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Management learning from air purifier tests in hotels: Experiment and action research☆

Wilco Chan[a,*], Shun-Cheng Lee[b], Alice Hon[a], Leon Liu[a], Danny Li[c], Ningyi Zhu[a]

[a] School of Hotel and Tourism Management, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong Special Administrative Region
[b] Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong Special Administrative Region
[c] Department of Civil and Architectural Engineering, City University of Hong Kong, Hung Hom, Kowloon, Hong Kong Special Administrative Region

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ABSTRACT

Recently, indoor air quality (IAQ) has become an important issue as it affects people's comfort and health. To mitigate the problem, application of some innovative air filtering devices has been generally recognized as one of the effective ways. This study adopted an action research-dominated approach to test whether the indoor air quality in the tested hotel rooms meets the recognized standard, and measure the pollutant removal efficiency of three types of air purifiers. Focus group discussion was carried out to ascertain the difference in hotel managers' understanding of indoor air quality research before the experiment and management response after the experiment. The result of field test indicates that the actual performance of the purifiers is not as good as the manufactures claim. The management response study also ascertains that hotel department heads' awareness, exposure and training in relation to IAQ testing is limited.

1. Introduction

Over the years, numerous studies have been carried out to measure the factors that influence the selection of hotel accommodation by customers. Many researchers have identified that cleanliness is the most important attribute influencing the decision of selecting hotel accommodation (Weaver and Oh, 1993; Callan and Bowman, 2000; Lockyer, 2005). Therefore, it is reasonable to deduce that good indoor air quality (IAQ) should also be an important attribute for hotels. This is especially true as hotel guests typically comprise a high proportion of international travelers and a good mix of dignitaries and officials who demand high IAQ. Equally, inadequate IAQ invariably brings complaints (Bohdanowicz and Martinac, 2002).

More recently, research findings have indicated that air pollution in East and South Asia has been deteriorating due to accelerated economic expansion and population growth. Brauer et al. (2012) found that there is a high concentration of fine particles (PM2.5) in South and East Asia (annual averages >50 $\mu g/m^3$). PM2.5 is generally considered to be the most robust indicator of adverse (mortality) impacts in epidemiologic cohort studies of long-term exposure. They are so small that they can get deep into the lungs and cause serious health problems. An extensive epidemiological literature relates PM2.5 to adverse health impacts (Pope et al., 2002; Pope and Dockery, 2006; Dockery, 2009). Latterly, the World Health Organization's International Agency for Research on Cancer (IARC) officially classified air pollution mixing with suspended particles in the air as a level 1 carcinogen. It stated that there is "sufficient evidence" that exposure to outdoor air pollution causes lung cancer and also linked it with an increased risk of bladder cancer. Such exposure has increased significantly in China (IARC, 2013). Since the ventilation systems need to regularly draw outdoor air into buildings, hotel guests who staying indoor still have to breathe the polluted outdoor air if there is no air filtration equipment in hotels. Therefore, travelers who plan to come to China are increasingly concerned about air quality. According to the China National Tourism Administration, from January to June in 2013, the total number of foreign arrivals dropped by 5% to just under 13 million compared with the same period in 2012 (Watt, 2013).

There are also other types of indoor air pollution in China apart from such incoming outdoor air pollutants. One of them is smoking. In China, smoking in hotel guest rooms still prevails except on non-smoking floors. Cigarettes generate high amounts of toxic air pollutants which also include PM2.5. These pollutants may be

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* Corresponding author.
E-mail address: hmwilco@polyu.edu.hk (W. Chan).

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carcinogenic, or may cause other non cancer-related health problems (Facchini et al., 1992; Rimm et al., 1993; Hu et al., 2001; Komiya et al., 2006). The other possible source for indoor air pollution in hotels is renovation. As stated by Meckler (1996), renovation work could be the greatest source of IAQ problems for buildings. Many interior materials contain volatile organic compounds (VOCs) which cause discomfort to the respiratory system and irritation to eyes (Burton, 1997). The increasing occurrence of poor levels of IAQ may be linked to the shortening length of the renovation cycle in hotels in recent years, and the opening of more new hotels which is set to grow further in coming years. One study has indicated that most new hotels in the Pearl River Delta of China were more polluted than older hotels and residential buildings (Chan et al., 2009a,b). In addition, poorly designed, maintained or operated air-conditioning and ventilation systems can also cause indoor air problems (Kuo et al., 2008). Many studies have shown that ventilation systems may occasionally act as a source of pollutants, such as microbes, chemical compounds or odors (Lysne et al., 1999; Sundell et al., 1993; Björkroth et al., 1997).

2. Problem statements

The study of air quality is a relatively new scientific discipline in hotels and in China. Its content and methods are complex and sophisticated. Hotel practitioners, generally speaking, have limited understanding of the research logistics and resources required to test and maintain air quality.

In particular, the sampling technique and analytical method for testing air quality depends on an array of equipment and facilities. Thus a laboratory equipped with these facilities is indispensable to carry out research on air quality. However, the investment required to establish such an independent laboratory is huge. At the time of writing, no hotel chain in the world has established such a laboratory and technical team to monitor the IAQ in hotels and provide technical assistance regarding IAQ issues to hoteliers. While there are a few IAQ consultants available on the market, their independence, technical support and expense have always been barriers to hoteliers achieving better IAQ. Even with the surge in clean air technologies in recent decades, hoteliers often face challenges finding the technical expertise or measuring equipment to verify the pollutant removal effectiveness of the technology (Chen et al., 2005).

An industry leader also expressed concern that there was inadequate reliable and independent data on the environmental improvements delivered by these technologies (Li, 2003). Most data are offered by manufactures. Hoteliers have reservation on their claimed effectiveness and reliability of the green products and facilities. The industry does not want to be subject to passive acceptance of these innovative technologies. Presently, in-depth technical advice about air cleaning and purification technologies from government and hotel management offices remains unavailable. The hotel industry needs valid and interpretable data being provided by independent parties.

Air filtration is one of the crucial technology-based measures to control and mitigate indoor air pollution. In addition, the ventilation system performs a vital role in the removal of these indoor air pollutants. In light of this, the present study aims to (1) test whether the indoor air quality in the tested hotel rooms meets the recognized standard; (2) test the pollutant removal efficiency of three types of air purifiers; and (3) ascertain the difference in hotel managers' understanding of indoor air quality research before the field test and management response after the field test.

3. Methodology

To better understand innovative technology for removing air pollutants, verify the effectiveness of some commercialized technology and promote the enhancement of hotel IAQ knowledge, the study adopted an action research-dominated approach.

The concept of action research can be traced back to the mid 1940s (Lewin, 1946). Since then, this concept has become divided into a wide spectrum of approaches including action research, action science, system intervention and action inquiry (List, 2006).

Our investigation is characterized by the involvement of researchers with a goal to achieve an enhancement of hotel IAQ by using air purification technology in the studied hotel (Baskerville and Wood-Harper, 1996; Baskerville and Pries-Heje, 1999). Differing from the typical consultancy approach and that of contracted research, which usually provides technical or specific deliverables, the action research in this case set out to collect hoteliers' real responses by direct observation and discussion via participation. The follow-through participation process included initiating the project, participating in meetings, exchanging views, installing air purifiers, cleaning air ducts, providing technical and professional knowledge guidance, checking equipment performance, collecting data, performing analysis, delivering findings and gauging management response. Through the process, researchers were able to professionalize the hotel department heads using three technical meetings, seven semi-technical meetings, six informal discussions and one "wrap-up" focus group discussion. The researchers' aim was to produce valid knowledge and act as a facilitator by proposing the topic, formulating the action research scenarios and compiling all the collected data (Waser and Johns, 2003). More importantly, the use of action research allowed the investigators to gain an in-depth and thorough understanding of how the company's management responded to the processes and findings about the application of air-cleaning technology. Compared with other techniques, which use questionnaires and interviews to obtain responses, the action research methodology in this case may greatly reduce "noise" in the data collection process and ensure a high degree of data reality.

To gauge the hotel management's response to the demonstration via technical research processes – planning, sampling, analysis and report – the study conducted a post-research focus group discussion with hotel department heads including the director of engineering, purchasing managers, the executive housekeeper, the front office manager, the executive and GM assistants.

Focus groups are an in-depth group interview technique employing relatively homogenous groups to provide information about topics specified by the researchers (Hughes and DuMont, 1993). They provide an opportunity to solicit true views from participants freely and in a flexible way. Such a method also allows for the exploration of beliefs and attitudes toward something new (Procter, 2000). In addition, focus group discussions have the merit of allowing participants to react to the responses of other participants, encouraging a series of subsequent discussions, causing a snowball effect (Wilkinson, 2004). Due to the exploratory nature of this research and the aforementioned advantages, the focus group method was adopted to explore the following two probing topics: (1) differences in the group's understanding about the investigation of air duct cleaning and its removal effectiveness before and after the research intervention; and (2) their response to the observed research process.

3.1. Sampling site and testing objectives

The test was carried out in a five-star hotel building with approximately 300 rooms and two restaurants, in a city in Southern China. The international hotel selected is a 27-storey building with a vertical ventilation system. The air pump is located in the roof of the hotel building, meaning that the lower the floor is the less fresh air it receives. These rooms are all standard two-bed rooms with separated fan coil units (FCU). The room area is about 40 m^2 with most