



Appraisal of indoor environmental quality (IEQ) in healthcare facilities: A literature review



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ARTICLE INFO

Article history:

Available online 16 April 2015

Keywords:

Indoor environment quality
Building assessment
Performance evaluation

ABSTRACT

This study reviews the relevant literature to ascertain the extent to which IEQ performance evaluation in healthcare facilities have been carried out. The aim is to draw understanding and to identify areas that are yet to be considered or needs more attention. The performance assessment of IEQ is based on four parameters. However, these parameters of IEQ have not been validated as a measurement construct for the evaluation of IEQ performance in buildings. Combinations of subjective and objective assessment methods of IEQ is also limited in ascertaining the degree of variation or equality in their measurement of the same trait factors.

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1. Introduction

Indoor environmental quality (IEQ) as one of the features of green buildings and sustainable environment has been drawing much attention, due to its high impact on the behaviour of the building users. The IEQ in buildings is essential in determining the success or failure of such buildings. A building is designed and constructed to be run, operate and occupy by people, and, as such, the requirements for their occupancy must be made as a prerequisite for their comfort. So also so, the significance of sustaining better IEQ in buildings should be a concern for both planners and managers of the built environment.

The environmental performance of a building does not only depend on the physical factors but also on the interface that exist between the physical environment and the occupants. The essential requirement of a building is to ensure that the building meets not only the required standards for an indoor environment but also occupants' needs and satisfaction. In whatever situation people find themselves, they are surrounded by an environment, as a result, maintaining health and comfort is a great challenge (Parsons, 2013). When designing an environment for people, the physical environment and peoples' response must be taken into account (De Giuli, Zecchin, Salmaso, Corain, & De Carli, 2013). This response by the people is what would determine comfort, wellbeing, satisfaction or dissatisfaction, with the environment. A building is considered as performing well if the users of the building appraise it so, and especially when it provides the users with healthy, and comfortable indoor environment that enhance their productivity and satisfaction. An environment, where people have the freedom of changing environmental conditions, tends to be more

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satisfactory than the one with restriction (Parsons, 2013). The requirement for comfortable IEQ in buildings is a result of the feedback that have been obtained from the occupants as the building users (Frontczak, Andersen, & Wargocki, 2012a). Therefore, an indoor environment can be referred to as performing well if it guaranteed up to 80% satisfaction for the building occupants (Mui & Chan, 2005; Wong, Mui, & Hui, 2008).

For buildings such as healthcare facilities, the issue of maintaining health and comfort should never be compromised or overlooked. In the practice of nursing, a healthy environment has been noted as having great impacts on the health of the patient. Ramaswamy, Al-Jahwari, and Al-Rajhi (2010) describe a hospital as a diagnostic human treatment environment where activities such as health education, training and research could be undertaken. A hospital environment that contributes to healing does not only adds to patient's wellbeing, but also to the wellbeing of the medical and supporting staff of the hospital. A hospital building that is rated as a high performance building in terms of its indoor environmental quality would attract, retains, and enhanced patient healing process and workers efficiency (Zborowsky & Kreitzer, 2008). The primary function of a hospital is centred on patient care. The hospital is, therefore, a facility that must be design for the maximum benefit of the occupants—patient, patient family as a visitor, and staff. The need to pay particular attention to the environmental quality of a hospital facility cannot be overlooked. The effect of poor IEQ is not only on the occupants' physical health but also their psychological health (Mahbob, Kamaruzzaman, Salleh, & Sulaiman, 2011; Sadek & Nofal, 2013). A poor IEQ create stressful feelings on the occupants' perception of their environment. The impact of IEQ on patient's satisfaction is a measure of psychological response and physical complaints (Sadek & Nofal, 2013). The design and settings of the indoor environment of hospital facilities should be such that the emotional needs of patients, their families, as well as the staff are taken into cognisance (Salonen et al., 2013).

The campaign for healthy and comfortable work environment in buildings has not yet taken root in the aspect of healthcare facilities. Green buildings have been attached more importance to the environmental consideration of the built form while health and wellbeing of occupants are given less attention. Researchers are, however, beginning to understand the need to centre on sustainable occupant environment as a measure of attaining sustainable development (Smith & Pitt, 2011). Hospital services and facilities quality and performance can be enhanced where continuous performance evaluation of the hospital environment is carried out in order to solve apparent problems. The aim of this paper is to review the underlying trends and developments on the concept of IEQ in healthcare facilities in order to identify areas of weaknesses in its assessment methods, and its characteristic impacts on the building occupants. This study will provide healthcare providers, practitioners, and the built environment professionals with relevant information on the processes involved in the assessment of quality and impact of the hospital environment on its occupants.

2. Concept of IEQ in buildings

Until recently, the needs to provide health personnel and patients with a satisfactory indoor environment have not been given the necessary attention it requires, especially in developing nations. However, there has been a trend towards developing a system that can provide a comprehensive building assessment in global, local and indoor environmental scale (Chiang, Lai, Chou, Li, & Tu, 1999). In developed nations like the United Kingdom (UK), it is a requirement by law for building owners to display their energy performance certificate, which does not really make any sense without

also considering a declaration of the indoor environment performance that have a significant influence on energy use (Ncube & Riffat, 2012). There is a need for all people to have an awareness and knowledge of the indoor environmental impact on health and comfort. Therefore, achieving an optimal indoor environment for all occupants in healthcare facilities calls for further studies (Salonen et al., 2013) in order to the necessary awareness and better understanding of the indoor environment influence. There is also the needs to integrate the requirements of the various users of healthcare facilities, and respond adequately to both current and future demand for environmental sustainability.

The need to provide building occupants with a comfortable indoor environment cannot be overemphasized. Smith and Pitt (2011) noted that, more attention has been given to green building design in the environmental consideration of the built form while health and wellbeing of the occupants are given less attention. Standards and guidelines concerning indoor environment such as (BS, 2007) are based on individual IEQ parameters. These parameters have been remarkably seen to have combined effects on occupants' satisfaction and efficiency (Huang, Zhu, Ouyang, & Cao, 2012). A study which evaluated the IEQ and its implication on medical activity in a Romanian hospital (Croitoru, Vartires, Bode, & Dogeanu, 2013) shows that, either standard are not followed in the design of hospital buildings or the standards do not meet the requirements of the occupants. If standards are not meeting the needs of occupants in hospital buildings, there is a need to redefine their IEQ requirements putting into consideration both the physical environmental attributes and occupants perception of these attributes. On the other hand, IEQ, as perceived by occupants, is often not acceptable, even if standards and guidelines for the different parameters are met (Bluyssen, 2010). Croitoru et al. (2013) suggested that standards with respect to IEQ should be changed and fashioned towards occupant's comfort to enhance their optimal comfort and efficiency. This is because standards and guidelines have always been found to be at variance with what the occupants of the building would require.

Several studies have been conducted on the indoor environmental quality of buildings and their occupants. Studies such as Astolfi and Pellerey (2008), Humphreys (2005) and Lai, Mui, Wong, and Law (2009) was carried out on factors relating to IEQ, while Chiang, Chou, Lai, and Li (2001), Heinzerling, Schiavon, Webster, and Arens (2013), Mui and Chan (2005), Ncube and Riffat (2012) and Wong et al. (2008) conducted studies on the integration of the parameters of IEQ into mathematical models as quantitative indicator of IEQ performance. On the other hand, Bluyssen, Janssen, van den Brink, and de Kluizenaar (2011), Schakib-ekbatan et al. (2010) and Veitch, Charles, Farley, and Newsham (2007) in their different studies included other parameters that are not related to IEQ. Frontczak et al. (2012a,b) on their part, study what factors constitute the comfort in residential buildings in Denmark and occupants' preferred ways of achieving this comfort. Their surveyed responses suggested that the acceptability of overall indoor environment depends on occupants' average acceptance of all the indoor environmental parameters at certain acceptability level. The respondents also acknowledge that their comfort is influenced by the environmental parameters. In assessing IEQ in schools, Catalina and Iordache (2012) concern was on the building design stage and the consequences of the interactions among the IEQ parameters on overall occupants' comfort and energy consumption. They developed a mathematical tool that could be applied in the assessment of IEQ for new building design and old building refurbishment. De Giuli, Da Pos, and De Carli (2012) in evaluating pupils' perception of the quality of indoor environment in a primary school asserted that, children's response to indoor environment is passive as teachers' preferences supersede theirs. De Giuli et al. (2012) study presented a method of analysing school buildings using both physical

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