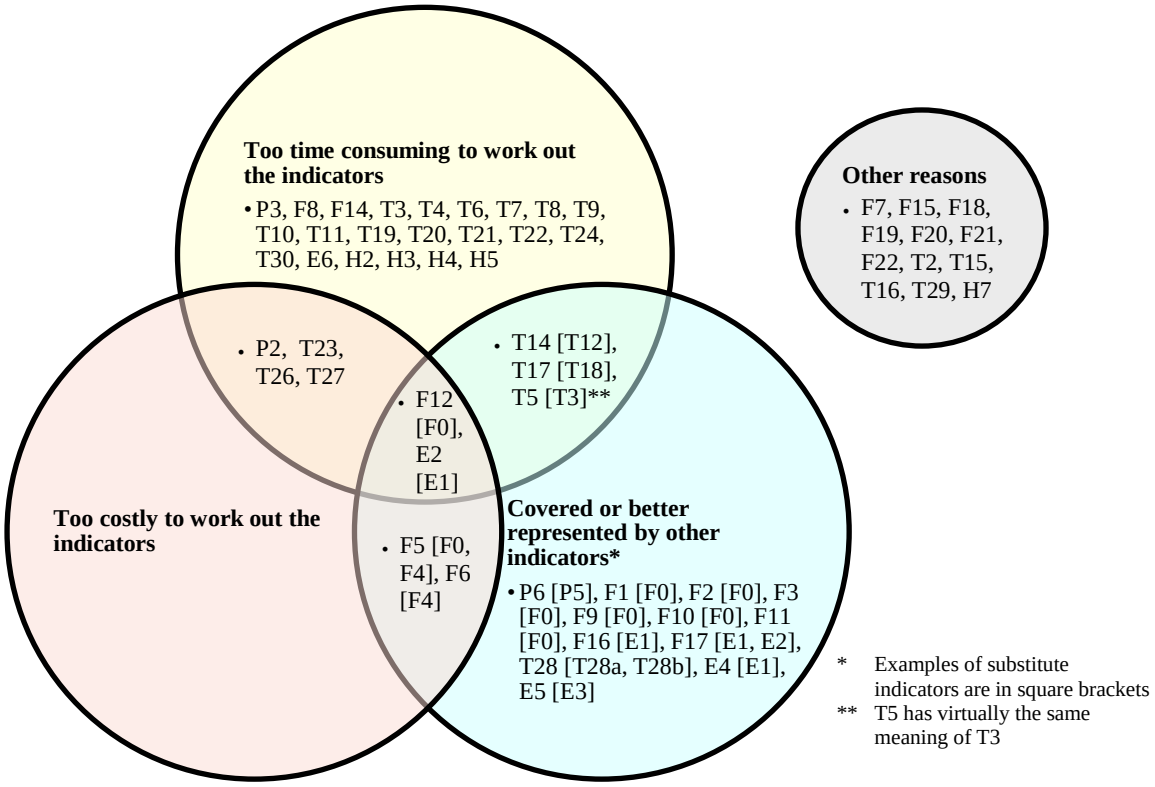

Figure 2 Interactions between the reasons for excluding the indicators

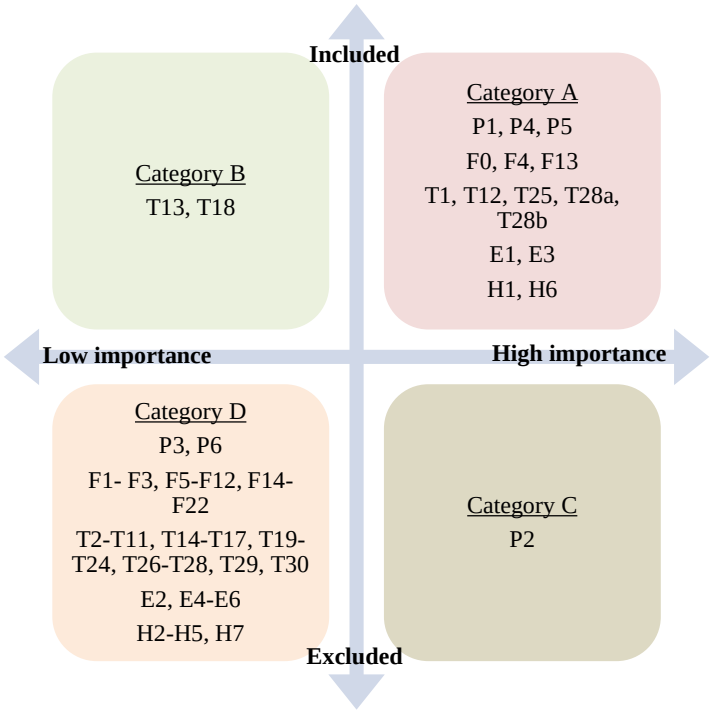

Figure 3 Four categories of the indicators on a grid matrix

Table 1 Importance levels and ranks of indicators (physical)

Performance indicators		Level	Group rank	Overall rank
(P1)	Thermal comfort	4.29	1	7=
(P2)	Visual comfort	4.00	3=	14=
(P3)	Aural comfort	3.57	5	23
(P4)	Indoor air quality	4.00	3=	14=
(P5)	Percentage users dissatisfied	4.14	2	11=
(P6)	Number of users' complaints per year	3.14	6	26=

Table 2 Importance levels and ranks of indicators (financial)

Performance indicators		Level	Group rank	Overall rank
(F0)	Ratio of total O&M cost to building income	4.43	1=	2=
(F1)	Percentage of personnel cost	2.57	6=	33=
(F2)	Percentage of subcontractor cost	2.57	6=	33=
(F3)	Percentage of contractor cost	2.57	6=	33=
(F4)	Actual costs within budgeted costs	4.00	3	14=
(F5)	Direct maintenance cost	2.14	12=	52=
(F6)	Breakdown severity	3.14	4	26=
(F7)	Equipment replacement value	2.00	16=	61=
(F8)	Maintenance stock turnover	2.14	12=	52=
(F9)	Percentage of maintenance material cost	2.00	16=	61=
(F10)	Percentage of corrective maintenance cost	2.29	9=	42=
(F11)	Percentage of preventive maintenance cost	2.29	9=	42=
(F12)	Percentage of condition based maintenance cost	2.71	5	30=
(F13)	O&M cost per building area	4.43	1=	2=
(F14)	O&M cost per capacity of installation	2.29	9=	42=
(F15)	Cost of equipment added or replaced	1.86	18=	68=
(F16)	Energy expenditure per building area	2.14	12=	52=
(F17)	Energy expenditure per person	2.14	12=	52=
(F18)	Total safety and security expenditure	1.71	23	74
(F19)	Security expenditure per building area	1.86	18=	68=
(F20)	Security expenditure per person	1.86	18=	68=
(F21)	Building income per building area	1.86	18=	68=
(F22)	Total rentable value of the building	1.86	18=	68=

Table 3 Importance levels and ranks of indicators (technical)

Performance indicators		Level	Group rank	Overall rank
(T1)	Work request response rate	4.29	3=	7=
(T2)	Scheduling intensity	2.29	17=	42=
(T3)	Manpower utilization rate	2.29	17=	42=
(T4)	Manpower efficiency	2.29	17=	42=
(T5)	Manpower utilization index	2.29	17=	42=
(T6)	Preventive maintenance ratio	2.71	11=	30=
(T7)	Percentage of corrective (reactive) work	2.00	28=	61=
(T8)	Percentage of preventive (proactive) work	2.00	28=	61=
(T9)	Percentage of condition based maintenance work	2.00	28=	61=
(T10)	Percentage of improvement work	2.29	17=	42=
(T11)	Number of man hours per capacity of installation	2.29	17=	42=
(T12)	Number of completed work orders per staff	4.14	5	11=
(T13)	Area maintained per maintenance staff	3.71	6=	20=
(T14)	Quality of scheduling	2.14	23=	52=
(T15)	Schedule realization rate	1.86	32	68=
(T16)	Schedule compliance	2.71	11=	30=
(T17)	Work order turnover	2.14	23=	52=
(T18)	Backlog size	3.43	8	24
(T19)	Urgent repair request index	2.43	14=	38=
(T20)	Corrective maintenance time	2.14	23=	52=
(T21)	Preventive maintenance time	2.14	23=	52=
(T22)	Response time for maintenance	3.14	9	26=
(T23)	Percentage compliance with required response time	2.14	23=	52=
(T24)	Number of maintenance induced interruptions	2.43	14=	38=
(T25)	Failure/breakdown frequency	4.29	3=	7=
(T26)	Mean time between failures	2.43	14=	38=
(T27)	Mean time to repair	2.57	13	33=
(T28)	Availability	3.00	10	29
(T28a)	Availability of fire services system	4.43	1=	2=
(T28b)	Availability of lift	4.43	1=	2=
(T29)	Efficiency of facilities	3.71	6=	20=
(T30)	Gross floor area under safety and security patrol	2.00	28=	61=

Table 4 Importance levels and ranks of indicators (environmental)

Performance indicators		Level	Group rank	Overall rank
(E1)	Energy use index	4.71	1	1
(E2)	Energy consumption per person	3.86	3=	17=
(E3)	Greenhouse gas emission per building area	4.43	2	2=
(E4)	Conduction of energy audit	3.86	3=	17=
(E5)	Conduction of carbon audit	3.86	3=	17=
(E6)	Conduction of environmental assessment	3.71	6	20=

Table 5 Importance levels and ranks of indicators (health, safety & legal)

Performance indicators		Level	Group rank	Overall rank
(H1)	Number of accidents per year	4.29	1	7=
(H2)	Number of legal cases per year	2.57	4	33=
(H3)	Number of compensation cases per year	2.29	6	42
(H4)	Amount of compensation paid per year	2.00	7	61=
(H5)	Number of health and safety complaints per year	2.43	5	38=
(H6)	Number of lost work days per year	4.14	2	11=
(H7)	Number of incidents of specific diseases per year	3.29	3	25

Table 6 Mapping result of the shortlisted indicators

Phase / Level	Input	Process	Output	More than one phase
Strategic	**3** (*F0**, *F4*, F13)	**0** -	**5** (*F0**, *H1*, *H6*, *T28a*, *T28b*)	**1** (*F0**)
Tactical	**3** (*F0**, *F4*, *T12**)	**2** (T1, *T25*)	**11** (E1, E3, *F0**, *P1*, *P4*, P5, *T12**, *H1*, *H6*, *T28a*, *T28b*)	**2** (*F0**, *T12**)
Operational	**1** (*T12**)	**1** (*T25*)	**3** (*P1*, *P4*, *T12**)	**1** (*T12**)
More than one level	**3** (*F0**, *F4*, *T12**)	**1** (*T25*)	**8** (*F0**, *P1*, *P4*, *H1*, *H6*, *T12**, *T28a*, *T28b*)	

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. * denotes indicator involving both the input and output phases, applicable to more than one level.