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Establishment of KPIs for facility performance measurement: review of literature

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Abstract

Purpose – The purpose of this paper is to identify key performance indicators (KPIs) and categorize them based on specific aspects of facility performance measurement in order to facilitate a holistic performance assessment.

Design/methodology/approach – A qualitative approach, based on the literature, is adopted. This approach relies on an extensive literature search of extant research papers, assessment reports, surveys and presentations to identify KPIs. The KPIs are arranged in appropriate categories based on their purpose and content.

Findings – The paper identifies indicators for performance measurement and classifies them into four major categories: financial, physical, functional, and survey-based. Indicators are arranged from general to the most specific indicators. The list presents indicators with their description, units of measurement, and literature sources.

Research limitations/implications – Future research could focus on further analysis of the list of KPIs in order to generate a more concise list of easily measurable indicators that exhibit wide applicability and valid categorization.

Practical implications – The lack of proper categorization hampers frequent and widespread use of performance metrics by the industry. This study proposes a list of KPIs and presents it in appropriate categories so it can be used more practically by facility management practitioners.

Originality/value – The list of KPIs generated covers aspects of facility performance assessment and shows wider applicability; thus, it could be utilized by practitioners for a holistic assessment of a wide range of facilities.

Keywords Performance measurement (quality), Quality indicators, Critical success factors, Facilities

Paper type Research paper

Background

Facility management deals with the management of built assets and incorporates controlling services necessary for successful business operation of an organization. It should aim not only at simply reducing the operating expenses of a built facility, but also at enhancing efficiency of the facility as well (Amaratunga *et al.*, 2000a). The physical environment has a major influence on the successful operation and efficiency

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of an organization; by modifying it, an organization's desired efficiency could be achieved (Amaratunga *et al.*, 2000b). Thus, to gauge the effectiveness of facility management, it is necessary to reach an understanding of the current conditions of the facility and to postulate changes in facility management practices in order to achieve the desired performance. Cable and Davis (2004) warn that poor facility management could result in inadequate facilities to support functioning, excess facilities not contributing to the organization's mission, cost inefficiencies, inadequacy, and unavailability of facilities for future needs. On the other hand, a strong facility management approach provides needed support to the organization's mission, the realization of future facility requirements, greater cost efficiency, and the ability to anticipate results of current management decisions.

Douglas (1996) explains the importance of building performance in both the inter-building and intra-building sense. The inter-building assessment is a comparative evaluation in which the building under study is evaluated against a similar building. In intra-building evaluation, the building is assessed on its own, based on its individual performance. Performance measurement is, therefore, the key to calibrating the effectiveness of a built facility in a comprehensive manner. Amaratunga *et al.* (2000a) argue that performance measurement is vital to an organization as it provides much-needed direction to management for decision making. Performance measurement extends opportunities to review past and present functioning, and to derive future strategies for successful operation of the organization and for the fulfillment of its strategic goals (Lebas, 1995).

Major facility performance measurement practices include benchmarking, a balanced scorecard approach, post occupancy evaluation, and measurement through metrics of key performance indicators (KPIs). Cable and Davis (2004) assert that performance measurement through the establishment of KPIs helps the senior management team to make important 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. Consequently, it is of tremendous importance to identify a set of KPIs to establish effective performance evaluation metrics for the facility under consideration. Performance metrics indicate long- and short-term finance and performance-related goals, and are vital for a healthier relationship between the customer and the provider of services (Baldwin *et al.*, 2000). Douglas (1996) asserts that benchmarking is vital in building performance measurement as it could be categorized as cost-related and non-cost-related benchmarks: cost-related benchmarks are quantitative in nature and provide short-term feedback, while non-cost-related benchmarks are qualitative in nature and provide long-term vision.

Some of the articles referenced in this paper discuss evaluating the performance of an organization and its services, since an organization's development depends on the buildings it uses. Moreover, organizational performance is closely related to a facility's performance (Preiser and Vischer, 2005). Alexander (1992) explains that facility management has a major impact on organizations, and its significance is increasingly being recognized. Furthermore, it is vital to identify and evaluate the contribution of a facility and its services towards fulfilling an organization's long-term goals.

This paper aims to develop a holistic approach for measuring the performance of built assets by identifying major KPIs, as suggested in the scientific and professional

literature. Specifically, this paper discusses the evaluation of facility performance from the user's/client's perspective.

Why performance measurement?

Cable and Davis (2004) argue that the identification of KPIs and the execution of performance measurement of a portfolio of buildings focuses on assessment of overall performance toward an organization's mission. Furthermore, performance measurement addresses issues related to the buildings or facilities owned, their current condition, additional facilities required for achieving organization goals, issues to be addressed, and the results of investment or no-investment decisions. Thus the purpose of performance measurement is to comprehend the impacts of management decision-making on success and failure of the portfolio and to suggest possible improvements (Cable and Davis, 2004). Barret and Baldry (2003) assert:

> When the facility management unit lacks reliable and comparable data on building performance and costs, its ability to make its most basic decisions is impaired, as well as its ability to make a convincing case for its recommendations.

Douglas (1996) points out goals of performance measurement, which include determining the extent to which a building is catering to its occupants and identifying major issues affecting its performance adversely.

Kincaid (1994) mentions that performance measurement is essential – particularly in order to perform comparisons and develop strategies for improvements. Furthermore, its focus must be not only on costs, but also on issues that shape the physical environment of the organization. Lebas (1995) argues that looking into the past, the present and the future to drive performance improvement decision-making strategies is one prime reason why one should execute performance measurement. Moreover, gauging the growth of organization, knowing the current condition of an 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) assert that rapid feedback about the condition of the building is essential for consistent and continuous improvement in building performance.

Amaratunga *et al.* (2000a) and Brackertz (2006) indicate that performance relates not only to the functional quality of the building, but also to the contribution made by the building in achieving the organization's goals. Hence, buildings do support organizations in meeting their long-term business and other goals. Cotts and Lee (1992) note that for making sound management decisions, facility managers need to evaluate buildings in a detailed manner. The assessment of buildings could be possible in the form of a total performance assessment that considers the 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 strategies in terms of results and to enable management teams to identify crucial issues affecting the organization, as well as issues pertaining to specific operations.

What to measure?

Researchers have put forth intensive efforts to determine appropriate and relevant KPIs that represent performance in a comprehensive manner. Cable and Davis (2004) state that a set of KPIs must be identified and tracked over a period of time so that it

can be compared against a baseline in order to examine improvements or deterioration. Amaratunga *et al.* (2000a) and Brackertz (2006) argue that, unlike past performance measurement, which focused primarily upon financial issues, current measurement practices must emphasize aspects like business, business goals, and job satisfaction. The popular metrics like those relating to financial and space aspects express the level of performance of the building but do not indicate the contribution made to the organization's strategic results (Brackertz, 2006).

The selection of performance measures also depends upon the type of users, since different users like managers, supervisors and customers, require different measures for different purposes (Lebas, 1995). Baldwin *et al.* (2000) state that customers and providers select metrics that reflect their respective expectations and goals. Customer-related metrics tend to converge upon output, while provider-related metrics emphasize the processes implemented.

The public and private nature of the organization and its facilities influences the preference of performance indicators to a certain degree. Cable and Davis (2004) assert that private sector organizations have a profit-oriented approach in selecting KPIs, but federal government organizations, like other public entities, emphasize excellent delivery of goods and services to the public.

Amaratunga *et al.* (2000a) assert that performance measurement cannot be executed solely on the basis of one indicator and suggest that the Balanced Scorecard approach provides holistic metrics of KPIs that include indicators relating to customers, internal processes, financial aspects, and innovation. Cable and Davis (2004) and Cripps (1998) add that facilities must be assessed for their alignment with an organization's goals and mission in order to recognize how well a facility helps the organization meet its goals and fulfill its mission.

Using a survey, Hinks (2004) found that respondents rank KPIs related to a business perspective quite differently than those associated with facility management. Furthermore, the author refers to the Facility Management Association Ideaction 2001 Conference in Melbourne, Australia, where participants ranked three top performance indicators from both a business and facility management perspective. The responses revealed a clear difference between the two and indicated that the customer satisfaction indicator was ranked among the top three in both categories. However, Kincaid (1994) places stress on operating costs and eventual reinvestment in the facility. Although he identified 31 elements of a building that should be inspected, he suggested assessing building performance by selecting six elements (conditioning, floor finishes, external façade, roof, electrical services and lights, and ceiling) that typically account for two-thirds of the total expenditure.

Eagan and Joeres (1997) emphasize the growing significance of environmental performance measurement on a facility. They mention that the International Standards Organization (ISO-14031), British Standards (BS-7750), and the European Union's Eco-management and Auditing Schemes (EMAS) are among organizations that have or are developing guidelines for environmental performance evaluation of building facilities. Eagan and Joeres (1997) complain that most of the current performance metrics include indicators relating to processes, results, and customer satisfaction, but very few mark environmental performance. Epstein and Wisner (2001) mention two organizations (Bristol-Myers Squibb and Severn Trent) that successfully used a Balanced Scorecard approach to measure environmental or sustainability performance

of buildings. They proposed adding an environmental and social perspective to the Balanced Scorecard method. Jasch (2000) asserts that measuring and monitoring the environmental performance of a facility is essential in learning about the level of compliance with environmental requirements, and it must include indicators to express the environmental goals achieved.

Critical success factors (CSFs) are also used to assess performance of an organization. Boynton and Zmud (1984) state that CSFs involve factors that relate to the most vital issues of an organization – its operation and future success. Moreover, these factors reflect areas that need to be taken care of for managerial or organizational success (Boynton and Zmud, 1984; Leidecker and Bruno, 1984). Boynton and Zmud (1984) argue that in spite of a few weaknesses (e.g. difficulty, validity, and applicability,) the CSF method is easily understood and supported by senior management. CSFs incorporate issues that to some extent govern the success and failure of an organization and thus are vital for the assessment of that organization (Chua *et al.*, 1999; Grunert and Ellegaard, 1992; Leidecker and Bruno, 1984; Belassi and Tukel, 1996). Chua *et al.* (1999) state that the CSFs can be identified by obtaining expert opinions in two ways: first, by asking respondents to list and rank indicators that are critical to the success of an organization; and second, by providing a list of factors and soliciting experts' opinions about their ranking. Grunert and Ellegaard (1992), citing Rockart (1979), explain that CSFs could be ascertained by soliciting managers' opinions on a list of indicators.

Belassi and Tukel (1996) argue that efforts are undertaken to enlist CSFs, but these CSFs emphasize only one specific aspect of an organization rather than the organization as a whole. There has been no attempt to group these factors together using a criterion so that their interrelationships could be understood and analyzed. Furthermore, most lists of CSFs demonstrate a single emphasis and thus possess limited applicability. The emphasis should be not only on generating a list that incorporates all of the CSFs that contribute to the success of an organization, but also on grouping these CSFs using a certain criterion so that project managers can identify and focus on critical aspects of a project (Belassi and Tukel, 1996).

Why 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 for comparison, based on which improvements can be sought for any individual indicator. Deru and Torcellini (2005) explain that relevant, clear, compatible, and authentic performance metrics facilitate the understanding of driving forces of a building's performance, assist designers in creating efficient facilities, and support owners in operating buildings in an efficient manner, as well as help management and decision-makers take necessary steps and track performance. Spendolini (1992) states that selecting proper factors that significantly influence the organization's performance is vital for the evaluation methods, e.g., benchmarking.

Hitchcock (2002) and O'Sullivan *et al.* (2004) state that performance metrics can define the performance objectives in a clear and quantifiable manner. Performance metrics relate to the objectives of the performance evaluation of a building and can be helpful in determining the progress towards the performance goals of a building (Deru

and Torcellini, 2005). Yuan *et al.* (2009) identified 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 the space in terms of amount (area and volume), quality (appropriateness, visual and environmental qualities) and shape (plan and layout), as he claims that space planning and management is a key element in building performance management.

Atkin and Brooks (2000) observe that for performance assessment, it is important to identify factors that are crucial to the success of the organization. Furthermore, these factors (CSFs), indicate the required efforts necessary to meet organizational goals and could consist of one or more KPIs that help management grasp, evaluate, and govern the progress made by the organization. Varcoe (1996) states that understanding organizational goals is vital for the measurement of performance as these could relate to respective objectives. Such objectives could be transformed into measures of performance evaluation that could provide essential performance metrics to assess a facility. Moreover, developing performance metrics facilitates the identification of additional indicators that could emerge as a result of change in the organization's strategies as well as in its objectives.

Amaratunga and Baldry (2003) categorized the KPIs according to four basic principles: customer relations, FM internal processes, learning and growth, and financial implications. Augenbroe and Park (2005) divided the indicators into four other categories: energy, lighting, thermal comfort, and maintenance. Hinks and McNay (2005) classified a long list of 172 KPIs under eight categories: business benefits, equipment, space, environment, change, maintenance/services, consultancy, and general. One need identified by Douglas (1996) is for a proper categorization of KPIs so that they represent broader applicability and potential use. Such a list would cater to facility management professionals interested in holistic performance evaluation, as well as assessment of a specific aspect of the facility. For example, facility management professionals interested in short-term financial appraisals would not find long-term functional or system replacement indicators useful. Studies have developed and built lists of large numbers of indicators, but certain ones are not usable because of the way they are categorized. Thus, categorization must provide facility management professionals the opportunity to select the performance indicators in which they are most interested (Douglas, 1996; Ho *et al.*, 2000; Gumbus, 2005).

The literature study emphasizes that performance evaluation of facilities management services is important not only for benchmarking against other facilities, but also for facilitating decision-making in the various aspects of facility management. Furthermore, the literature suggests that performance indicators must

be categorized in such a manner that they are useful for holistic performance assessment, as well as for assessment of any specific aspect of the facility.

Research objectives

This study aims to provide the facility management industry with a concise and categorized set of performance indicators that holistically represent performance measurement and exhibit applicability to a broader range of buildings and facilities. The emphasis is on identifying key indicators that express wider aspects of a facility's performance and on categorization that is representative of the facility management industry's demands. This part of the study aims to establish performance metrics that cover performance indicators as developed in previous studies. This paper addresses the following objectives, to:

- search current literature on performance measurement metrics and KPIs and to identify indicators which are significant in performance measurement;
- establish a list of performance indicators that form the performance measurement metrics; and
- classify these KPIs into major categories based on their objective and what they represent.

Research methods

The research method adopted is parallel to the concept of discovery through literature proposed by Swanson (1986), which emphasizes the creation of new knowledge by referring to bibliographic information available in the form of peer-reviewed papers, conference proceedings, and other valid forms of literature. This approach is gaining wider acceptance and being used in a large number of research studies (e.g., Kostoff *et al.*, 2006; Srinivasan, 2004; Weeber *et al.*, 2001).

Data were collected through an extensive literature search that included published books, articles in peer-reviewed journals and conference proceedings, assessment reports of federal facilities, benchmarking surveys, and presentations on performance measurements. Each paper was studied in terms of what performance indicators it offered, and how these indicators are related to the performance assessment methods (e.g., Balanced Scorecard) mentioned in the paper. The initial list of KPIs was collected and sorted into one of three major categories: maintenance, energy, or others. Applying this sorting mechanism, it was found that most indicators were put into the maintenance category. Douglas (1996) discusses sorting cost-related and non-cost-related KPIs, which led the authors to put all cost-related indicators under a separate category called "financial." Further analysis of the KPIs revealed that some indicators represent operational performance of a facility or organization; these were then regrouped under either "functional" or "physical," based on their scope and intent. Those KPIs found to be unquantifiable or based on subjective opinions were grouped as "survey-based" KPIs. Table I demonstrates major research studies performed to derive and categorize KPIs, and reveals that most of the categories adopted by these studies fall under one or more of the four categories proposed in this paper. Therefore, the list of KPIs was arranged under the following four categories:

(1) financial indicators, which relate to costs and expenditures associated with operation and maintenance, energy, building functions, real estate, plant, etc.;

Sources	Categories: Financial	Functional	Physical	Survey-based
Amaratunga and Baldry (2003)	Financial implications	FM internal processes Learning and Growth		Customer's relations
Gumbus (2005)	Financial implications	Operational Learning and growth		Customer's relations
Hinks and McNay (1999)	Business benefits	Space Equipment Change Consultancy	Maintenance and service	Environment General
Ho *et al.* (2000)		Safety and security Size and use of facility	Ground and environment Energy consumption Cleaning Maintenance Parking Refurbishment	
Augenbroe and Park (2005)			Energy Lighting Maintenance	Thermal comfort
Massheder and Finch (1998)	Business	Acquisition Disposal	Portfolio Building performance	

Table I.
Categorization of KPIs

(2) physical indicators, which are associated with the physical shape and conditions of the facility, buildings, systems, and components;

(3) functional indicators, which are related to the way the facility and the buildings function and which express building appropriateness through space adequacy, parking, etc.; and

(4) survey-based indicators, which are based solely on respondents' opinion to surveys that are primarily qualitative in nature.

Results are presented in a tabulated form where indicators are named, described, and their respective units and sources of information are also given. A total of 35 major indicators are identified by this study of compiling the set of KPIs. It should be stressed that other indicators developed by other researchers and presented in the literature are legitimate for use in cases where needed. The list of indicators presented in this paper represents the views and perceptions of the authors as well as the industry representatives who were consulted for the purpose of this study. The industry representatives' opinions were obtained by administering a brief survey to eleven

facility management professionals who are involved in facility management services and consultancy. These industry representatives were asked the following two questions:

(1) Do you agree or not agree with the proposed categorization of KPIs? If not, please suggest how you would pursue this issue.

(2) Do you agree or not agree that proper facility performance metrics categorization would help in facilities management?

If yes, how it can enhance the quality of performance-based facility management decisions? Seven out of eleven respondents replied, constituting a response rate of 63.6 percent, and their responses are summarized in the next section. These professionals work for built facilities in the realm of K-12 education, higher education, healthcare, office buildings, federal organizations, and oil industry.

Findings

The study identified the following major indicators of performance assessment in four major categories. Following is the tabulated description of each indicator along with its description, units of measurement, and source of information. Key indicators are arranged in the tables from general indicators to the most specific indicators in respective categories. Such categorization permits the analysis of impacts of one indicator on one or more other indicators. Presented this way, their interrelationships can be better understood.

Table II summarizes the facility management professionals' responses to the short survey. All of the professionals surveyed agree on the proposed categorization, with some comments made about the need for a fourth category (survey-based), asserting that indicators mentioned in this category could fall in the other three categories (financial, physical and functional). Six out of the seven respondents said that proper categorization of KPIs would help facility managers do their job better.

Financial indicators

All cost-related indicators are grouped under the category of financial indicators that express costs and expenditure of the facility, the buildings, and their systems and components (see Table III). These financial indicators are different than KPIs in other categories as they provide prompt appraisal of financial performance and can be utilized for short- as well as long-term decision making by the various management levels in the facility. These financial KPIs represent performance in terms of currency expended per unit area, person, or output/product.

The above-mentioned indicators provide a holistic financial appraisal of a facility's performance. Indicators like occupancy costs, operating costs, grounds-keeping costs, etc. provide an estimate of current expenses in the facility or organization, while indicators like deferred maintenance and capital renewal express impending costs that are currently deferred. Capital costs and CRV indicate periodic major expenses required for the extension of property, plant, and equipment for the development of the organization. Therefore, facility management professionals who are interested in measuring financial performance can refer to this category of performance indicators.

Respondents	Agree/do not agree with the proposed categorization	Agree/do not agree that the proper categorization would help in facility management	Additional comments
A	Agree	Agree	"Survey-based category includes indicators that could fall under other three categories." "Anything that can be done to standardize KPIs related to FM would be appreciated"
B	Agree	Agree	–
C	Agree	No response	"Survey-based indicators are a big factor in performance standards"
D	Agree	Agree	"Many of these indicators listed are used by federal facilities." "Survey-based indicators seem to address the physical and functional indicators in a qualitative manner." "Categorization helps facility management professionals in selecting set of indicators of their choice"
E	Agree	Agree	"Any effort to accumulate and translate data would support facility management practice"
F	Agree	Agree	–
G	Agree	Agree	"Kilowatt-hour usage must be tracked; measures to reduce this consumption need to be surveyed"

Table II.
Responses of facility management industry professionals on proposed categorization

Physical indicators

KPIs indicating the physical condition of the building or a facility under study are classified under the physical indicator category (see Table IV). This category represents the physical state of a building in terms of appropriateness (how well the building supports the desired function), quality of space (spatial, environmental, and psychological issues), accessibility (site, location, and handicap accessibility), and resource consumption (energy, water, and material). This category contains qualitative as well as quantitative indicators.

The KPIs mentioned above cover broad aspects of physical condition of a building as they incorporate indicators denoting quality of space as well as spatial and volumetric aspect of a space. Furthermore, the state of the physical condition of a facility expressed by quantitative (e.g. BPI) and qualitative indicators (e.g. Building's Physical condition) relates to resource consumption. For example, a facility with poor physical conditions, like poor HVAC systems, may result in relatively higher energy consumption. Studies aiming at a physical assessment of a building or a facility can utilize these KPIs for relevant performance measurement.

Table III.
Financial indicators

Indicators	Description	Units	Sources
Operating costs	All costs related to facility operation, such as insurance, air conditioning, ventilation, overhead and wages, energy, fire protection, lifts and escalators, repair and maintenance, security, cleaning and garbage, sundries, and other expenses and fees	$US (or equivalent) per: (1) Unit area; (2) Person; (3) Employee; or (4) Product	IFMA (2008); Gibberd (2007); Cable and Davis (2004); Epstein and Wisner, 2001); Loosemore and Hsin (2001); State Council of Higher Education (2001); Baldwin *et al.* (2000); Ho *et al.* (2000); Tsang *et al.* (1999); Macsporran and Tucker (1996)
Occupancy costs	Total cost associated with building occupancy, from building occupation to disposal. It includes real estate and personal property taxes, insurance for the building and its contents, depreciation and amortization costs, etc. This may also be considered a subset of "operating costs"	$US (or equivalent) per: Unit area; Person; Employee; or Product	Mignola and Tery (2006); Baldwin *et al.* (2000); Ho *et al.* (2000); Massheder and Finch (1998)
Utility costs	Monthly or annual cost of utilities, including electricity, fuel oil, gas, steam, water, sewage, etc.	$US (or equivalent) per unit area	IFMA (2002, 2008); Nutter (2005); Wireman (2005); Baldwin *et al.* (2000); Haasl (1999); Carter and Williams (2008); Helmke-Long (2007); Gillespie *et al.* (2006); Barley *et al.* (2005); Cable and Davis (2004); Loosemore and Hsin (2001); Jasch (2000); Rumsey *et al.* (2000); Gursel *et al.* (2007); Seebauer and Viniczay (2006); Chow *et al.* (2003); Norford *et al.* (2003)
Capital costs	All costs required to purchase and extend building property, to procure plant and equipment, and to operate the business or organization	$US or $US (or equivalent) per employee	Kelly *et al.* (2005); Epstein and Wisner, 2001); Vail Cascade Hotel (2001); Baldwin *et al.* (2000); Gerrard (2000); Jasch (2000)
Building maintenance cost	Costs for labor (in-house or contracted-out) and materials required for building monitoring, inspection, repairs, maintenance, and response to service requests	$US (or equivalent) per unit area	IFMA (2002, 2008); Fowler *et al.* (2005); Weber and Thomas (2005); Fowler (2004); Kutucuoglu *et al.* (2001); Loosemore and Hsin (2001); State Council of Higher Education (2001); Ho *et al.* (2000); Baldwin *et al.* (2000)
Grounds-keeping cost	Costs for labor (in house or contracted-out) and materials required for landscaping, storm water management, and parking lot or garage maintenance	$US (or equivalent) per unit area	IFMA (2008); Gibberd (2007); Cable and Davis (2004); Epstein and Wisner, 2001); Loosemore and Hsin (2001); State Council of Higher Education (2001); Baldwin *et al.* (2000); Ho *et al.* (2000); Tsang *et al.* (1999)
Custodial and janitorial cost	Costs for labor, personnel, supplies, and equipment used for providing janitorial and custodial services	$US (or equivalent) per unit area	IFMA (2002, 2008); Ho *et al.* (2000); Baldwin *et al.* (2000)

(*continued*)

Indicators	Description	Units	Sources
Current replacement value (CRV)	An estimated cost of restoring the building to its original condition and function. It includes the costs for materials, labor, equipment, architectural and engineering fees, construction management, and other contingencies	$US (or equivalent)	IFMA (2008); Kinnaman (2007); Teicholz and Evans (2007); Cable and Davis (2004); Economics Research Associates (2004); Parsons/3DI (2003); Shohet *et al.* (2003); Kyle (2002); Epstein and Wisner (2001); Parsons/3DI (2006); Loosemore and Hsin (2001); State Council of Higher Education (2001); Ho *et al.* (2000); Jasch (2000)
Deferred maintenance, and deferred maintenance backlog	Cost of maintenance of property, plant and equipment that is postponed from a facility's operating budget cycle due to financial constraints. It is measured by conducting condition assessment surveys of existing property, plant and equipment, and by determining the amount of funds required to restore back to a condition of "as good as new"	$US (or equivalent)	IFMA (2002, 2008); Magellan Consulting (2007); Teicholz and Evans (2007); Cable and Davis (2004); Coast Community College District (2003); State Council of Higher Education (2001); Ho *et al.* (2000); Kyle (2002)
Capital renewal	The budget required for performing major renovations in the building, its systems, subsystems, and components	$US (or equivalent)	IFMA (2002); Kinnaman (2007); Magellan Consulting (2007); Coast Community College District (2003); State Council of Higher Education (2001)
Maintenance efficiency indicators (MEI)	Indicates the efficiency with which maintenance activities are implemented	MEI values can be divided into three ranges: low, reasonable, and high, based on the actual investment in maintenance, compared to the actual performance of the building	Pati *et al.* (2009); Augenbroe and Park (2005); Shohet *et al.* (2003); Lavy and Shohet (2007)
Facility condition index (FCI)	Represented by the ratio between the total cost of deficiencies to the CRV, or by the ratio between the costs of Deferred Maintenance to the CRV	Percentage of CRV	Teicholz and Evans (2007); Ciminelli (2003); Parsons/3DI (2003)
Churn rate and churn costs	Represents the process of moving a group of employees and/or equipment within a period of time (per month or year)	Expressed as percentage of total average employees in a specific time period or in currency ($US or equivalent)	IFMA (2002); Fowler *et al.* (2005); Fowler (2004); Vail Cascade Hotel (2001); Baldwin *et al.* (2000); Ho *et al.* (2000)

Table III.

Table IV.
Physical indicators

Indicators	Description	Units	Sources
Building physical condition – quantitative: Building Performance Index (BPI)	Indicates the physical-functional state or condition of a facility in terms of building components, systems and processes	Measured as a 100-point scale where a score greater than 80 points represents the building and its performance as good or very good; a score of 70 to 80 points indicates marginal condition, which requires some preventive maintenance measures; a score of 60 to 70 points indicates the deterioration of the building components and system, which requires preventive and breakdown maintenance; a score of less than 60 points indicates poor condition of the building	Pati *et al.* (2009); Augenbroe and Park (2005); Shohet *et al.* (2003); Lavy and Shohet (2007)
Building physical condition – qualitative: general building maintenance in: (1) building physical condition; (2) sanitary, plumbing and storm water; (3) mechanical services; and (4) lighting and electrical	Includes maintenance in terms of routine repairs, major and minor repairs and replacements in: (1) building; (2) sanitary, plumbing and storm water systems; (3) mechanical systems; and (4) lighting and electrical systems	Measured on a scale of good, fair, poor, and unsatisfactory based on condition assessment	Pati *et al.* (2009); Bergeson and Bigelow (1992); IFMA (2008); Teicholz and Evans (2007); Mignola and Tery (2006); Preiser and Wang (2006); Seebauer and Viniczay (2006); Arkansas Commission of Public School (2005); Augenbroe and Park (2005); Donnel Kay Foundation (2005); Fowler *et al.* (2005); Hammond *et al.* (2005); Staskiewicz (2005); Leung *et al.* (2004); Mendell and Heath (2004); Ciminelli (2003); Parsons/3DI (2003); Shohet *et al.* (2003); Kyle (2002); Cohen *et al.* (2001); Henry (2001); Parsons/3DI (2006); State Council of Higher Education (2001); Hitchcock *et al.* (1998); Kincaid (1994); Douglas (1993/1994)
Property and real estate	Includes real estate area and provides an estimate of owned versus leased area in order to know what fraction is owned and what is leased	Area in sq. ft and fraction of leased or owned area in % of total real estate	Brackertz (2006); Seebauer and Viniczay (2006); Hammond *et al.* (2005); Baldwin *et al.* (2000); Ho *et al.* (2000); Douglas (1993/1994)
Waste	Total waste generated for disposal, waste to landfill, hazardous waste, cost of waste disposal, and amount of waste recycled or reused	Volume per year or month, $US (or equivalent) per year or month, ton per month & $US (or equivalent) per month; reused or recycled waste: percentage of total waste generated; disposal cost: $US (or equivalent) per volume	IFMA (2002, 2008); Donnel Kay Foundation (2005); Fowler (2004); Epstein and Wisner, 2001); Baldwin *et al.* (2000); Jasch (2000)
Health and safety	Includes an estimation of condition of employees' health and safety and organization's compliance with applicable codes related to the health and safety of employees	Employees' number of accidents per year, number of lost work hours, number of workers' compensation claims	Kyle (2002); Pitt and Tucker (2008); Gibberd (2007); Seebauer and Viniczay (2006); Mignola and Tery (2006); Hammond *et al.* (2005); Leung *et al.* (2004); Mendell and Heath (2004); Moore *et al.* (2003); Cohen *et al.* (2001); Epstein and Wisner, 2001); State Council of Higher Education (2001); Vail Cascade Hotel (2001); Baldwin *et al.* (2000); California Department of Education (1988); Preiser (1995); Bergeson and Bigelow (1992)

(*continued*)

Indicators	Description	Units	Sources
Indoor environmental quality (IEQ)	Measured in terms of indoor pollutants, thermal comfort, noise, light, and ventilation; thermal comfort: air temperature, mean radiant temperature, humidity, and air speed; indoor air quality: fresh air distribution, restriction of mass pollution (gases, vapors, micro-organisms, smoke, dust, etc.); day lighting and views: views and natural day light through windows.	Each parameter is measured in its respective units of measurement	Pati *et al.* (2009); IFMA (2008); Gillespie *et al.* (2006); Preiser and Wang (2006); Augenbroe and Park (2005); Donnel Kay Foundation (2005); Fowler *et al.* (2005); Leung *et al.* (2004)); Mendell and Heath (2004); Moore *et al.* (2003); Cohen *et al.* (2001); Henry (2001); Gursel (2000); Hitchcock *et al.* (1998); Kincaid (1994); Bergeson and Bigelow (1992); Jasch (2000); Mignola and Tery (2006); California Department of Education (1988)
Accessibility for disabled	Provision for disabled and preparedness of facility to accommodate special needs of handicapped people	Measured on the basis of level of accessibility of the facility for disabled individuals	Preiser and Wang (2006); Ciminelli (2003); Henry (2001); Preiser (1995); Bergeson and Bigelow (1992)
Resource consumption – energy: (1) energy use: total facility energy use; or building energy use; (2) net energy consumption; (3) annual energy consumption; (4) total natural gas consumption; (5) building electrical consumption; or (6) building electrical demand, demand intensity, or peak electricity demand	(1) Total energy consumed by entire facility, including stored fuels or gases; energy consumed in the process of heating, ventilation, and air conditioning, lighting, domestic hot water, plug loads, and other building energy use. This does not include process energy (energy consumed in manufacturing, industrial, or commercial activities) (2) Total facility energy use minus facility energy production (includes energy production and energy savings as a result of using energy star rated equipment and employing energy efficient efforts) (3) Total consumption of energy per year (4) Total natural gas consumed by the facility (5) Total building electricity consumption (6) Building electrical demand is the maximum amount of electricity that a building consumes at a given time Demand intensity is the maximum electricity consumption per unit area at a given time.	(1) kWh, Btu or Joules (2) kWh, Btu or Joules (3) kWh or kVA, kWh or kVA per unit area per hour, or kWh or kVA per person per hour (4) kBtu per unit area, kBtu per person, or therms per year (5) kW or kVA (6) kWh; kW per sq.ft or kVA per sq. ft; kW or kVA	(1) and (2) Carter and Williams (2008); Helmke-Long (2007); Brackertz (2006); Gillespie *et al.* (2006); Augenbroe and Park (2005); Barley *et al.* (2005); Fowler *et al.* (2005); Nutter (2005); Cable and Davis (2004); Fowler (2004); O'Sullivan *et al.* (2004)); Chow *et al.* (2003); Norford *et al.* (2003); Cohen *et al.* (2001); Loosemore and Hsin (2001); Vail Cascade Hotel (2001); Baldwin *et al.* (2000); Ho *et al.* (2000); Jasch (2000); Rumsey *et al.* (2000); Douglas (1993/1994); IFMA (2008); Barley *et al.* (2005); Donnel Kay Foundation (2005); Pati *et al.* (2009); Austin (2008); Gillespie *et al.* (2006); O'Sullivan *et al.* (2004); Hitchcock *et al.* (1998); Cohen *et al.* (2001); Deru and Torcellini (2005); Gumbus (2005) (3) Carter and Williams (2008); Helmke-Long (2007); Gillespie *et al.* (2006); Barley *et al.* (2005); Cable and Davis (2004); Loosemore and Hsin (2001); Jasch (2000); Rumsey *et al.* (2000 (4) IFMA (2008); Gursel *et al.* (2007); Gillespie *et al.* (2006); Seebauer and Viniczay (2006); Nutter (2005); Chow *et al.* (2003); Norford *et al.* (2003); Rumsey *et al.* (2000) (5) Pati *et al.* (2009); Gillespie *et al.* (2006); Augenbroe and Park (2005); Barley *et al.* (2005); Nutter (2005); Loosemore and Hsin (2001); Rumsey *et al.* (2000) (6) Barley *et al.* (2005); Fowler *et al.* (2005); Nutter (2005); Fowler (2004); Rumsey *et al.* (2000)

(*continued*)

Table IV.

Table IV.

Indicators	Description	Units	Sources
Resource consumption – water: (1) water consumption; or (2) net water consumption	(1) Total building water use (2) Total water consumption minus reused, recycled and treated water	Volume per month, volume per product	Carter and Williams (2008); IFMA (2008); Hammond *et al.* (2005); Fowler (2004); Fowler *et al.* (2005); Shohet *et al.* (2003); Epstein and Wisner (2001); Loosemore and Hsin (2001); State Council of Higher Education (2001); Jasch (2000); Hitchcock *et al.* (1998); Lebas (1995); Nutter (2005); Seebauer and Viniczay (2006)
Resource consumption – materials: (1) material consumption, or (2) net material consumption	(1) Quantity of total material used in the process of operation and/or production (2) Total material consumption minus waste, reused, and recycled material	Cubic feet or tons or any appropriate unit of weight	IFMA (2008); State Council of Higher Education (2001); Jasch (2000); Hitchcock *et al.* (1998); Lebas (1995); Fowler (2004); Fowler *et al.* (2005); Epstein and Wisner (2001); Tsang (1998)
Security	Describes the condition of security and effectiveness of security measures in the facility or organization	Number of security incidents per year	Chrusciel (2006); Parsons/3DI (2006); Mignola and Tery (2006); Preiser and Wang (2006); Hammond *et al.* (2005); Leung *et al.* (2004)); Moore *et al.* (2003); Henry (2001); Loosemore and Hsin (2001); Preiser (1995); Baldwin *et al.* (2000)
Site and location	Characteristics of facility's site in terms of size, location, safety, sound and quality, accessibility, contours, preservation and development	Points are given on the basis of: Size: length to width ratio; location: proximity to homes and other community facilities; safety, sound and quality: site is away from dangerous facilities like freeways, railroads, dams, airports, industries, traffic intersections and electric lines, level of external noise; accessibility: good vehicular and pedestrian connections; contours: slopes allowing minimal modification of site; utilities: proper utilities connections.	Brackertz (2006); Fowler *et al.* (2005); Hammond *et al.* (2005); Kelly *et al.* (2005); Cable and Davis (2004); Mendell and Heath (2004); Ciminelli (2003); Moore *et al.* (2003); Kyle (2002); California Department of Education (1988)

Functional indicators

KPIs listed under the category of functional indicators measure the functioning performance of a building or a facility by evaluating aspects related to organizational or business mission, space, employees, and other supportive facilities (see Table V). Overused and underused spaces can very well express the state of space utilization in a building, while productivity and turnover rate can determine occupants' satisfaction with the building or facility.

The list of KPIs under this category explains aspects like building spaces and support facilities in terms of adequacy, and building occupants in terms of productivity, and expresses how well these aspects contribute to attaining long-term business or organizational goals. These indicators, like many others, can be utilized for setting long-term goals and for strategic planning by senior management.

Survey-based indicators

KPIs that cannot be quantified or that are collected by communicating the opinions of respondents are grouped in the category of survey-based indicators (see Table VI). Surveys typically use a questionnaire in which the questions depend on the type of study being performed. Respondents could include building occupants, such as full- and part-time employees, or transient occupants, like customers or visitors, and/or any other respondents, as required by the study.

This category of indicators could be useful to professionals measuring environmental and psychological aspects of a building or facility where the higher importance is given to respondents' reactions and opinions. The results of such survey-based studies largely depend on the number of responses and on their demographic characteristics (age, gender, location, etc.).

Discussion and conclusions

The list of indicators presented above does not represent the entire list of performance indicators developed and discussed in the literature, as there are a large number of indicators being used in facility performance evaluation. Some of the metrics can be measured and quantified, while others are expressed by survey data in qualitative terms.

Unlike similar studies that categorized KPIs into four to seven categories, this paper prefers to classify KPIs in only four categories, as these represent a combination of physical, functional, financial, and psychological factors that influence the performance of a building or a facility. The categories adopted by other studies either emphasize specific points of interest of performance measurement, or they are too general, resulting in many categories that are repetitive or overlapping.

The list of performance metrics, as identified from previous studies, raises a question as to why so many indicators exist. If that is the case, it is probable that something is not working well in the current use of performance indicators. A careful examination of studies on performance indicators and facility assessment reports suggests that various factors, such as the complexity of what is being measured, large variances, resources available for measurements, more opportunities for making improvements, certain business trends, and various definitions and interpretations of the results tend to affect the use and the existence of this large number of performance indicators.

Table V.
Functional indicators

Indicators	Description	Units	Sources
Productivity	Measures productivity in terms of: (1) occupant turnover rate; (2) absenteeism; or (3) occupants' satisfaction and self-rated productivity	(1) turnovers per year (2) absentees per year, or (3) survey-based data	IFMA (2008); Fowler *et al.* (2005); Mendell and Heath (2004); Illozor *et al.* (2002); Cohen *et al.* (2001); Kagioglou *et al.* (2001); Vail Cascade Hotel (2001); Amaratunga *et al.* (2000a); Eagan and Joeres (1997); Lebas (1995)
Parking	Availability of parking spaces	Number of parking spaces per person	IFMA (2008); Seebauer and Viniczay (2006); Fowler *et al.* (2005); Gumbus (2005); Hammond *et al.* (2005); Loosemore and Hsin (2001)
Space utilization	Measures over-used and under-used spaces, adequacy of space, and proper space management	Survey-based data	Preiser and Wang (2006); Deru and Torcellini (2005); Gumbus (2005); Hammond *et al.* (2005); Kelly *et al.* (2005); Illozor *et al.* (2002); Loosemore and Hsin (2001); Baldwin *et al.* (2000); Hinks and McNay (1999); Kincaid (1994)
Employee or occupant's turnover rate	It is the ratio of number of employees turned over in a period of time to the total average number of employees in that period	Ratio (number of employees turned over to the total average number of employees in a given period of time) and number of turnovers per year	Fowler *et al.* (2005); Fowler (2004); Baldwin *et al.* (2000)
Mission and vision, and Mission Dependency Index (MDI)	Facility's preparedness to fulfill its mission. MDI indicates priority of mission in projects and funding	MDI is measured using a 100- point scale, usually represented by the following colors: blue (0-40), green (40-55), yellow (55-70), orange (70-85), and red (85-100, most critical)	Gillespie *et al.* (2006); Mignola and Tery (2006); Cable and Davis (2004); Vail Cascade Hotel (2001); Cripps (1998)
Adequacy of space	Suitability of space for the proper functioning of the facility. Sufficiency of space for various building operations, maintenance, equipment, and other supportive systems	Survey-based data	Preiser and Wang (2006); Staskiewicz (2005); Weber and Thomas (2005); Preiser (1995); California Department of Education (1988)

Table VI.
Survey-based indicators

Indicators	Description	Units	Sources
Customer/building occupants' satisfaction with products or services	Measures the ability to deliver quality products and services to customers, effectiveness of their delivery, timeliness, and overall customer satisfaction with building, building services, and building systems	Customer survey-based data	Baldwin *et al.* (2000); Fowler *et al.* (2005); Wireman (2005) Fowler (2004); Amaratunga and Baldry (2003); Illozor *et al.* (2002); Kyle (2002); Harris and Mongiello (2001) (Kagioglou *et al.* (2001); Amaratunga *et al.* (2000b); Hinks and McNay (1999); Lebas (1995); Climaco (1992)
Community satisfaction and participation	Community involvement, interaction and favorability, and satisfaction among the community	Survey-based data	Gibberd (2007); Brackertz (2006); Henry (2001); Jasch (2000); Climaco (1992)
Learning environment, educational suitability, and appropriateness of facility for its function	Appropriateness of a facility to perform its functions in terms of functional, spatial, and psychological aspects	Survey-based data	Gibberd (2007); Magellan Consulting (2007); Hammond *et al.* (2005); Staskiewicz (2005); Cable and Davis (2004); Henry (2001); Hinks and McNay (1999); Climaco (1992)
Appearance	Exterior and interior visual qualities, harmony with surroundings, scale and proportion of spaces, and visual stimulation of the facility	Survey-based data	Preiser and Wang (2006); Hammond *et al.* (2005); Henry (2001); Baldwin *et al.* (2000); Preiser (1995); California Department of Education (1988)

The complexity of the information being sought tends to influence the number and types of performance indicators. Differing information like data, cost, time, and psychology, when measured individually, often result in a varying number of metrics. Studies relating to performance metrics vary in terms of research objectives and emphasis; hence, outcomes may differ as well, resulting in various types of performance indicators. Literature referred to in this paper shows that studies focused on maintenance, organizational and operational aspects focus on different indicators than those emphasizing energy or other psychological aspects. In addition, the time perspective also plays a role in determining performance indicators, as research from short- and long-term perspectives develops different types of indicators. For example, the focus of short-term indicators is on rapid assessment, while long-term indicators are focused on strategic planning and continuing functionality and operations of the organization. Research studies often employ various methods of assessment, e.g. separate KPIs, Balanced Scorecard, benchmarking, and CSFs, from which this large number of metrics emerge.

Limited resources for measurement may also affect the number and types of indicators developed and used, as some information is readily accessible while other information is difficult to extract due to their complex nature. Qualitative data are at times difficult to calibrate, hence there is a tendency to convert this data into quantifiable data, which creates new complexities. Current trends at local, regional and global levels tend to impact performance metrics significantly, as they represent the demands of the industry. About two decades ago, the trend in performance measurement was moving toward the management of maintenance activities, while current trends concentrate on sustainable energy and economic savings. These can be seen in endeavors to develop performance indicators toward these measures.

The authors believe that this study, as well as other studies, shows that there is a missing factor in the development of KPIs, which is forcing researchers to opt for improved performance metrics. Some of the reasons responsible for this may be lack of applicability (to a broad range of facilities), lack of a holistic approach, and failure of proper categorization. The facility performance metrics must have broad applicability so that with slight modifications, metrics could be used in a broad range of buildings. Performance metrics studies showing a holistic approach cover facility performance broadly and, hence, result in a list of indicators. Lack of proper categorization often results in lesser use of performance metrics because the categories selected have no meaning to the industry. Therefore, the authors suggest that categorization of performance indicators in terms of cost-related and non-cost-related, or functional and physical would be more appropriate, making them more practical for practitioners. Practicality should be viewed in terms of the direct interpretation of KPIs on facility managers' decision making, and measuring the impact of these decisions on facility performance.

This study suggests that broader applicability, a holistic research approach, and better categorization of performance indicators would benefit the field of performance measurement and would provide a more pragmatic perspective to research studies. The list of KPIs presented in this study is extracted from the literature; however, this study does not undermine the relative significance of the other indicators not presented in this paper.

Future research

The major problems identified in the efforts to establish facility performance metrics during this study relate to the large number and complex nature of KPIs, limited applicability, and non-existent or improper categorization. A careful analysis of these indicators could combine most of them into fewer indicators. This paper could be extended to a study that results in a more concise list of indicators that are not only representative of the major aspects of performance measurement, but also sufficient so decisions can be made based on them.

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