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# Indoor air quality audit implementation in a hotel building in Portugal

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ABSTRACT

Hotels are designed to provide high levels of comfort for guests; however, frequent complaints related to uncomfortable thermal environment and inadequate indoor air quality (IAQ) appear. On the other hand, there is little research concerning IAQ audits of hotels up to now.

This study is aimed to establish and demonstrate the comprehensive IAQ audit approach for hotel buildings, based on Portugal national laws. A 4-star hotel building in Portugal is used as a case study to demonstrate the IAQ audit application and evaluate its comprehensiveness and usefulness to the hotel or facility managers. The systematic approach involves the measurement of physical parameters – temperature (dry bulb), relative humidity and the concentration of the suspended particulate matter ($PM_{10}$) – the monitoring of the concentrations of selected chemical indicators – carbon dioxide ($CO_2$), carbon monoxide (CO), formaldehyde (HCHO) and total volatile organic compounds (TVOCs) – and the measurements of biological indicators (bacteria, fungi, *Legionella*). In the present case, air exchange rates are measured by the concentration-decay method using metabolic $CO_2$ as the tracer gas.

The comprehensive IAQ audit revealed four main problems in the hotel building: (1) insufficient ventilation rate; (2) too high particle concentration in some rooms; (3) contamination by *Legionella* of the sanitary hot-water circuit; (4) poor filtration effectiveness in all air handling units (AHUs).



## 1. Introduction

Hotels are designed to provide high overall comfort and multi-faceted services to guests frequently accustomed to, and willing to pay for exclusive amenities, treatment, and entertainment. Comfortable indoor environment, safety, and reliability are some of the amenities valued by guests. However, little research has been published about the indoor air quality (IAQ) of hotel buildings up to now and most hotel managers often ignore these important issues [1,2]. On the other hand, state-of-the-art technical infrastructure is typically utilized in hotels to provide high levels of comfort, especially thermal comfort. Nevertheless, using energy-intensive space-conditioning systems does not warrant absolute guest's satisfaction [1,3]. Guests frequently complain about thermal discomfort, even where expensive and sophisticated systems are operated. Complaints in hotels are most commonly related to uncomfortable air temperatures (too high or too low), and to the difficulty or impossibility of individual adjustment [3]. Moreover, space conditioning (heating, cooling, and ventilation for the purpose of maintaining high standards of air quality and thermal comfort) typically accounts for about half the total energy consumed in hotels [4,5]. Hence, most hotel designers and managers always pay attention only to the energy consumption of hotels operation. Managers take the management of resources as a major role that inevitably leads to housekeeping's greater emphasis on those tasks with visual satisfaction. Nevertheless, hotels are public places accommodating a vast variety of international travellers; therefore the demand for good IAQ may be higher than for other types of buildings [6].

Teeters et al. [6] claimed that facility managers in the hospitality sector have only reacted to those IAQ problems that have caused immediate irritation to guests or employees. However, inadequate air quality as well as the lack of air circulation is another frequent complaint. In addition, the IAQ of hotel buildings affects the health of guests especially in terms of bacterial contamination. For example, Legionnaire's disease broke out in one USA hotel (182 people illness and 29 deaths in 1976) and more than 60 outbreaks worldwide in hotels, hospitals and offices were reported [7–9]. Furthermore, the severe acute respiratory syndrome (SARS) broke out in "M" hotel in Hong Kong has increased the public awareness to indoor air quality of hotels [8].

On the other hand, the European Parliament and Council approved in December 2002 a directive on the energy performance of buildings 2002/91/EC (EPBD) [10], which introduced the obligation of energy certification of buildings. European Standardization Organization (CEN) has drafted several standards to help the member countries implementing the directive. One of these is the "Indoor environmental input parameters for design and assessment

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