

**Building Science Group**

Prof. Dipl.-Ing. Andreas Wagner  
Englerstraße 7, Geb. 20.40  
76131 Karlsruhe

Tel.: +49 721 608 - 46511

Fax: +49 721 608 - 46092

<http://fbta.arch.kit.edu>

**Occupant satisfaction as an indicator  
for the socio-cultural quality of  
sustainable office buildings**

**Project Leader: Prof. Andreas Wagner**

**Main Investigator: Karin Schakib-Ekbatan**

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# 1 Introduction

Due to their demand of natural resources buildings are increasingly in focus with regard to sustainability. Certification systems and labels are auxiliary instruments for the practical application of political objectives and concepts in the building industry [1]. Apart from the internationally established rating-systems such as LEED (Leadership in Energy and Environmental Design, USA) or BREEAM (BRE Environmental Assessment Method, GB), the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) in cooperation with the German Sustainable Buildings Society (DGNB) developed the German assessment system for sustainable office and administration buildings. While methods and strategies for the monitoring of technical or economical characteristics are widely established, little is known about approved criteria for the socio-cultural dimension of buildings. Experiences show that there is often a significant gap between the calculated and the metered energy consumption for a variety of reasons which can be assessed by continuous monitoring. Thus, as complement to technical monitoring or lifecycle analyses, surveys have a great potential of gaining relevant and continuous feedback from the occupants as a basis for various improvements in comfort and energy efficiency regarding day-to-day operations [2, 3].

## 2 Research context and objectives

Currently the German assessment system for sustainable new office and administrative buildings (Federal Ministry of Transport, Building and Urban Affairs) is expanded to existing office and administration buildings. To compare the predicted comfort from the initial certification which is based on standards, documents and inspection, to the actual status it is intended to implement occupant surveys in this process. The occupants' votes would allow a continuous check whether forecasted comfort parameters can be achieved under real building operation and are applicable to support a continuous monitoring procedure.

Against this background the main goals of the presented project were:

- comparison of the applied questionnaire for post-occupancy evaluation with the criteria for the 'socio-cultural and functional dimension' of the German assessment system,
- identification of potential for modifications regarding the criteria (e.g. the spectrum of comfort aspects, weighting factors) which addresses occupants' issues,
- identification of potential for a modularization of the questionnaire,
- identification of potential for an integration of occupants' votes in the German assessment system.

### **3 Methods**

To work on the research objectives, besides literature the documents of the German assessment system and field studies in six certified buildings ( $N = 1.120$ ) were taken as a basis as well as experiences from former field studies conducted by the Building Science Group. In the context of a quasi-experimental design the field studies were carried out in winter and summer season. To increase the reliability of the analysis, data from the former field studies were partially integrated.

### **4 Results**

#### **4.1 Matching the applied questionnaire with the criteria of the socio-cultural dimension of the German assessment system for sustainable buildings and general aspects regarding user surveys**

A precondition for the implementation of surveys in the assessment system is that the criteria of the assessment system respectively the items of the questionnaire are congruent. This could be found for the comfort parameters thermal, visual and aural comfort, indoor air quality and occupant control. Due to the fact that the criteria of the German assessment system address functional issues which cannot be valued by occupants (e.g. hazardous incidents) a score based on occupant surveys cannot be congruent to the score for this criteria group of the assessment system.

Aiming at a continuous monitoring with respect to occupants votes, a time interval of three years is suggested considering time and costs. Moreover the participation of the occupants in surveys might decrease, in case improvements cannot be achieved before the next survey. Surveys should be based on reliable instruments such as the Occupant Indoor Environmental Quality (IEQ) Survey™ of the Center for the Built Environment, UCLA Berkeley, [www.cbe.berkeley.edu](http://www.cbe.berkeley.edu)). In field studies of the KIT's Building Science Group the survey instrument INKA (Instrument für Nutzerbefragungen zum Komfort am Arbeitsplatz) was applied which is based on the Occupant Indoor Environmental Quality (IEQ) Survey™. Reference values for winter and summer surveys are available from the field studies of the Building Science Group. If other questionnaires are used, comparisons to these reference values will not be feasible. For further surveys within the framework of the German assessment system it is recommended to build a database of occupants' votes.

For an adequate evaluation of surveys in buildings which are going to be assessed, the auditors should have some background information on post-occupancy evaluation (choice of questionnaire, sample size etc.). Thus, accordant instructions should be part of the education of auditors.

## **4.2 Modification of the criteria group 'socio-cultural and functional quality'**

Results from international as well as from our field studies have shown that from the occupants' perspective a variety of comfort parameters are of importance if the evaluation of the workplace itself is addressed, e.g. layout of the office or office type. These issues are not part of the German assessment system, but for a holistic approach of the relation between human beings and the built environment, these issues should be considered.

An important source for optimization is to rethink the weighting factors for the comfort parameters which were defined by expert ratings. This is particularly the case for aural comfort, which is strongly linked to the office type (e.g. open plan offices). Again, results from field studies approved the importance of the aural comfort which is weighted in the current German assessment system with a factor of 1, in comparison to thermal comfort, visual comfort, indoor air quality and user control which are weighted with factor of 2 and 3 respectively (thermal comfort in summer). Therefore the weighting factor for aural comfort should be adjusted to the other comfort parameters.

## **4.3 Modularization of the survey instrument**

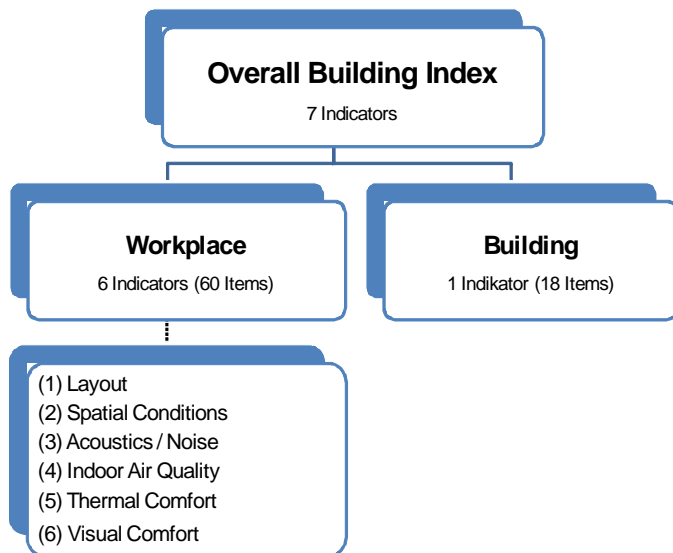
Based on statistical analyses (e.g. principal component analysis with optimal scaling) of the summarizing questions regarding comfort, an overall building index as well as a partial index was developed. The overall building index consists of seven comfort parameters, reflecting comfort issues of the workplace as well as the building itself (e.g. restrooms, safety). The partial index includes four indicators, which are addressed in the criteria group 'socio-cultural and functional quality' (Fig. 1 and 2) and which show a high degree of congruency between the criteria group and the content of the questionnaire.

The reliability analyses of the items show acceptable to excellent values (Cronbach's alpha<sup>1</sup> = .74 to .90). The component loadings of the principal components analysis with optimal scaling were consistently high respectively very high. The explained variation for the overall building index is about 50% and 58% for the partial index. The data showed that both, the overall building index as well as the partial index, turned out to be acceptable as a one-dimensional structure.

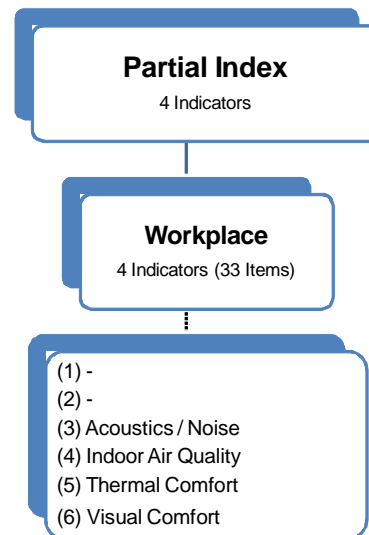
A modularization of the survey seems to make sense for several reasons. As an initial feedback regarding the occupants' acceptance, a comprehensive survey based on the overall building index is recommended. A reduced (and time-saving) questionnaire with the four indicators can be used in the context of regular monitoring of energy-related issues. For the certification process two different indices are available.

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<sup>1</sup> Measure of the internal consistency or reliability of a scale or psychometric score.



**Figure 1** Facets of the Overall Building Index



**Figure 2** Facets of the Partial Index

#### **4.4 Integration of results from occupant satisfaction surveys in the German assessment system for existing buildings**

While the assessment of the qualitative and quantitative aspects of occupant satisfaction surveys as part of the certification system can be managed, the direct implementation of results from occupant surveys into the scoring system presupposes a standardized approach. The application of comparable questionnaires becomes mandatory, even better, an identical survey instrument has to be applied. Otherwise the results from different surveys would not be comparable, e.g. because of different item batteries or different rating scales.

Unlike the profiles for parameters of the German assessment certification system, which are based on standards or documents and which are aligned to an achievable maximum, the assignment of subjective votes is an open discussion. The survey data which is the basis for the development of the indices, derive from about 40 buildings of different energy performance standards and cannot be seen as standard values. Thus, the achievable maximum for occupant votes is not answered yet. In practice, the multi-step transformation of values determined in the certification process (10 points - 100 points - degree of compliance in percent - final note) raises the question, how meaningful these points are at the end to describe the subjective rating. Especially for soft factors it is advisable to stay close to the raw data.

The five-point-scale in the questionnaire for the collection of occupant votes on comfort issues ranges from -2 (very dissatisfied) to 2 (very satisfied). With respect to the experiences from the field studies we recommend to give points for mean results in the range of > - 1 to 1. In accordance to the results from surveys it seems to be hard to achieve a mean score above 1 (satisfied), especially in buildings with a great number of employees. Worse results

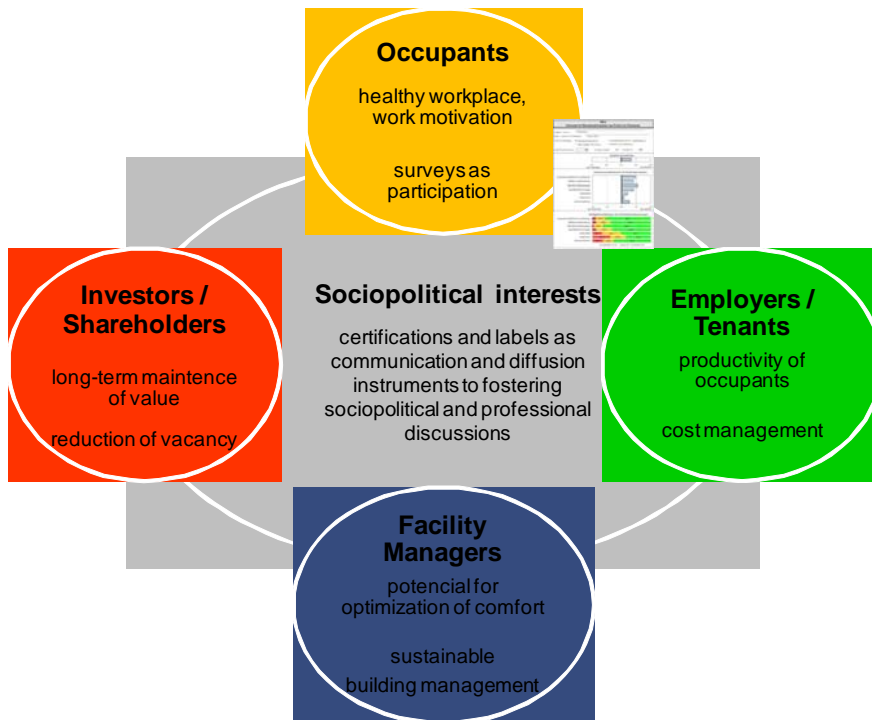
than -1 (dissatisfied) should not obtain any points. This suggested procedure should be validated by further findings from the application of the German assessment system for existing buildings.

## **5 Summary and recommendations**

Aiming at a comprehensive approach towards the evaluation of sustainable buildings, the consideration of occupant votes as a descriptive characteristic of the social quality plays an essential part of a certification system. An update of the German assessment system for the monitoring of existing buildings should provide the integration of occupant surveys in regular intervals as a mandatory part of the procedure. The collection of subjective ratings regarding comfort issues at the workplace and building features is substantial to support a sustainable management of buildings.

From the perspective of different stakeholders, occupants' surveys are of interest and provide benefit (see Figure 3). With the certification system, socio-political concerns will be put into practice. Considering the occupants' feedback is a participatory procedure; it also corresponds to the protection of goods and goals such as well-being, health and safety. The experiences from the German assessment system with respect to the operation of buildings could react to the certification process for new buildings in terms of modification of the socio-cultural quality of sustainable buildings. An adequate working environment as a token of appreciation is applicable to support the motivation of employees as well as the efficacy of work production.

Surveys are of interest for the employers (who are often tenants at the same time) in terms of substantial reasons when it comes to plan and to calculate interventions in the building (e.g. structural interventions). The evaluation of the workplace environment from the occupants' view provides information for the facility management staff regarding an optimization of energy-related as well as cost-related parameters such as indoor temperatures or indoor air quality. For investors and shareholders, the occupants' acceptance respectively satisfaction is an important indicator with respect to value conservation and reduction of vacancy.



**Figure 3 Stakeholder model for the integration of surveys in an assessment system**

Indices should not replace an in-depth-analysis of a building. Beyond the interpretation of results based on aggregated data, details should be considered as well. The previous field studies have shown that specific building characteristics (e.g. glass facade, offices which are orientated towards an atrium, the lack of external sun protection) can affect the overall comfort ratings. For example, the aural comfort is closely related to the office type: In open plan offices, the aural comfort is rated significantly worse compared to cell or group offices with up to five or six persons.

The discussed aspects illustrate the complexity of the social issues in the field of building performance and the challenge of translating social reality into scores. Furthermore, when considering comfort as ‘a matter of culture and convention’ [4] changes in importance of comfort parameters over time respectively generations are expectable, and so instruments for measuring subjective issues should be well defined and adjusted for its scope. These might include structural or organizational changes in the working context or the demographic change.

## 6 Literature

- [1] Kaufmann-Hayoz, R., Bättig, Ch., Bruppacher S., Defila R., Di Giulio A., Ulli-Ber S., Friederich U., Garbely M., Gutscher H., Jäggi Ch., Jegen M., Müller A., North N. (2001): A typology of tools for building sustainability strategies. In R. Kaufmann-Hayoz, H. Gutscher (Eds.), *Changing things - moving people. Strategies for*

*promoting sustainable development at the local level* (pp. 33-107). Basel: Birkhäuser.

- [2] Brill, M., Weidemann, S. & the BOSTI ASSOCIATES (2001). *Disproving myths about workplace design*. Jasper: Kimball International.
- [3] Wagner, A. & Schakib-Ekbatan, K. (2011). User satisfaction as a measure of workplace quality in the office. In C. Schittich (Ed.), *Work Environments: Design in Physical Space, Mobility, Communication* (pp. 54-57). Basel: Birkhäuser.
- [4] Chappells, H. & Shove, E. (2005). Debating the future of comfort: Environmental sustainability, energy consumption and the indoor environment. *Building Research & Information*, 33 (1), 32–40.