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Of comfort and cost: Examining indoor comfort conditions and guests' valuations in Italian hotel rooms

Tiziana Buso [a,*,1], Federico Dell'Anna [b], Cristina Becchio [a,1], Marta C. Bottero [b], Stefano P. Corgnati [a,1]

[a] Department of Energy (DENERG), Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy
[b] Department of Regional and Urban Studies and Planning (DIST), Politecnico di Torino, Viale Mattioli 39, 10125 Torino, Italy

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ABSTRACT

Among co-benefits that energy efficiency interventions in buildings entail, occupants' improved comfort is one of the most acknowledged. In this study, a monetary valuation of improvements in comfort conditions in accommodation facilities was carried out. With an interdisciplinary approach to the problem, the evaluation was two-folded, aimed at monetizing co-benefits and extra costs of improved indoor environmental quality. Comfort co-benefits were estimated by employing the economic-based Contingent Valuation Method. In this framework, survey results allowed calculating respondents' Willingness to Pay for excellent comfort conditions in hotel rooms, quantified in a 14% increase of the room rate. The energy approach, based on dynamic simulations, allowed to quantify extra costs of improved thermal condition in a reference existing hotel. These findings suggest that guests' appreciation of comfort is higher than the investment costs required to provide them with comfortable conditions and highlight that energy efficiency measures are often necessary to reach the desired indoor comfort level.

1. Introduction

Energy efficiency (EE) in buildings holds a leading role in European development strategies. Defined by finance and energy experts as an untapped resource for Europe's economic growth [1], it is a key area of actions in the transition to a low-carbon society envisaged by 2050 [2]. However, the current market up-take of EE projects in Europe is still disappointing, with an average renovation rate of the building stock around 1% [3]. The rising trend in the energy use in buildings, detected since 1990s, worsen the scenario [3]. In this context, tertiary sector is a major player [3] and, within this sector, hotels rank among the top-five energy use intensive categories [4,5]. Because of their high energy consumptions and the number of users they host, hotels represent an interesting building category to be considered in the low-carbon transition challenge.

To foster the scaling-up of EE projects in private and public sectors, many international reports [6–8] affirm that these investments generate a number of economic, social and competitive advantages, beyond the obvious energy and carbon savings. Recent studies proposed to include these less tangible advantages, defined in literature as co-benefits [9], in the valuation of EE projects [10–12]. This novel approach to the decision making process introduced new issues in the real estate appraisal discipline; while the identification of co-benefits gives rather universal results [13,14,6,8,15], their quantification is very case- and location- dependent [14]. Nonetheless, the monetary value of co-benefits needs to be estimated in order to include these aspects in the decision process for investments in energy efficiency.

Among co-benefits, increased indoor comfort appears as a key element in all the relevant literature on the topic, both from public and private perspectives [13,14,6–8,15]. This statement builds upon solid findings from on-field studies: many post-retrofit surveys revealed that increased comfort is the main source of occupants' satisfaction [16,17]. However, the translation of the unquestionable positive effects of increased indoor comfort in monetary terms is still poorly investigated. Indeed, valuing comfort in itself is one of the most difficult areas of economic evaluation of energy efficiency actions, because of the inner subjectivity of comfort perception. The scientific approach to the evaluation of

* Corresponding author.
E-mail addresses: tiziana.buso@polito.it (T. Buso), federico.dellanna@polito.it (F. Dell'Anna), cristina.becchio@polito.it (C. Becchio), marta.bottero@polito.it (M.C. Bottero), stefano.corgnati@polito.it (S.P. Corgnati).
[1] IEEM (Indoor Environment & Energy Modeling) Centre, TEBE (Technology Energy Building Environment) Research Group, Department of Energy (DENERG), Politecnico di Torino, Italy.

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comfort has evolved over years as an investigation of physiological, psychological and sociological factors, in particular in the field of thermal comfort. The well-known Fanger's theory [18], based on the evaluation of thermal neutrality between the occupant and his surroundings, was complemented by the adaptive comfort theory proposed by de Dear and Brager [19], who proved that occupants' level of adaptation and expectation is strongly related to outdoor climatic conditions as well. Recently, further theoretical developments suggested that occupants' motivation can play an even greater role in occupants' comfort preferences [20].

Placing an economic value on the improvement in comfort is a topic tackled by very few researchers so far. Clinch and Healy [21] valued post-retrofit increased comfort levels in dwellings by using the proportion of energy savings forgone as a proxy for the value that households placed on comfort improvements. For instance, if post-retrofit actual energy savings amounted to 60% of the potential energy savings predicted through calculations, the remaining 40% of forgone savings was assumed to equal households' implicit willingness to pay to increase thermal comfort in their dwellings. Simulation results revealed that comfort benefits amounted to 21% of the potential energy savings of the analysed building stock, after its hypothetical retrofit. Fang et al. [22] proposed a method that monetizes comfort levels based on pre and post-retrofit conditions. The Annualized Energy Related Cost (AERC) was calculated for several retrofit options of a reference residential building and plotted versus the comfort level, expressed in Fanger's indicators Predicted Mean Vote (PMV) and Percentage of People Dissatisfied (PPD). The difference in AERC between pre- and post-retrofit with the same comfort level (obtained thanks to a comfort-stat control in the simulation tool) represented comfort monetization, amounting to 10.6% increase in heating and cooling costs. The European Commission, in its guidelines for Cost-Benefit analysis for investment projects [23], suggests two possible cases for the evaluation of comfort benefits, based on a counterfactual scenario: (1) the pre and post- comfort levels are equal and the benefit is calculated as the energy savings obtained with the retrofit; (2) post-retrofit comfort level is higher than pre- and benefits are equal to the difference between the energy cost that pre-retrofit building would have had to reach the post-retrofit (higher) comfort level and the post-retrofit energy cost.

Common feature of these studies is that they monetize comfort as a function of the energy savings obtained by simulated energy efficiency measures in buildings. Moreover, the focus is on thermal comfort, mainly assessed through indoor temperature and Fanger's indicators, while psychological and sociological factors are not taken into account.

Monetization of co-benefits and competitive advantages are especially interesting for the hotel sector. In these buildings the large potential for operational costs reduction is coupled with the growing attention of costumers to ecological matters [24]. Particularly, valuing comfort is a stimulating task from hoteliers' perspective; Accommodation businesses build their success on the service quality offered, among which high indoor comfort levels are essential [25]. Because of this service-oriented nature, it is licit to infer that guests will be more sensitive to comfort as a factor influencing their willingness to pay.

Building on these premises, in the present paper a multidisciplinary approach is proposed to monetize comfort in hotels, taken from the economic and energy disciplines. From the economic side, the challenge to monetize comfort co-benefits was faced; being comfort a non-market good, the Contingent Valuation Method (CVM) was used to directly estimate the guests' preferences for it. While CVM has been employed in several studies for valuing outdoor environmental parameters such as acoustic annoyance [26] and air quality [27], no literature was found related to contingent valuation of comfort conditions in indoor environment, neither for single aspects influencing comfort (e.g. temperature, air quality), nor for its global evaluation. This study represents a first test of CVM for the estimation of a comfortable indoor environment. Particularly, the paper aims at quantifying the willingness to pay (WTP) for improved indoor environmental quality (IEQ) in hotel rooms through the preferences revealed by questionnaires given to potential guests. So far, the hotel sector has been object of many applications of the CVM aimed at evaluating guests' WTP for green practices [25,28], defined as an ancillary service. Findings of the present paper will explicit the link between comfort and willingness to pay in a direct way and enable a comparison between guests' preferences for essential (comfort) and non-essential (green initiatives) attributes offered by a hotel. From the standpoint of the energy evaluation, the extra costs of improved comfort conditions were investigated. The questionnaire-based results (economic approach) were compared to the rise in energy costs that a Reference existing Hotel may face in order to improve its thermal comfort level without undergoing any retrofit measure. Based on results of energy simulations, the increase in energy use and in the consequent energy costs for improved comfort conditions were assessed and the potential of energy efficiency measures to improve comfort while lowering the energy use was highlighted.

Framing this piece of research in the debate linking energy studies and social science allows to include its findings in broader avenues of research. These promising research paths have been unveiled only in recent years, in parallel with the growing need for an interdisciplinary approach to tackle world scale problems. Particularly, the study conducted by Sovacool [29] represents an important reference for energy research and social sciences research questions. Based on the quantitative content analysis of 15 years of research papers published by 3 major energy-related scientific journals, Sovacool identified 14 research paths with high potential for future development. Referring to Sovacool's findings, the present paper offers its contribution on one side to the application of human-centred research methods, on the other side to deepen the understanding of the how to boost private investments on R&D and innovation. Indeed, it couples personal opinions and experiences of comfort with economic and energy analysis, towards the understanding of the financial convenience of a comfortable indoor environment.

The paper is organized as follows: Section 2 presents the theoretical framework employed for the economic evaluation and the CVM technique; Section 3 describes the selected CVM survey instruments and the data collection process; Section 4 presents the framework for the statistical analysis used to evaluate the survey results, that are presented and discussed in Section 5. Section 6 compares the outcomes in terms WTP with the energy simulation results for a Reference Hotel, in which different comfort levels are set as the only variables of the model. Discussion of these findings and future projections are presented in Sections 7 and 8.

2. CVM theoretical background

In the economic discipline, Willingness to Pay (WTP) is used to directly valuate non-market goods. The direct valuation approach is used to measure the total economic value of a non-market good by asking for respondents' stated preferences (SP). Contingent Valuation Method (CVM) is among the most preferred technique because it can measure the total economic value of a good in a direct way. Conceived in 1947 [30], the CVM was first applied in the '60s [31] and since then it found wide applicability in the field of environmental economics [32,33]. For instance, many studies focused on outdoor environmental quality and on low carbon strategies, such as: noise reduction [34,26], air quality [27,35], CO_2 emission reduc-