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Users' perceptions of sustainable buildings – Key findings of recent studies

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ABSTRACT

Motivated by a desire to discover how buildings operate in practice and inspired by the pioneering PROBE Studies (post-occupancy review of buildings and their engineering) the author has spent the last decade investigating both the design and the users' perceptions of (mainly) sustainable buildings. This has involved visiting some 60 commercial or institutional buildings worldwide, interviewing the designers, and in most cases personally conducting a questionnaire survey of the users covering operational, thermal, lighting, noise, control and satisfaction issues.

This paper highlights some of the key findings from these investigations, including the design features of the sustainable buildings, how their performance compared with that of more conventional buildings, whether refurbishments achieved better or worse perception scores than new designs, and the characteristics of the users' comments.

The paper concludes by outlining potential approaches to benchmarking user perception scores and advocating for their inclusion in building sustainability rating tools.

1. Introduction

The current set of building sustainability rating tools (LEED [1], CASBEE [2], BREEAM [3], SBTool [4], Green Star [5], etc) were developed for application to new building designs and tend to focus on technical aspects such as energy consumption, water use or materials. This is a concern to some commentators (the writer included) because actual performance in operation, according to Cole, 'can be severely compromised because the specification and technical performance fail adequately to account for the inhabitants' needs, expectations and behaviour' [6] and, in the words of Mumovic and Santamouris 'unexpected behaviour by occupants can degrade whole system performance and potentially overturn the savings expected by designers or policy-makers' [7].

The Australian NABERS protocol [8] offers one answer to this question. Arguably the most advanced Building Sustainability Rating Tool (BSRT) of its kind it is aimed specifically at existing buildings in operation. Launched in its present form in 2008, this protocol does not attempt to amalgamate a set of weighted category ratings into a single overall figure but reports separately the ratings for the following four categories – energy, water, waste, and indoor environment. While the energy rating is the well-established (but now renamed) former Australian Building Greenhouse Rating system which dates from 1999, the recently developed Indoor Environment ratings is the first to take account of users' perceptions of this aspect of the building's performance rather than relying solely on measurements of environmental conditions. While many individual quantitative measurements of temperature, lighting, acoustics, etc. are feasible, none of them can readily integrate an individual's sense of comfort overall.

The overall mission of the author and his collaborators has been to provide an independent and unbiased evaluation of how the users perceive some of our commercial and institutional sustainable building developments. In order to do this, a worldwide set of commercial and institutional buildings, all of which had well-recognised sustainability credentials or features, were sought out and evaluated. Most of the buildings were located in predominately temperate climatic zones, ranging from cold temperate (the north-east of the USA and Canada for example) to warm temperate (southern California and New South Wales in Australia for example), with a few in the hot-humid climates of south-east Asia. The intention was to find out the context for these projects, how they were designed, and most importantly, the users' perceptions of their performance.

This paper summarises some of the more important findings. In particular: the key features of the buildings that rated best for comfort and satisfaction; the performance of refurbished buildings

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by comparison with new sustainable buildings; the performance of sustainable buildings by comparison with conventional buildings; the nature of the users' comments in relation to their perception scores; and the potential for incorporating user perception scores into building rating tools.

We are firmly of the belief that people can provide one of the best measures of building performance since "for many aspects of a building the true experts are the people who know most about using it – the users" (refer to Ref. [9] for more explanation). People know if they are too hot or too cold, have too much or insufficient light, whether it is too noisy, how comfortable they are overall, and in the final analysis, how conditions in the building are affecting their health and productivity.

The ultimate objective is to pave the way for the incorporation of users' perceptions of a range of aspects of building performance into the rating tools for commercial and institutional buildings in operation.

2. Methods

The main method used was to conduct questionnaire surveys of the users of a range of such buildings. The buildings selected were all commercial or institutional in nature. Most accommodated office activities predominantly, several were tertiary-level academic teaching buildings, while a few housed laboratories or research organisations, or contained a combination of light industrial and administrative functions. Virtually all were recipients of national awards for sustainable or low energy design, were highly rated in terms of their respective country's building sustainability rating tool, or in some way pioneered sustainable architecture.

Several had advanced natural ventilation systems, broadly defined as natural ventilation where some of the ventilation openings are automated or some specially designed natural ventilation elements have been incorporated into the design. Others utilised a mixed-mode system of ventilation – these were predominately Changeover systems where the mechanical systems were designed to operate during cold or hot outside conditions, and the natural ventilation systems during mild conditions, though two buildings had Zoned systems where large parts of the building were either air conditioned or naturally ventilated. Only three of the buildings were fully air conditioned with predominantly sealed facades. Full details of the systems of environmental control in some of these buildings are described elsewhere [10].

Most had been built or refurbished in the course of the last decade, and all had been occupied for a year or more before the survey work was carried out, giving most occupants time to experience their surroundings over at least a full annual cycle.

Generally speaking, these investigations involved undertaking several visits to each of the buildings to personally distribute and collect a questionnaire survey seeking the users' perceptions of a range of factors. The questionnaire used was the Building Use Studies [11] standard two-page office version. During these visits a structured, recorded interview was conducted with a key architect and environmental engineer from the design team, and a detailed tour undertaken of each building and its facilities, photographing key features, and collecting relevant documentation.

The 60 or so questions of the standard two-page questionnaire used cover a range of issues. Fifteen of these elicit background information on matters such as the age and sex of the respondent, how long they normally spend in the building, and whether or not they see personal control of their environmental conditions as important.

However, the vast majority ask the respondent to score some aspect of the building on a seven-point scale; typically from 'unsatisfactory' to 'satisfactory' or 'uncomfortable' to 'comfortable', where a '7' would be the best score. The following aspects were covered:

- Operational – image to visitors, space in building, space at desk, furniture, cleaning, meeting rooms availability, storage arrangements, and facilities.
- Temperature (overall and whether it is too hot or cold, stable or varies) and air (overall and whether it is still or draughty, dry or humid, fresh or stuffy, odourless or smelly) in both winter and summer.
- Lighting (overall, whether there is too much or too little natural light and artificial light, and whether there is glare from sun and sky or from the artificial lights).
- Noise (overall, and whether there is too much or too little from colleagues, other people, inside sources, and outside sources; and the frequency of unwanted interruptions).
- Personal control – of heating, cooling, ventilation, lighting, and noise; and
- Satisfaction – design, needs, comfort overall, productivity, and health.

In the case of 'Image to visitors', for example, users are asked "How do you rate the image that the building as a whole presents to visitors?"; in the case of 'noise overall', users are asked "How would you describe noise in your normal work area?"; and in the case of 'comfort overall' users are asked "All things considered, how do you rate the overall comfort of the building environment?" Note however that in several instances a '4' would be the best score where, for example the respondent is being asked if the temperature is too hot (1) or too cold (7); while in others a '1' would be best where, for example, the respondent is being asked if the air is odourless (1) or smelly (7).

In the case of productivity a recent survey [12] of a wide range of methods used for its assessment has concluded that occupant surveys are the best method for measuring and comparing productivity. Leaman et al. [13] have noted that "It is impossible to measure productivity 'objectively' across a building in use; results have to be based on subjective responses of samples of occupants drawn from cross-sections of users. This is not to say that subjectively obtained data are in any way inferior. It just means, as Gary Raw [a lead researcher in the field of Sick Building Syndrome] so aptly said "in buildings, people are the best measuring instruments: they are just harder to calibrate". Thus the questionnaire simply asks respondents to assess whether they perceive themselves to be more or less productive or comfortable in the building they occupy.

In the case of 'Productivity' the question posed was "Please estimate how you think your productivity at work is decreased or increased by the environmental conditions in the building?" with the users indicating their response on a scale ranging from '−40% or more' to '+40% or more' with 10% intervals. In the case of 'comfort overall' the question posed was 'all things considered, how do you rate the overall comfort of the building environment' with users indicating their responses on a 7-point scale ranging from 'unsatisfactory' to 'satisfactory'.

Respondents were also given the opportunity and space to add a brief comment on nine of the aspects they were asked to score as well being able to note matters that 'worked well' or 'hindered' their activities.

Of course, willingness on the part of the building owner and tenants to be surveyed was also an essential prerequisite, and not all building owners approached felt in a position to accept our invitation. Much as one would like the sample of buildings to be random or structured in some way, it is rarely feasible in this kind of research. Hence, one has to be aware of the context for each case study and ever vigilant for potential bias in the mix. As noted