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RESEARCH ARTICLE

Rafaela BORTOLINI, Núria FORCADA

Facility managers' perceptions on building performance assessment

Abstract During the operational phase, building performance may decrease in various areas, so that the end users' requirements are no longer met. Consequently, indicators are useful to assess and improve the performance of existing buildings. In this study, we carried out a literature review and organized a focus group with facility management experts to gather and analyze facility managers' perceptions on operational indicators that could be used to assess the performance of buildings. The results revealed that the core indicators used to measure a building's operational performance are related to safety and assets working properly, health and comfort, space functionality, and energy performance. The findings also revealed that these indicators can be obtained from three sources: a) facility managers/operators, who carry out corrective maintenance and perform technical inspections, b) regular users, who report complaints and fill-in satisfaction questionnaires, and c) sporadic users, who also fill-in satisfaction questionnaires. These indicators and their sources can contribute to a better analysis of building performance and the definition of measures to improve performance during the operational phase of a building.

Keywords building performance, facility management, non-residential buildings

1 Introduction

Performance can be described as behavior in service of a facility for a specified use (ISO 11863, 2011). Buildings deteriorate over time, and even faster when they are not maintained properly (Heo et al., 2012). Furthermore, old buildings have relatively poor energy performance, since they were constructed before the introduction of energy legislation (Droutsa et al., 2016), and they represent a high percentage of existing building stock (Ruparathna et al., 2016). Specifically, non-residential buildings account for 25% of the total stock in Europe (BPIE, 2011).

Even if a building maintains its original properties (e.g., not showing visible degradation), it might not meet the performance requirements of users, owners and/or facility managers. Users normally want a comfortable space, in other words, one that contains well-functioning building equipment, has a clean environment, and is safe (Ali, 2009). Owners focus on investment decisions relating to costs (Love et al., 2013), and facility managers are concerned with the overall functionality of the built environment (Cotts et al., 2009). To assess whether these performance requirements are being met, it is essential to evaluate the performance of a building to determine whether it is necessary to intervene (Talon et al., 2005). Without this information, maintenance work may have high costs associated with unnecessary interventions or urgent repairs (Silva et al., 2016).

Those performance requirements can be grouped into categories (Lützkendorf et al., 2005). The category in turn can be measured with individual performance indicators. Facility managers are those in charge of systematically studying and assessing a building through the use of these indicators (Douglas, 1996; Mwasha et al., 2011). The importance of measuring building performance through key performance indicators (KPI) has been emphasized by various authors (Sinou and Kyvelou, 2006; Pati et al., 2009; Liu et al., 2011; Cecconi et al., 2014; Yan et al., 2015). Despite existing studies on performance evaluations, few reported studies evaluate indicators based on the experiences of the facility managers who have implemented and observed the actual operational indicators in the

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Rafaela BORTOLINI, Núria FORCADA (✉)
Department of Project and Construction Engineering (DPCE), Group of Construction Research and Innovation (GRIC), Universitat Politècnica de Catalunya (UPC), Terrassa, Barcelona, Spain
E-mail: nuria.forcada@upc.edu

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assets they manage. An exploration of the experiences of practitioners who have implemented these indicators is essential to understand users' needs and expectations regarding performance. Therefore, the recognition of the most important performance categories and then the establishment of the operational indicators can guide facility managers to determine what maintenance work should be undertaken to improve building performance and thus meet users' needs.

The aim of this paper is to determine facility managements' perceptions on building operational performance indicators. Identification of the most important performance categories, indicators and sources, and where to get these indicators will help facility managers to decide on the most appropriate measures to enhance building performance. To achieve the aim, we reviewed and discussed previous research on building performance, and organized a comprehensive focus group with facility management professionals.

2 Background

2.1 Building performance

Building performance can be described as the practice of thinking and working in terms of ends (Gibson, 1982). It is a basic feedback system that compares explicitly stated performance criteria with the actual measured performance of a building (Preiser and Nasar, 2008). The performance approach was originally concerned mainly with improving the project delivery process for new construction (Lützkendorf, 2005). However, the term "performance" in a broad sense is related to buildings meeting the needs and requirements of users (Bakens et al., 2005) in providing a conducive, safe, comfortable, healthy and secure indoor environment to carry out different activities, including work, study, leisure, family life, and social interactions (Ibem et al., 2013).

The performance of buildings is managed by a facility management (FM) team, who should consider a set of processes that operate at three levels: strategic, tactical and operational (CEN, 2006; 2011). The operational level, focus of this research, is the primary function of FM (Chotipanich, 2004). This operational function supports the basic routine, and regular needs of an organization (CEN, 2011). An effective operational FM provides a safe and efficient working environment which is essential to the performance of any building (Chotipanich, 2004). At this level, the operators monitor the building performance and report the performance gaps to the higher management (Ruparathna et al., 2016).

At operational level, building performance can be categorized as: Technical, functional, behavioral, aesthetic and environmental (Straub, 2003; Hovde and Moser, 2004; Lützkendorf and Lorenz, 2006; Preiser and Nasar, 2008; Yan et al., 2015).

Technical performance is related to structural, physical and other technical features and characteristics of the building (Lützkendorf, 2005). Buildings must provide physical protection for their occupants and assets, which includes protection from crime, vandalism, terrorism, fire, accidents and environmental agents (Sinopoli, 2009).

The functional performance of a building describes and assesses how well use-specific activities and processes can be performed. It covers how well-suited the design of the space is for the planned use, the extent to which the design is accessible and barrier-free, and the adaptability of the building to changing user requirements and uses, among other factors (Lützkendorf, 2005). The correct functioning of elements is also related to the functional performance of a building (Sullivan et al., 2010).

Behavioral performance is related to the interaction between occupants and building systems to meet comfort and health needs, which may differ vastly due to individual variance in user perception and be influenced by many contextual factors (Yan et al., 2015).

Another category can be identified as aesthetic properties. Aesthetic performance is associated with the building's image and appearance (Preiser and Nasar, 2008), which is related to the absence of surface defects, and the homogeneity of color and finishes (Straub, 2003).

Due to increasing concern for global sustainability, environmental performance has become more important. This category is related to evaluating the performance of buildings across a broad range of sustainable considerations and analyzing the building's features that affect the local and global environment (Alwaer and Clements-Croome, 2010).

2.2 Operational indicators

A performance indicator considers one or many aspects and is a measure that can generate a quantified value to indicate level of performance (Duffuaa and Ben-Daya, 2009). Indicators can be used to measure status, compare and assess, identify objectives and define targets, plan improvement actions and continuously measure changes over time (Talamo and Bonanomi, 2015).

Indicators should be generic to the context with standardized measurements, reasonably simple (usable by anyone), flexible (useable on many different types of buildings) (Alwaer and Clements-Croome, 2010), relevant and reliable (reasonably free from error and bias and faithfully represent what they purport to represent) (Carlucci, 2010), easily converted into knowledge (Marr, 2010), and trusted by all stakeholders (Innes and Booher, 2000). The participation of those who use and learn from the indicators is extremely important (Innes and Booher, 2000). If the stakeholders are involved in the process of developing indicators and if they can relate them to their own contexts and perspectives, then the indicators will really become part of their thinking and ordinary decision-making (Innes and Booher, 2000).

Previous studies on performance indicators have focused on different performance categories, and particularly on the savings achieved by monitoring sustainable energy performance indicators, which are related to environmental performance. In this category, the most common indicator is energy consumption (Lavy et al., 2010). Mwasha et al. (2011) investigated sustainable indicators integrated into energy efficiency measures to improve building performance and pointed out the importance of the thermal energy performance of the building envelope. Wang et al. (2012) stated that energy performance assessments can detect faults and diagnose the causes of poor performance in buildings.

Moreover, the most commonly used building environment assessment tools (LEED, BREEAM, Green Star, CASBEE, BEAM) (Wang et al., 2012) also provide some indicators relating to the operational phase, such as glare, thermal, ventilation and lighting user control, acoustic condition, cleaning/hygiene condition, accessibility (barrier-free access), waste disposal and reuse of water.

Technical performance indicators are considered the most critical, as they may detect defects and failures that could put the life of end users at risk (Khalil et al., 2016). Structural resistance to fire and stability are two important indicators to be considered in this category (Lützkendorf, 2005). Weber and Thomas (2005) identified asset failures and the severity of their consequences as an indicator. Safety, hydrothermal and other serviceability issues were identified by Flores-Colen et al. (2010) as important aspects related to technical performance.

Suitability of a space for specific activities is commonly identified as a functionality indicator (Lavy et al., 2014). Thermal comfort, humidity control, air quality, light quality, noise and workplace pollution are generally considered as indicators of comfort/well-being that are also related to functional performance (Atzeri et al., 2016, Ornetzeder et al., 2016). Taking into account visual comfort, Pati et al. (2006) determined that light quality is one the most important features of the work environment that affects user satisfaction. Some studies related functional performance with complaints when occupants' expectations diverge from the conditions of the building's space, for example, when a space is too hot (Goins and Moezzi, 2013).

Table 1 summarizes the performance categories described by previous studies and some example of indicators for each category.

Table 1 Performance categories and examples of operational indicators (Straub, 2003; Hovde and Moser, 2004; Lützkendorf and Lorenz, 2006; Preiser and Nasar, 2008; Yan et al., 2015)

Performance category	Example of indicator
Technical	Good layout of evacuation routes Structural condition [number of defects. severity]
Functional	Suitability of spaces [occupation/m^2] Air quality [CO_2 level]
Behavioral	Thermal comfort [number of complaints about temperature/year]
Aesthetic	Façade appearance [peeling defect on façade/m2]
Environmental	Waste generation [kg/year] Energy consumption [kWh/m^2/year]

3 Research method

A combination of focus groups and a literature review is an appropriate technique to define indicators. It provides interesting results as it brings together both academic and industry views (Kim Y H and Kim H H, 2008; Alwaer and Clements-Croome, 2010; Krueger and Casey, 2009). The focus group technique is defined as a carefully planned series of discussions to learn what people think about a specific area of interest in a permissive, non-threatening environment (Krueger and Casey, 2009). Furthermore, interactions among participants can yield important data (Morgan, 1998) and the sense of belonging to a group can increase participants' sense of cohesiveness (Peters, 1993).

In this paper, we carried out a literature review and organized a focus group to analyze facility managers' perceptions on operational indicators that could be used to assess the performance of buildings. The research process used to define these indicators was based on Krueger and Casey (2009) and consisted of three stages (Fig. 1).

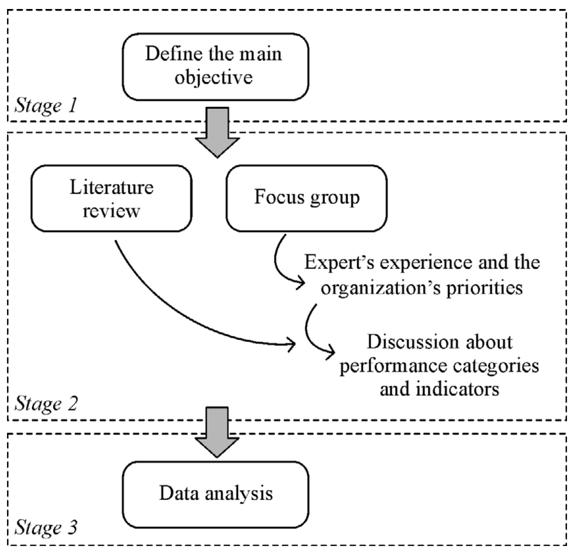

Fig. 1 Research process

Stage 1. Definition of the main objective

The first stage of the research process was to define the study's main objective: To analyze facility managers' perceptions on indicators that could be used to assess the performance of a building in use. The identification of indicators was limited to the operational level. The focus of this assessment was non-residential buildings, specifically the group of buildings classified by the International Building Code (2018) in B (Business), E (Educational) and M (Mercantile).

- Business buildings such as offices, banks, etc.
- Educational buildings such as schools, universities, etc.
- Mercantile buildings such as department stores, markets, etc.

Particular types of non-residential buildings such as hospitals were not considered due to their strict requirements and particularities. In hospitals, for example, patients' health is directly associated with the facility's environmental performance. Therefore, facility managers need to evaluate multidimensional aspects in rigorous decision-making process when they address building performance (Kim and Augenbroe, 2013).

Stage 2. Definition of performance categories and indicators

In stage two, performance categories and indicators were first selected by reviewing the literature, and second by a focus group comprised of key people with experience in FM. Data were collected through a literature search that included published articles in peer-reviewed journals, conference proceedings, sustainability assessment methods and existing building codes. Each paper was studied in terms of what performance indicators it offered, and how these indicators were related to performance assessment. The results of this investigation were used as the basis for discussion in the focus group.

The focus group was conducted with FM professionals including engineers, architects and technicians who were involved in FM services and consultancy. Some researchers suggest that smaller groups help to encourage interaction between group members (Wilbeck et al., 2007). The experts who were invited to join the focus groups were selected on the basis of experience as follows: Level I: Over 20 years of work experience; Level II: 10–20 years of work experience; Level III: 5–10 years of work experience (based on Zhang et al., 2014). Experience in academic research and availability were also taken into account. Generally, individuals' judgment tends to become increasingly sophisticated and stable with the accrual of educational and work experience (Zhang et al., 2014). Although the participants were selected for their knowledge of the topic to be discussed, some heterogeneity was also considered, to encourage active discussion and contrasting opinions (Krueger and Casey, 2009; Wilbeck et al., 2007). Therefore, experts from different companies with experience in different types of buildings were considered in the selection.

Participants were formally invited to take part in the focus group via an e-mail, in which the purpose of the group was explained. A total of 12 experts participated. Seven of the participants had over 20 years' experience in FM consulting and maintenance activities, two had between 10 and 20 years of experience, and 3 had between 5 and 10. Table 2 summarizes the participants' details.

The experts included industrial engineers (8), an architect (1), quantity surveyors (2), and a technical engineer (1). Although all the experts were from Spain, five of the respondents had experience in international working places and all the participants had experience in implementing and evaluating operational indicators in buildings.

The focus group meeting followed a schedule divided into two main steps. To establish a sense of belonging to the group, in the opening question (Krueger and Casey, 2009) participants were asked to explain their current role within their organization and their experience in FM. Then, the introductory question was designed to get everyone talking, and was an easy question to answer (Krueger and

Table 2 Participants' positions and level of work experience

Participant	Level of work experience	Position
1	I (more than 20)	FM consultant and director of an FM company
2		FM consultant at a company with experience in European projects and government administration
3		Head of the maintenance department on a public university campus
4		Coordinator of a maintenance department at a public university
5		Head of a maintenance department at a government building
6		Head of a department in a private foundation in the construction sector with experience in government administration
7		Project management consultant with experience in international projects and integrated project delivery
8	II (between 10 and 20)	Deputy head of a maintenance department on a public university campus
9		FM consultant at an international company
10	III (between 5 and 10)	FM at a company with experience in government administration
11		FM on a private university campus
12		FM consultant at an FM company

Casey, 2009). Thus, the experts were asked to present their company's main building management concerns. In the next step, key questions were proposed (Hallas, 2014) and participants were asked to brainstorm and suggest essential performance categories, indicators and sources of information to assess the performance of a building in use. Essentially, end questions bring the discussion to a close, with final comments about the topic that are important to the participants (Krueger and Casey, 2009). The experts were also put into groups of four to discuss the categories and indicators, and reach an agreement on the most important. Each group was comprised of experts from different disciplines. After this activity, a representative from each group was invited to present the results of their discussions to the whole group.

The focus group lasted two hours and was kept open using phrases such as "can you give me an example," "tell me more about it." The open nature of the meeting stimulated avenues of interest to be pursued as they arose, without introducing bias in the answers (Krueger and Casey, 2009). Moreover, participants who were relatively silent (e.g. who were too shy to speak about an issue, or who did not want to reveal that they had a different opinion) or who dominated the discussion were moderated. Continuous effort was made to break any barriers that may have existed between the moderator and the participants, as suggested by Wilbeck et al. (2007). An assistant moderator took notes during the focus group, to support the digital transcription process, maintain validity and safeguard in case the digital recorder failed.

Stage 3. Data analysis

The empirical material derived from the focus group discussion was analyzed by first categorizing it in a process by which the researchers sought to address the most important themes, highlight noteworthy quotes and identify any unexpected findings (Breen, 2006). Then, the results of the focus group and the literature review were combined.

4 Results

4.1 Discussion on building performance categories and operational indicators

The performance categories and some examples of indicators identified in the literature review (Table 1) were used as the basis of a discussion with participants. The experts discussed the most relevant categories and indicators presenting their individually experiences and also discussing in small groups for subsequent presentation to the whole group.

All experts agreed that it was essential to meet regulations (as a threshold), so building regulations were taken for granted. Consequently, prevention of occupational risks and safety were considered the most relevant categories of building performance.

"…we support small and medium-sized public administration… in those buildings we define some actions, and the first priority is safety, fulfillment of regulations… and later we try to incorporate measures to reduce energy consumption…"

The discussion on functional performance centered on the following aspects: suitability of the space, assets working properly, and health and comfort. The suitability of the space allows users to do their job.

"…we start with space management, dealing with the users' needs related to space to perform their activities… buildings should have the safety and habitability conditions to allow staff and users to carry out their activities satisfactorily…"

The functionality of the working areas and the functionality of buildings (for example, ergonomic workplaces) were also considered an essential indicator.

All experts highlighted the importance of users' well-being. They all considered that health and comfort was the priority in definitions of well-being. Although productivity is difficult to measure, and the quality of employees' work cannot be measured directly (Kumar et al., 2013) it is related to their satisfaction:

"…the main aim of private companies is the satisfaction of their employees… in the long term, the well-being of the end user becomes a benefit for the owner..."

In terms of health and comfort, temperature, humidity, air velocity and lighting were considered the core indicators. However, experts agreed that:

"You cannot define objective ranks to be fulfilled in all buildings and/or rooms. A museum will require different temperatures and humidity to conserve paintings. In this case, the conservation of paintings is a priority instead of the user welfare. The same happens in an office or commercial building. Depending on the degree of activity, different comfort ranges will be needed."

As an indicator of health and comfort, the time that the room is outside of temperature limits was considered to be a useful parameter. However, experts revealed that the limits should be fixed by the company and might vary according to the room and the uses. Existing research stated that non-residential buildings face a complex issue, due to variations in use. Requirements vary depending on the time and number of occupants; and these factors are associated with use (lecture halls, laboratories, and offices) (Chung and Rhee, 2014). Furthermore, the interaction between occupants and building systems to achieve comfort may vary depending on the user (Yan et al., 2015) and the occupant's lifestyle (Sharmin et al., 2014).

The level of cleanness of a building was also considered to be important and was considered to be taken for granted. Although it is almost always underestimated and frequently neglected, cleaning is one of the most relevant operations in a building (Flores-Colen et al., 2008).

In discussions of environmental performance, experts described the importance of assessing energy consumption considering the resources (electricity, gas, etc.) to save costs. This is also related to "energy certificates" that assess a building against a set of quantitative and qualitative performance criteria, and award credits (points or numerical scores) when a building is deemed to have met specified criteria (Lee, 2013).

All experts agreed that the aesthetic appearance of a building was the least important category in terms of building performance assessment. This is consistent with previous studies in which users were found to value aesthetic aspects as relatively unimportant (Preiser and Nasar, 2008).

From a more managerial approach, experts revealed that building performance indicators depend on the resources (for example, human, technological and financial) that are available for the building, and the quality of the service/ building that should be achieved.

"It is necessary to define the use of the building and other parameters like the degree of "quality" or the "quality of the services" provided by the building… what the clients expect, what the possibilities of the company/ building are…"

An FM consultant stressed the different requirements of end users:

"...an important aspect is to define who our clients are… if we consider a public or a private building, the clients are different... in private buildings, we are interested in the satisfaction of both internal and external clients, especially in buildings for public services ... we want employees' (internal) satisfaction to have better work quality, and the customer (external) to buy more..."

Generally, buildings managed by the government have fewer resources, consequently the quality of services provided by the building is different from that of private buildings. In private companies, extra services are valued, including co-working areas, spaces for individual work, areas for fitness activities and car parks. Therefore, each organization's selection of performance indicators will reflect the objectives and requirements of the corporate strategy (Kumar et al., 2013).

Some experts complained about existing indicators that include economic aspects such as energy costs, instead of using energy consumption. An FM consultant from a private company declared:

"Companies define many indicators that deal with economic aspects which are useless in the day-to-day (e. g., electricity cost/m^2). If we need to analyze operational performance we require indicators that allow improvement measures to be implemented and comparisons to be made in different regions and countries, for example, electricity consumption/m^2. In this case, one can repair equipment, replace lights, etc. so as to reduce the electricity consumption, but when electricity costs are analyzed, the decisions should be made at managerial level (e.g., change the electricity contract)."

Other experts highlighted the importance of analyzing the operational costs and the cost of replacing equipment. This is related to the facility condition index (FCI) that measures the combined effect of maintenance and replacement on a facility's condition in the form of a ratio (Lavy et al., 2014). In describing this issue, an FM consultant stated:

"It is important to know how the facility manager at operational level transmits the results to his director at economic and financial level… the director is concerned about the ratio of investment and replacement expenditure and what is cost effective for the company…"

Therefore, although the financial aspect is considered important to measure performance, these metrics are used for strategic planning (Kumar et al., 2013). According to Kumar et al. (2013), users at the highest level of management (strategic) traditionally refer to aspects that affect company performance, while those at operational level deal with the physical condition of assets (building performance).

Some participants described the importance of measuring the performance of the maintenance process, even though it was not the aim of this research. In this respect, the percentage of work orders completed in a schedule and the accomplishment of a maintenance plan were considered relevant in analyses of maintenance process performance (Kumar et al., 2013). Indicators to control whether tasks are being performed were also considered important, since they helped to monitor the output to be achieved in the process. It is notable that this topic came up, as maintenance actions have a considerable impact on FM. Maintenance is key in the extensive field of FM, as it is the focus of most FM activities (Lewis et al., 2011). However, these metrics are outside the scope of this study, which concentrates on indicators for assessing building performance.

Another important aspect indicated by the participants was the use of reliable data to calculate these indicators by analyzing the inventory, drawings, lighting level of spaces, CO_2 levels, etc. Therefore, it is necessary to monitor and inspect the building to get real data. This is also related to "technical building inspections," which are compulsory in some countries. Mandatory building inspection ensures that a building is safe and its environment is healthy (Chan et al., 2014). It consists of a visual inspection followed by a technical report to describe the condition of the building, any defects that have been found and their possible causes (Housing, Planning and Lands Bureau, 2006). In particular, technical inspections analyze elements that might represent a danger in public installations.

Similarly, to the study by Kumar et al. (2013), some experts considered that having a lot of indicators was impractical, and that indicators should be simple to allow the possibility of benchmarking. One expert declared:

"Indicators provide an opportunity for benchmarking…

I can compare my company with the market and see how my company is going."

According to Lavy et al. (2010), the establishment of benchmarks allows comparison with other facilities, and helps guide management in decision-making, which is related to the success of current FM practices.

Experts mentioned that technicians and operators will only collect data if they trust it is meaningful, and the results are made available for consultation and use. A large amount of data collection can generate unknown indicators for the collectors, hence, they may distrust the data and fear the effects (Kumar et al., 2013).

The results of the focus group also revealed that the range of performance indicators for business, educational and mercantile buildings depends on the building's desired level of quality. Therefore, public buildings might have different levels of performance from private buildings. However, the indicators for evaluating building performance should be the same.

4.2 Data analysis

The analysis of the literature review and the conclusions of the focus group revealed that the main performance categories to assess the operational performance of a building could be limited to: safety and assets working properly, health and comfort, space functionality and energy performance.

For each category, operational indicators were provided from literature review and experts suggestions. These indicators can be obtained from three main sources of information:

- FM/operators: these indicators include those that can be measured by extracting from and using simple databases, such as the Computer Maintenance Management System (CMMS), sensors connected to Building Management Systems (BMS) that report malfunctioning, energy consumption by area (Kumar et al., 2013) and building inspections.
- Regular users: these indicators are related to complaints about comfort or malfunctioning of elements through a call desk. The end user notices a problem and can complain, for example, if the HVAC system is not working properly. However, the user cannot give feedback about internal characteristics such as problems with the HVAC pumps' pressure.
- Sporadic users: these indicators are obtained from questionnaires that mainly use satisfaction ratings about comfort-related aspects.

Regular users can report an incident relating to a system (such as elevators) not working properly, and can complain about the comfort of their working space (for example, its temperature). The term "complaint" is used here to mean a statement that a condition is unsatisfactory or could be improved (Goins and Moezzi, 2013), while an incident is an event that is either unpleasant or unusual, such as malfunctioning of some equipment. CMMS are the usual tool to gather incidents and complaints made by regular users. The participants considered that the satisfaction of sporadic users can be determined through questionnaires, which is in accordance with Au-Yong et al. (2014), who stated that user comfort indicators are normally obtained through questionnaires.

Figure 2 illustrates the main findings of these researches by presenting the relationship among the indicators within each category, the data sources and the tools where to get these indicators.

Figure 2 also presents examples of operational indicators for each performance category. For instance, in the energy performance category, FM/Operators manage BMS tools to get information about the electricity consumption (kWh/m^2). The space functionality can be evaluated in terms of efficiency (m^2/person) or in terms of quality by satisfaction surveys. The health and comfort category can be evaluated in a subjective and objective way. In one hand, regular and sporadic users can complete satisfaction surveys to report their satisfaction in terms of thermal, air, light and acoustic quality (Likert scale). On the other hand, FM/Operators can evaluate objectively the same category by monitoring the temperature (°C) and humidity (%) by sensors connected to BMS, and by using lux meter and sound level meter for measurement of light and acoustic quality, respectively. The safety and assets working properly category can be evaluated by defects detected in technical inspections conducted by FM/Operators and alarms monitored by BMS. This indicator can also be measured by the number of complaints reported by regular users within each building element or system.

5 Conclusions and future work

This paper presented the facility managers' perceptions on performance indicators for business, educational and mercantile buildings. The indicators were initially compiled from existing research on building performance, to form the basis of a focus group discussion. Despite the performance categories identified in the literature review (technical, functional, behavioral, aesthetic and environmental), focus group discussions resulted in the categorization of performance considering a different approach. All experts agreed that building performance assessment could be limited to: Safety and assets working properly, health and comfort, space functionality, and energy performance.

The results revealed that indicators should be reliable, allow comparison between buildings, and facility managers should be concise and concentrate on the most relevant ones. Experts argued that a great quantity of indicators can be impractical and not useful. Participants suggested indicators such as structural condition to evaluate the safety and assets working properly, tempera-

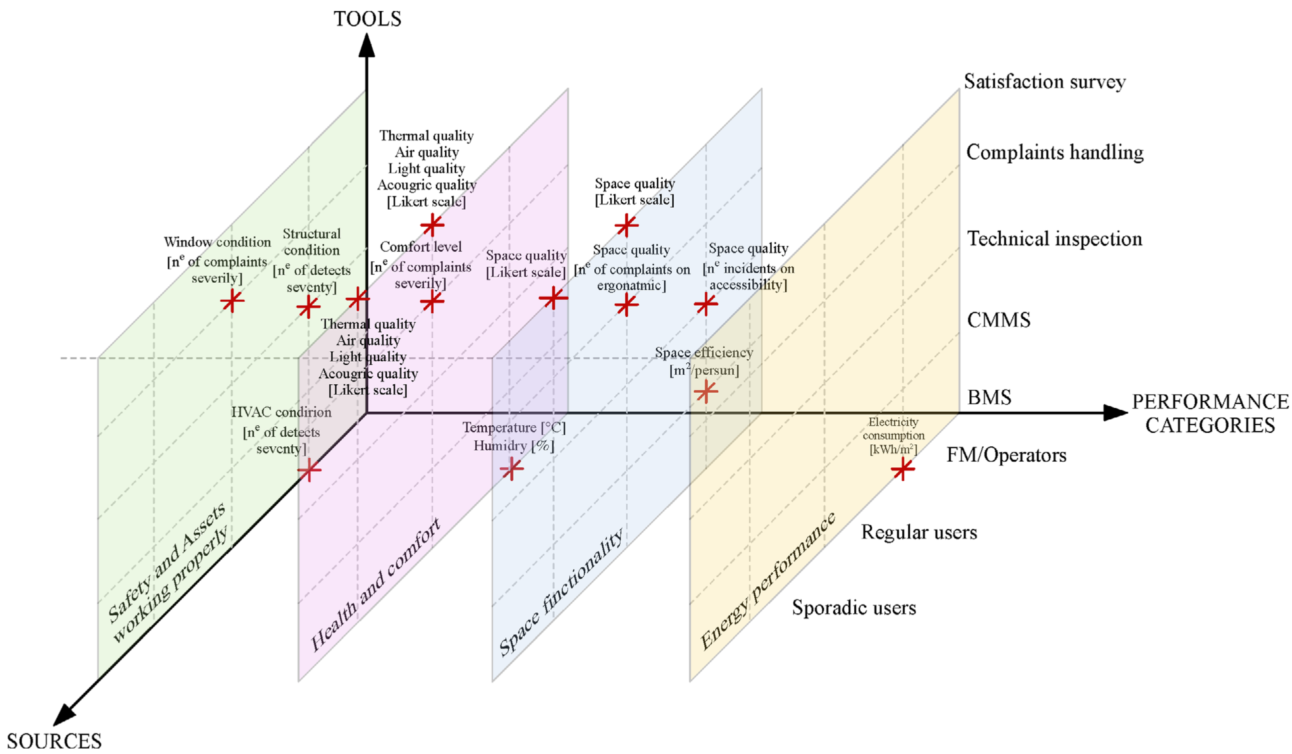

Fig. 2 Building performance assessment

ture and humidity to evaluate health and comfort, number of occupants per room to evaluate space functionality, and energy consumption per square meter and year to evaluate energy performance.

The results also suggested that operational indicators should be classified into three sources, based on different users: FM/operators, regular users and sporadic users. To obtain operational indicators, these three sources can be related to specific tools. FM/operators use CMMS, BMS systems and on-field inspections, while regular and sporadic users report complaints by CMMS and/or questionnaires.

Unlike previous research on performance assessment, the focus group's findings revealed that categories' importance in building performance assessment depend on the objectives of the evaluation, considering private and public buildings. Although all participants had experience in FM in the same group of buildings, experts working in public buildings (government and academic buildings) and those working in private buildings (academic and offices buildings) had different perspectives. Experts with experience in public buildings were more concerned about safety requirements due to a lack of resources, whereas experts working for private organizations prioritized indicators related to user satisfaction.

The results of this study could help facility managers to make decisions to improve the performance of existing buildings and meet users' needs. The results can be used to analyze and compare the performance of different buildings and establish a ranking of building performance that is similar to that obtained in the energy domain. Results of these levels of performance could be used by the administration to propose mandatory "building performance evaluations" to assess the building stock and propose incentives for high-performance buildings. Furthermore, these levels could be used to prioritize maintenance actions when there is a tight budget for managing many buildings, for example, on university campuses. The performance indicators can be used to evaluate individual buildings and define preventive, predictive and corrective maintenance actions.

This study was limited to business, educational and mercantile buildings and the indicators represent the views and perceptions of FM who were consulted in the focus group. Future work will include the definition of acceptable levels of performance for each indicator within each category, and a determination of how to measure the severity of each indicator. The severity of defects identified in inspections and incidents/complaints from users takes into account how the criticality of the problem affects the overall functionality of the building. Future research will also include the validation of these indicators and level of performance in existing buildings. This validation will include an analysis of existing monitoring data, undertaking of technical building inspections, and the use of questionnaires to evaluate building performance.

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