KPIs for facility’s performance assessment, Part I: identification and categorization of core indicators

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Abstract

Purpose – The purpose of this paper is to synthesize the previously established list of key performance indicators (KPIs), to identify and categorize the core performance indicators that are measurable and quantifiable.

Design/methodology/approach – A literature-based qualitative approach is adopted for accumulating desired information on identifying and categorizing the core indicators. The list of KPIs established in an earlier paper is narrowed down considering the future research needs suggested by the literature.

Findings – The quantifiable and measurable core indicators are identified and categorized in the form of a list. The core indicators are defined and the variables required to quantify them are described by citing peer-reviewed literature.

Research limitations/implications – This paper represents the first step toward establishing a relevant list of quantifiable and measurable core KPIs. Future research papers could emphasize derivation of mathematical expressions for determining the identified core KPIs and validating these KPIs using simulation of real building data.

Practical implications – The need to establish a concise and relevant list of quantifiable and measurable KPIs that could express more than one type of information about a facility’s performance is identified in this paper. This paper presents and describes a narrowed down list of core KPIs, which could be utilized by facility management industry professionals while performing a holistic performance assessment.

Originality/value – This paper provides a list of core KPIs that could express more than one aspect of a facility’s performance and that is measurable and quantifiable.

Keywords Assessment, Identification, Asset management, Quantitative techniques, Performance indicators

Paper type Research paper

Introduction

Performance measurement reviews past and present functioning, derives strategies for future endeavors, compares performance within and among the facilities, assesses the
performance toward the organization’s goals and provides needed direction to management for decision-making (Amaratunga et al., 2000a, b; Cable and Davis, 2004; Lebas, 1995; Douglas, 1996; Barret and Baldry, 2003; Kincaid, 1994). Douglas (1996) explains the importance of building performance in both inter-building and intra-building senses. The inter-building assessment is a comparative evaluation in which the building under study is evaluated against another similar building. In intra-building evaluation, the building is assessed on its own, based on its individual past performance. Performance measurement is, therefore, the key to calibrating the effectiveness of a built facility in a comprehensive manner. Kincaid (1994) mentions that performance measurement is essential in order to perform comparisons and develop strategies for improvement. According to Lebas (1995), gauging the growth of an organization, knowing the current condition of the organization’s facilities, developing future plans, and preparing blueprints to accomplish those plans are among the driving forces behind performance measurement. Cohen et al. (2001) posit that for consistent and continuous improvement in building performance, rapid feedback about the condition of the building is essential.

Among major facility performance measurement practices are benchmarking, balanced scorecard approach, post occupancy evaluation, and measurement through metrics of key performance indicators (KPIs). Cable and Davis (2004) assert that performance measurement using established KPIs helps the senior management team to make strategic decisions. Developing performance metrics is an important step in the process of performance evaluation, as it includes relevant indicators that express the performance of the facility in a holistic manner (Cable and Davis, 2004; Varcoe, 1996; Brackertz, 2006; Amaratunga et al., 2000a; Amaratunga et al., 2000b; Lebas, 1995). Consequently, it is of tremendous significance to identify a set of KPIs to establish effective performance evaluation metrics for the facility under consideration. The selection of measures of performance as KPIs depends on who actually uses the performance assessment (e.g. executives, managers, or supervisors), the public or private nature of the organization, the assessment objectives (financial, functional, or physical), and prevailing trends in the industry (Lebas, 1995; Cable and Davis, 2004; Amaratunga et al., 2000b; Hinks, 2004; Eagan and Joeres, 1997; Cripps, 1998).

Previous research studies propose lists of a wider range of KPIs that could comprehensively cover the performance of a facility. However, the large number of KPIs adds a level of complexity and is narrow in perspective, thus lacking quantification and applicability across a range of projects (Shohet, 2006; Neely et al., 1997). Researchers agree on the fact that there needs to be a list of quantifiable and relatively easily measurable KPIs that demonstrate wider applicability, a holistic approach to the performance evaluation, conciseness, relevance, and proper categorization (Shohet, 2006; Hinks and McNay, 1999; Slater et al., 1997; Augenbroe and Park, 2005; Cohen et al., 2001; Ho et al., 2000; Douglas, 1993/1994; Douglas, 1996; Amaratunga and Baldry, 2003; Gumbus, 2005). Lavy et al. (2010) present a literature-based list of categorized KPIs that covers the assessment of facility performance, breaking down the KPIs into four major categories: financial, physical, functional, and survey-based.

This paper aims to narrow down the list of indicators developed by Lavy et al. (2010), so that concise, quantifiable, and measurable performance metrics that show wider applicability and coverage may be identified.
Performance measurement: current state of research

Need for performance assessment

Cable and Davis (2004), Amaratunga et al. (2000b) and Brackertz (2006) argue that performance measurement of a portfolio of buildings, with the help of KPIs, focuses on assessment of overall performance towards an organization’s mission. Furthermore, performance measurement provides guidance for decision-making related to facility extension, appropriateness of facility towards organization mission, and making or not making investments. Thus the performance measurement enables understanding the impacts of management decision-making on success and failure of the portfolio and is used to suggest possible improvements (Cable and Davis, 2004). Barret and Baldry (2003) assert that reliable and comparable data on building performance and cost are essential for making effective and justifiable decisions and recommendations. Douglas (1996) emphasizes determining the extent to which facility is serving its users and identifying issues that affect facility performance adversely. Cotts and Lee (1992) note that a detailed appraisal is essential for making sound management decisions. The assessment of buildings is possible in the form of a total performance assessment considering architectural and engineering aspects, or a predictive assessment that relates buildings to organizations by diagnosing performance failures (Cotts and Lee, 1992). Varcoe (1996) emphasizes the importance of facility performance measurement in order to evaluate the strategies in terms of results, and enable management team to identify crucial issues affecting the organization, as well as issues pertaining to specific operations.

Performance metrics

Ho et al. (2000) state that performance metrics represent indicators of performance that can be used for a genuine comparison within and between organizations. Performance metrics provide an essential common platform of comparison, based on which improvement can be sought for any individual indicator. Deru and Torcellini (2005), and Spendolini (1992) explain that relevant, clear, compatible and authentic performance metrics facilitate understanding the driving forces of a building’s performance, assist designers with creating efficient facilities, support owners in operating buildings in an efficient manner, and help management and decision makers take necessary steps to track performance. Hitchcock (2002) and O’Sullivan et al. (2004) state that performance metrics can define performance objectives clearly and quantifiably. Yuan et al. (2009) identify KPIs in five major perspectives: physical characteristics of project, financing and marketing, innovation and learning, stakeholders, and project processes; they state that a genuine performance measurement is only possible after the major KPIs are identified, finalized and monitored.

Ho et al. (2000) argue that the development of performance measurement metrics is the first step in a facilities benchmarking process. Performance metrics assist in establishing benchmarks that provide guidance to management in decision-making and indicate the success of current facility management practices. Furthermore, authentic, well-defined, and compatible performance indicators could easily be transformed into strategies through analysis and decision-making. Douglas (1996) emphasizes the importance of indicators that portray space in terms of amount (area and volume), quality (appropriateness, visual, and environmental qualities,) and shape...
Future research needs
Proper categorization. Amaratunga and Baldry (2003) categorize KPIs according to four basic principles:

1. customer relations;
2. FM internal processes;
3. learning and growth; and
4. financial implications.

Augenbroe and Park (2005) divide the indicators into four other categories:

1. energy;
2. lighting;
3. thermal comfort; and
4. maintenance.

Hinks and McNay (1999) classify a list of 172 KPIs under eight categories:

1. business benefits;
2. equipment;
3. space;
4. environment;
5. change;
6. maintenance/services;
7. consultancy; and
8. general.

Gumbus (2005) derives a list of performance measures organized into categories relating to the four perspectives of the balanced scorecard approach. Ho et al. (2000) propose a comprehensive and detailed set of KPIs categorized under eight major classes.

One need identified by Douglas (1996) is for a proper categorization of KPIs to represent broader applicability and potential use. Studies have developed and built lists of large numbers of indicators, but some of them are not usable because they are not categorized properly. Professionals interested in short-term financial appraisal have nothing to do with long-term functional or survey-based assessment, and vice versa. Thus, categorization must provide the opportunity for facility management professionals to select the list of performance metrics in which they are most interested (Douglas, 1996; Ho et al., 2000; Gumbus, 2005).

Minimization of performance indicators. Establishing a list of a large number of indicators cannot be the only goal of facility performance assessment. Such a comprehensive list needs to be filtered through a certain set of genuine criteria to develop a concise list of those indicators that express one or more aspects of
performance assessment effectively (Ho et al., 2000; Slater et al., 1997). Ho et al. (2000), Slater et al. (1997), Hinks and McNay (1999), Cohen et al. (2001) and Gumbus (2005) emphasize minimization of performance indicators in order to obtain a more precise but relevant set of KPIs.

Hinks and McNay (1999) refer to research studies performed by Varcoe (1996) and Slater et al. (1997) and suggest that there must not be more than four to six performance indicators tied to, at the most, five to six well-defined business or facility objectives. Slater et al. (1997) claim that the number of KPIs should be kept to a minimum of seven and a maximum of 12 for a comprehensive evaluation of a facility’s performance.

Holistic assessment. Unlike past assessment of facility performance that emphasized financial aspects, current assessment also concentrate on aspects like business, organizational goals, job satisfaction, work environment, environmental issues, and other non-financial qualitative aspects, in a detailed manner (Amaratunga et al., 2000b; Brackertz, 2006; Douglas, 1996; Cotts and Lee, 1992; Cable and Davis, 2004; Cripps, 1998; Eagan and Joeres, 1997; Jasch, 2000; Epstein and Wisner, 2001). Therefore, a holistic approach to performance measurement and assessment is needed in order to cover facilities comprehensively in terms of their overall performance (Hinks and McNay, 1999; Douglas, 1993/1994; Douglas, 1996; Gumbus, 2005; Cable and Davis, 2004).

Quantifiable and measurable indicators. Research studies are lacking in providing a set of quantifiable KPIs for strategic decision-making in organizations (Shohet, 2003). The performance indicators to measure facilities and/or organizations should be not only easily measurable but also quantifiable in order to make valid comparisons and decisions (Shohet, 2003; Augenbroe and Park, 2005; Ho et al., 2000; Gumbus, 2005; Tsang et al., 1999; Cable and Davis, 2004; Tsang, 1998; Chan et al., 2001).

Applicability to wider range of projects. Most research studies so far have focused on either specific aspects or on specific project requirements and thus demonstrate limited applicability to a wider range of projects (Shohet, 2003). Studies have shown that performance metrics should be generalized so that they can be applied across the facility management industry (Shohet, 2003; Hinks and McNay, 1999; Neely et al., 1997).

Research objectives
The above-mentioned research indicates the need to develop a more effective and efficient set of KPIs for performance evaluation. This paper aims to narrow down the previously evolved list of KPIs into a concise set of performance indicators that demonstrate wider applicability, comprehensiveness and categorization, and are core and quantifiable. Following are the objectives of this paper:

- Narrow down the list of indicators by eliminating measures possessing overlapping and redundant information.
- Identify core indicators with the potential to express more than one aspect of facility performance.
- Ensure that these KPIs are measurable and quantifiable, and possess relatively wider applicability across the facility management industry.
- Develop and organize these indicators in the form of either quantifiable measures or indexes (with derivation of formulae to compute).
Research methods
This paper follows a research process suggested by the literature that involves establishing a broad list of performance indicators gathered from literature sources, organizing them in respective categories and narrowing them down into a compact, yet relevant, set of core and quantifiable performance metrics (Hinks and McNay, 1999; Ho et al., 2000; Slater et al., 1997; Gumbus, 2005). Lavy et al. (2010) carried out an extensive literature search identifying a list of core performance metrics, and organized them into relevant categories depending on the type of information represented. This paper incorporates research methods involving the following steps in establishing a compact set of key performance indicators.

Categorization of performance metrics
Out of the list of performance metrics derived by Lavy et al. (2010), three categories, namely functional, physical, and financial, were selected for study. The fourth category of survey-based indicators has been omitted, as suggested by an industry survey administered in the same study. Measures relating to functional performance (e.g. indoor/outdoor environmental quality and space utilization) were added to the functional category, while indicators expressing the physical conditions of the facility (e.g. facility condition and maintenance) were added to the physical category. Performance metrics indicating costs and other financial aspects were added to the list of financial indicators. These three categories are emphasized in the literature review, and cover operations and maintenance aspects of a facility. Performance indicators are classified according to the type of information conveyed and their primary impacts on any of the three categories.

Narrowing down the list of performance measures
The aim, in this process, has been to minimize the number of indicators so that a concise and relevant set of KPIs could be evolved. The process of minimizing the number of indicators includes discussion with industry representatives involved in the practice of facility performance measurement and referring to relevant literature.

Following are the criteria used for narrowing down the list of performance indicators: redundancy, availability of data, ease of data collection and interpretation, relevance to K-12 school facilities, and data representing issues that can be controlled by a facility manager. Indicators identified by Lavy et al. (2010) were analyzed, and those found to convey redundant or overlapping information, were eliminated. If two or more indicators addressed a similar aspect of facility performance, they were merged into one indicator. Emphasis was also given to those indicators that can be easily measured and gathered, and to those demonstrating relatively more profound impact on the performance of a facility. Data availability is also a major criterion used to narrow down the list of KPIs. Green building rating systems, like Leadership in Energy and Environmental Design in Existing Buildings (LEED-EB) was considered in this process, and aspects already covered by LEED-EB were removed from the list. This research on KPIs is being developed with a special emphasis on K-12 school facilities and thus, performance metrics required for these facilities were also included in the list (e.g. absenteeism).

Performance metrics that convey a level of holistic information regarding performance measurements in functional, physical, or financial aspects were selected.
Emphasis was given to performance measurements in the core domains of facility management, including operations and maintenance management, physical building condition, space use, indoor/outdoor air quality, and user satisfaction. Such metrics were further analyzed and modified, if required, in order to make them measurable and quantifiable.

Findings: list of core identified indicators
The following sections describe the process of narrowing down the list of KPIs. Table I presents the KPIs identified and categorized by Lavy et al. (2010). The fourth category of survey-based indicator was replaced with another category of user satisfaction that more properly portrays the opinions of a facility’s users.

The first step was to identify KPIs from the Table I that could be expressed with fewer indicators. KPIs, such as building maintenance cost, grounds keeping costs, janitorial costs and maintenance expenditure, could be properly demonstrated by the maintenance efficiency indicator (MEI). KPIs like current replacement value and deferred maintenance possess no significant meaning individually, but could be more meaningful if expressed in the form of a condition index (CI). Furthermore, a building’s physical condition (quantitative and qualitative) and building performance index could be indicated by a CI as well. The CI includes a widely used facility condition index (FCI), which is actually a collective indicator for a building’s maintenance and replacement program. The indicators related to capital expenditures, such as capital cost and renewals and replacement expenditure, could be properly conveyed by a replacement efficiency index (REI), which includes comparing the actual replacement

<table>
<thead>
<tr>
<th>Financial</th>
<th>Functional</th>
<th>Physical</th>
<th>User satisfaction</th>
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<tbody>
<tr>
<td>Operating costs</td>
<td>Building physical condition – Qualitative</td>
<td>Productivity</td>
<td>Customer/building occupants' satisfaction with products or services</td>
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<tr>
<td>Occupancy costs</td>
<td>building physical condition – quantitative: Building performance index (BPI)</td>
<td>Parking</td>
<td>Community satisfaction and participation</td>
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<tr>
<td>Utility costs</td>
<td>Resource consumption – energy; water; materials</td>
<td>Space utilization</td>
<td>Learning environment, educational suitability, and appropriateness of facility for its function</td>
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<td>Capital costs</td>
<td>Property and real estate</td>
<td>Employee or occupant’s turnover rate</td>
<td>Appearance</td>
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<td>Building maintenance cost</td>
<td>Waste</td>
<td>Mission and vision, and Mission dependency index (MDI)</td>
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<td>Grounds-keeping cost</td>
<td>Health and safety</td>
<td>Adequacy of space</td>
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<td>Custodial and janitorial cost</td>
<td>Indoor environmental quality (IEQ)</td>
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<td>Current replacement value (CRV)</td>
<td>Accessibility for disabled</td>
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<td>Deferred maintenance, and deferred maintenance backlog</td>
<td>Security</td>
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<td>Capital renewal</td>
<td>Site and location</td>
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<td>Maintenance efficiency indicators (MEI)</td>
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<td>Churn rate and churn costs</td>
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Table I. List and categorization of KPIs

**Source:** Lavy et al. (2010)
Maintenance efficiency

Building maintenance is one vital aspect of facility management that could affect the performance of facilities considerably (Adams and Smith, 2005; De Groote, 1995; Horner et al., 1997). While efforts are put into minimizing maintenance expenditures, facility management focuses on continuing the safe and profitable use of a building with as little maintenance as possible (Horner et al., 1997; De Groote, 1995; Kutucuoglu et al., 2001; Shohet and Lavy-Leibovich, 2004; Then, 1995; Tsang et al., 1999; OLA, 2000). Three primary categories of maintenance are discussed in the literature: corrective (unplanned), preventive (planned), and condition-based maintenance. Corrective maintenance comes into play when a particular component or a system breaks down suddenly; preventive maintenance, on the other hand, relates to anticipating and planning for future maintenance events. Condition-based maintenance is conducted based on the current physical condition of a building’s components and systems (Horner et al., 1997).

Studies, such as Chan et al. (2001), propose using preventive and corrective maintenance figures to judge the maintenance performance of a facility. Shohet (2003) and Shohet and Lavy-Leibovich (2004) propose a building performance indicator (BPI) for the assessment of a facility’s performance, and assert that this indicator could become vital if the maintenance efficiency indicator (MEI) could be integrated.

According to Horner et al. (1997), current maintenance strategies are driven by the maintenance budget, which represents planned maintenance, the determination of which is not simple. They also discuss three bases to determine a maintenance budget:

1. last year’s maintenance expenditure;
2. Department of Energy (DOE) formula; and
3. a survey of the facility to determine maintenance expenditure results.

Preventive maintenance could be planned on the basis of a current condition assessment of a building’s components and equipment (OLA, 2000). Shohet et al. (2003) put maintenance efficiency among four primary KPIs, and discuss that MEI expresses the investment in maintenance in relation to the performance of the building facility. Queensland Government (2009) points out the importance of maintenance efficiency in determining and reviewing the maintenance budget. Maintenance efficiency is found to be among the most successful hard performance indicators of maintenance that contributes effectively to strategic decision-making (Pati et al., 2008, 2009a; Augenbroe and Park, 2002; Shohet, 2003; Shohet et al., 2008). Pati et al. (2009a, b), Park and Augenbroe (2003) and Augenbroe and Park (2002) discuss the importance of MEI in assessing maintenance performance, and suggest that it is a quantified expression of efficiency with which available resources are expended. Furthermore, they reveal that the MEI must be calculated in terms of maintenance expenditure with respect to a building’s physical performance, as expressed by BPI (Shohet et al., 2008; Lavy and Shohet, 2007). Furthermore, Weber and Thomas (2005) discuss that maintenance cost actually depends on maintenance effectiveness and efficiency. Therefore, maintenance
expenditure and physical condition of the facility are two significant parameters with which to define maintenance efficiency and performance.

The earlier concept, proposed and referred by the above-mentioned authors, defines MEI as a ratio of maintenance expenditure to BPI. BPI is an index expressing the level of a building’s performance expressed on a scale, which does not necessarily denote the quantification of a building’s performance. Thus, evaluating investment in maintenance against BPI is not an appropriate method to determine maintenance efficiency.

*Replacement efficiency*
Expenses and authorization needed to renew and/or replace equipment and building components that are either damaged or whose service life has come to an end is called replacement in facility management (Rondeau *et al.*, 2006). Replacements are essential for the proper functioning of a facility and are done periodically. Furthermore, planned replacements are not always the same every time, as they vary year-to-year depending on the type and amount of replacement (OLA, 2000).

Capital renewal, another important measure of the capital budget, determines future renovation requirements (excluding future new construction) for building and building systems that have reached the end of their service life (Vanier, 2001a; State Council of Higher Education, 2001; Magellan Consulting, 2007; Coast Community College District, 2003; Fagan and Kirkwood, 1997). Literature suggests various methods to determine and assess replacements in a facility. The capital renewal index, a measure to evaluate replacements in a constructed facility, is a ratio of annual capital renewal to the current replacement value (APPA *et al.*, 2003; Kinnaman, 2007).

*Condition index (CI)*
Developing an indicator is crucial for comparing constructed facilities in terms of their physical condition, as such indicators need to be easily measurable and quantifiable. The National Association of College and University Business Officers (NACUBO) was among the first organizations to provide a conceptual framework of FCI in their publication *Managing the Facilities Portfolio* (see Rush *et al.*, 1991) (Briselden and Cain, 2001). Facility condition index (FCI) has been defined as a ratio of maintenance deficiency to the current replacement value (CRV) of the facility or system under study (Rush *et al.*, 1991; Briselden and Cain, 2001; Department of Interior, 2008; Teicholz and Edgar, 2001; Uzarski and Grussing, 2008; Geldermann and Sapp, 2007; Vanier, 2001b, c). The physical condition of the facility is related to the amount of maintenance deficiency in the facility (Rush *et al.*, 1991; Briselden and Cain, 2001; Department of Interior, 2008; Teicholz and Edgar, 2001). FCI is a widely used indicator for evaluating the condition of a constructed facility by incorporating deferred maintenance and CRV (Briselden and Cain, 2001; Teicholz and Edgar, 2001; Vanier, 2001b, c). Numerous institutions and organizations use FCI to assess facility condition and in the capital planning process (Briselden and Cain, 2001; Teicholz and Edgar, 2001). Rush *et al.* (1991) describe FCI values under 0.05 as good, 0.05-0.1 as fair, and above 0.1 as poor (Rush *et al.*, 1991; Teicholz and Edgar, 2001, Uzarski and Grussing, 2008; Vanier, 2001b, c).

Condition can be quantified in terms of a percentage, with higher and lower percentages denoting excellent and poor conditions, respectively. Such an indicator is
called a condition index (CI), which can be calculated by subtracting FCI out of one and multiplying the result by 100 (Department of Interior, 2008). CI values range from 0 to 100 percent, with “0” as worse, and “100” as excellent condition (Department of Interior, 2008; McKay et al., 1999; Uzarski and Grussing, 2008; Uzarski et al., 2007). McKay et al. (1999) assert that the main purpose of CI is to furnish a snapshot of a facility’s condition at a given time. The United States Army’s Engineering and Research Development Center, Construction Engineering Research Laboratory (ERDC-CERL) uses building condition index (BCI), quite similar to FCI, which is an inspection-based indicator for condition assessment of building components, systems, and the entire building (Uzarski and Grussing, 2008; Vanier, 2001b, c). Uzarski and Grussing (2008) explains that in the BCI method, an inspection of a component section condition index (CSCI) is calculated for each system component, after which the CI for the whole system is determined by taking weighted averages of CSCIs based on their CRVs (Watson, 2009; Uzaraski and Grussing, 2001; Teicholz and Edgar, 2001).

**Functional index**

One key function of a facility is to provide its occupants an enclosed and protected space, shelter from climate, and privacy (Douglas, 1996; Loosemore and Hsin, 2001). Douglas (1996) asserts that space is vital in deciding the functional worth of a building and in order to evaluate its suitability, one must assess its three primary aspects: amount (area and volume), quality, and shape. Space planning and management is an important performance measure to judge the spatial efficiency of a facility, which could affect the organizational effectiveness of a facility (Douglas, 1996; Douglas, 1993/1994; Zimmerman and Martin, 2001; Ilozor and Oluwoye, 1999; Cole and Brown, 2009). Space management assessment helps a facility manager identify the under-used and over-used spaces affecting spatial efficiency (Douglas, 1993/1994; Schroeder et al., 1995).

The amount of space provided also affects the performance of its occupants. Hinum (1999) mentions Earthman’s study (Virginia Polytechnic Institute and State University, in an international seminar in Austria in 1998), which demonstrates that space adequacy is one key factor affecting student performance in a school. One space assessment method suggested by Hammond et al. (2005) is space utilization assessment, one of the key assessments performed by the United States Coast Guard (USCG). The concept of evaluating space against the standard space required is suggested by the literature (Hammond et al., 2005). Space utilization can be determined by evaluating a facility in terms of its compliance with space standards (Hammond et al., 2005). Furthermore, USCG evolved a suit of indices to assess facilities that includes a space utilization index determining whether spaces are underutilized or over-used. Loosemore and Hsin (2001) emphasize the determination of the percentage of space that contributes to the organization’s core objectives. Thus, the literature suggests that space is vital for the functional worth of a building, and space utilization must be assessed during performance evaluation against the space standards to determine a fair use of space.

**Indoor/outdoor environmental quality (IOEQ)**

Indoor environmental quality (IEQ) of a building is a primary concern today as it reflects and influences the health and well-being of its occupants (Mendell and Heath,
According to the United States Environmental Protection Agency (USEPA, 2009), Americans spend 90 percent of their time indoors, where the level of pollutants is much higher than it is outdoors, due to constant and long exposure to indoor air pollutants through inhalation. According to Fowler et al. (2005), IEQ has major impacts on occupant health and productivity, and eventually could adversely influence occupant turnover rate, absenteeism, and satisfaction. Furthermore, IEQ-related problems possess economic implications, as Prakash (2005) suggests that IEQ-related problems, like sick building syndrome, other building-related illnesses, and absenteeism result in increased costs. Improved IEQ performance of a facility enhances the satisfaction and productivity level of its occupants (Fisk, 2000; Mozaffarian, 2008; Prakash, 2005; Fowler et al., 2005; Fard et al., 2006; Heath and Mendell, 2002). Mendell and Heath (2004) reveal that the poor IEQ in school facilities adversely impacts the academic performance and attendance of students, as it causes health-related problems. Moreover, they conclude that the performance of students in school or non-school indoor atmospheres demonstrates a direct relationship to indoor pollutants, thermal comfort, and building characteristics.

The literature argues that facility performance evaluation must include indoor environmental quality (IEQ) as one of the primary indicators (Henry, 2001; Gursel et al., 2007; Mendell and Heath, 2004; Fowler et al., 2005; Moore et al., 2003). Gursel et al. (2007) mentions indoor climate and HVAC system as primary performance domains that must be evaluated and assessed. Furthermore, indoor climate could be assessed in terms of the IEQ and thermal comfort the buildings provide to their occupants. The National Australian Built Environment Rating System (NABERS), Post Occupancy Review of Buildings and their Engineering (PROBE), Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), EcoEffect, and Leadership in Energy and Environmental Design (LEED), all specify IEQ as a factor in their building performance evaluation strategies (Fowler et al., 2005; Malmqvist, 2008). In addition, compliance with all relevant local, state, and national fire codes should be achieved in order to provide the users with not only a healthy, but also a safe indoor atmosphere. The evaluation of fire safety may include verifying that the fire safety system is maintained properly and regularly (Hassanain, 2008). These include fire evacuation plans, sprinkler systems, fire extinguishers, exit signs, emergency lighting, and unblocked exits (Hassanain et al., 2010).

Absenteeism
The built environment has a profound impact on the action and life of its inhabitants, and thus, could affect their performance significantly. In the case of school facilities, an improved physical environment may provide a positive social atmosphere with positive effects on learning (Young et al., 2003; Olson and Kellum, 2003; Brooks-Pilling and Wright, 2005). Olson and Kellum (2003) emphasize the importance of sustainable school buildings with improved environmental aspects, such as indoor air quality (Schneider, 2002) and day-lighting, and assert that such environments could be positive for improved student performance. Young et al. (2003) cite a study (August, 1991) that surveyed 2000 schoolchildren: 33 percent of them selected “Building maintenance and construction” as the number one aspect that needs improvement. Facility performance could result in an increased or decreased number of absenteeism cases, which might impact the performance of the entire school (Olson and Kellum, 2003; Brooks-Pilling...
A study conducted by the Thomas Jefferson Center for Educational Design at the University of Virginia reveals that facilities-related performance resulted in increased absenteeism among students (Young et al., 2003). A report submitted to the US District Court, Northern District of California by Biegel (2000) claims that attendance in schools is vital for the academic performance of the school, and must be emphasized. Schools’ academic performance is closely related to students’ behavioral aspects, such as absenteeism, and this, in turn, may be used as an indicator for school facilities performance (Finn and Rock, 1997; Filner et al., 1982; Finn, 1989).

User perception
Organizations are keen to assess the performance of their facilities from the user’s point-of-view. With that, they can make decisions about improving user satisfaction in order to successfully operate. “User” indicates a client or a customer to whom the facility is delivering its services, while “perception” means the user’s opinion or observation about the facility’s environment and delivered services (Tucker and Smith, 2008). Tucker and Smith (2008) further emphasize the importance of user satisfaction by citing an example of the balanced scorecard approach, which assesses facilities from four perspectives, namely financial, customer, internal business processes, and learning and growth. Moreover, the authors argue that the customer and internal business processes perspective directly and indirectly pertains to user satisfaction. The authors conclude that user perception could significantly affect the productivity of a workplace and eventually, the strategic approach adopted by the organization. The opinions and observations of both categories, staff and customers, are vital for successful business operation. Fleming (2004) argues that facility managers typically are more interested in the technical performance of facilities (e.g. equipment and machines) and tend to neglect users’ opinions. Moreover, the author emphasizes the need to measure user satisfaction, user comfort, and user productivity. Saidi (2007) discusses the role of a healthcare facility’s condition in patients’ healing and emphasizes the importance of user perception (of both staff and patients) to assess this phenomenon. Saidi (2007) uses research tools, specifically surveys and interviews, to collect data related to user perception, and argues that healthcare facilities may be performing well technically in terms of the service delivery and patient care. However, the users may have different, or even negative, perceptions. Saidi (2007) adds that feelings, mental pictures, and human experiences, mostly govern user perception. Turpin-Brooks and Viccars (2006) and Preiser (1995) talk about the Post Occupancy Evaluation (POE) that focuses on user perception of the facility and utilizes data gathering tools like surveys, interviews, and personal observations.

Conclusions
Performance measurement is vital for reviewing past and present functioning of a facility and for making decisions regarding future strategies. Furthermore, it reveals the contribution of a facility toward achieving the organization’s goals. Literature studied for the purpose of this paper emphasizes the need to conduct performance assessments, and points out the lack of proper KPIs. Past research studies on key performance indicators have attempted to establish a relatively comprehensive list of
KPIs; however, these sets of KPIs include a large number of indicators, at times not quantifiable or containing overlapping or redundant information.

Research studies on performance assessment of facilities indicate an urgent need to not only gather existing performance metrics, but also to minimize their number in order to avoid redundant information. This also suggests the importance of selecting core indicators that can express more than one aspect of facility performance. Furthermore, facility management professionals would benefit from categorization of the core indicators, as they could more effectively utilize them. The literature points out the requirement to introduce a wider applicability to the KPIs, so that they could be applied to a larger variety and type of facilities.

This paper builds on Lavy et al’s (2010) paper, and attempts to minimize the extensive list of KPIs by identifying and selecting the core indicators. It also categorizes the selected core indicators into relevant categories so that they can be chosen by facility management professionals according to their requirements. Furthermore, these core KPIs are presented together with a list of their major variables, as identified through a review of related literature.

**Future research**

This research focuses on establishing a list of KPIs that is concise, relevant, categorized, and quantifiable, and possesses the capability to perform a holistic facility performance assessment. This paper is the first step in an endeavor to create a literary base for future research. Future studies must derive proper mathematical expressions for these core indicators, so that they may be measured, calculated, and analyzed properly.

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