ZESZYTY NAUKOWE POLITECHNIKI RZESZOWSKIEJ **Nr 283**
Budownictwo i Inżynieria Środowiska z. 59 (1/12/I) **2012**

Eva KRÍDLOVÁ BURDOVÁ[1]
Silvia VILČEKOVÁ[2]
Technical University of Košice

THE ENVIRONMENTAL ASSESSMENT OF OFFICE BUILDINGS IN SLOVAKIA

The Slovak building environmental assessment system has been processed. The main fields and relevant indicators are proposed on the base of available experience database analysis from environmental, social and economic performance of buildings. The existing systems and methods used in many countries were the base of new system development. The developed building environmental assessment system (BEAS) deals with evaluation of site selection and project planning, building construction, indoor environment, energy performance, waste and water management. The aim of paper is introduced the BEAS developed in Slovakia. The paper also presents the evaluation of selected office buildings in the phase of their conceptual design.

1. Introduction

Due to an increasing awareness of the effects of the contemporary development model on climate change and the growing international movement towards high performance buildings, the current paradigm of building is changing rapidly. Such change is affecting both the nature of the built environment as well the actual method of designing and constructing a facility. This newly emerging approach differs from established practice in the following important ways: by selecting project team members on the basis of their eco-efficient and sustainable building expertise; increased collaboration among the project team members and other stakeholders; greater focus on global building performance than on building systems; a strong emphasis on environmental protection for the whole life-cycle of a building; careful consideration of worker health and occupant health and comfort throughout all phases; scrutiny of all decisions for their resource and life-cycle implications; the added requirement of building commissioning, and a real emphasis on reducing construction and demolition waste [1, 2]. Appropriate choice of distribution system can ensure

[1] eva.kridlova.burdova@tuke.sk
[2] silvia.vilcekova@tuke.sk

the quality of air at lower air exchange. To ensure air quality in indoor environment of buildings contributes significantly to the effective choice of an appropriate distribution of ventilation [3]. The assessment of building environmental performance covers a wide range of issues and may involve not only a number of environmental, but also economical, social and cultural factors. The comprehensive assessment of buildings requires a multidisciplinary and multi-criteria approach which demands cooperation among civil engineers, architects, environmentalists and other experts from different areas of building environmental assessment.

In the past decade, integrated assessment systems, methods and tools have been developed and used in different countries for evaluating the sustainable performance of buildings. A variety of different tools exist for building components, whole buildings and whole building assessment frameworks. The tools cover different phases of a building's life cycle and take different environmental issues into account. These tools are global, national and, in some cases, local. A few national tools can be used as global tools by changing the national databases. Tools are developed for different purposes, for example, research, consulting, decision making and maintenance. These issues lead to different users, such as designers, architects, researchers, consultants, owners, tenants and authorities. Different tools are used to assess new and existing buildings [4].

The paper is organized as follows. Next section is focused on summarizing of building environmental assessment systems and tools used world-wide and developing the building environmental assessment system in Slovakia. The core of the paper started at section 3 with the environmental assessment system of office buildings located in the east of Slovakia.

2. Building environmental assessment systems and tools used world-wide

An important trend is the increasing number of tools world-wide that aim at making comprehensive environmental assessment of buildings and provide rating for simplified communication [5]. The most significant building environmental assessment systems used worldwide include: BREEAM (UK), Green Globes (Canada), LEED (USA), SBTool (international tool), CASBEE (Japan), HK-BEAM (Hong Kong), NABERS (Australia), LEnSE (EU), France HQE (France), E-audit (Poland), Protocollo ITACA (Italy) etc. [6]. The amount of information and tools are available to assist designers and builders in incorporating sustainable technologies and design strategies in their projects. In relation to existing tools, many reports [6, 7] present a description of the characteristics for a number of evaluation tools which are used for building and building materials, nationally and internationally.

3. Building environmental assessment tool in Slovakia

In the recent years the evaluation of building performance in terms of environmental, social and cultural aspects is also a discussed topic in the Slovak republic. The new building environmental assessment system has been developed at the Institute of Building and Environmental Engineering, at the Technical University of Kosice. The systems and tools used in many countries were based on the new system development for applications under Slovak conditions. The main fields and relevant indicators of building environmental assessment were proposed on the basis of available information analysis from particular fields of the building performance and also according to our experimental experiences. The foundation of system development was mainly based on the SBTool. BEAS is a multi-criteria system which included environmental, social and cultural aspects. The proposed fields and indicators respected and adhered to Slovak standards, rules, studies and experiments. The developed assessment system for Slovakia contains 6 main fields [8].

The methodology of the derivation of assessment indicator in BEAS has been performed according to a study [9]. An indicator list has been derived by a three-step process. In order to establish a comprehensive set of indicators of the building environmental assessment method for office buildings, a combination of reviewing existing methods of building environmental assessment used worldwide, valid Slovak standards and codes, and an academic research papers has been conducted. A three-step process has been conducted in this method. The first step, a full range of indicators relating to the sustainable building efficiency, has been collected through a wide-ranging literature review. In step 2, a draft indicator list has been selected from the full indicator list based on an in-depth analysis. In step 3, a questionnaire survey has been conducted in order to get the comment from the experts to refine the draft indicators. As a result, a final indicators list has been proposed. The final indicators list is presented for each main field of assessment in the next sections of this paper.

The hierarchy structure of proposed building environmental assessment system is shown. Main fields are:

A – Site Selection and Project Planning,
B – Building Construction,
C – Indoor Environment,
D – Energy Performance,
E – Water Management,
F – Waste Management.

Some of main fields have subfields, for example field marked as A has two subfields A1 – Site selection and A2 – Site development. Fields and subfields have determining indicators. The total number of the indicators is 52 [10-12].

The hierarchy structure allowed the use of multi-criteria analysis (MCA) for weight significance determination. MCA is a tool for the evaluation of effectiveness and decision support. The significance weight of proposed fields and indicators were determined by the mathematical method of the Analytic hierarchy process, the Saaty method and the Pairwise comparison method – Fuller method. The criteria weight was assigned using Saaty's matrix [13].

The weightings of criteria for multi-criteria analysis methods should be standardized and the condition holds that:

$$\left.\begin{array}{l} v = \ v_1, v_2, ..., v_n \\ \sum_{i=1}^{n} v_i = 1 \\ v_i \leq 1 \end{array}\right\} \quad (1)$$

where: vi – weight of i criterion,
n – number of criterion.

In the Fig. 1 is shown indicators of assessment with their final weights.

Way of assessment

Each main field has several indicators which have the intent of assessment and the scale of assessment. This scale is from negative (–1 point), acceptable practice (0 point), good practice (3 point) and best practice (5 point). Result of each indicator is obtained so that the point from scale is multiplying with weight of indicator. The result is presented in last evaluative list in form of column graph and comprehensive tables [8].

Office buildings assessment

Buildings are long-lasting products which have huge impacts on the environment during their entire life. The design of buildings should take into consideration long-term environmental, social and economic benefits [14]. For the system verification was selected eight office buildings located in the east of Slovakia. In the Fig. 2 are shown results of buildings evaluation in the main fields and a total score of assessment for each main field. Office building marked as 1 is located in Snina, 2 is located in Spišská Nová Ves, 3 is located in Košice, 4 is located in Michalovce, 5 is located in Bardejov, and office buildings marked as 6, 7 and 8 are located in Košice.

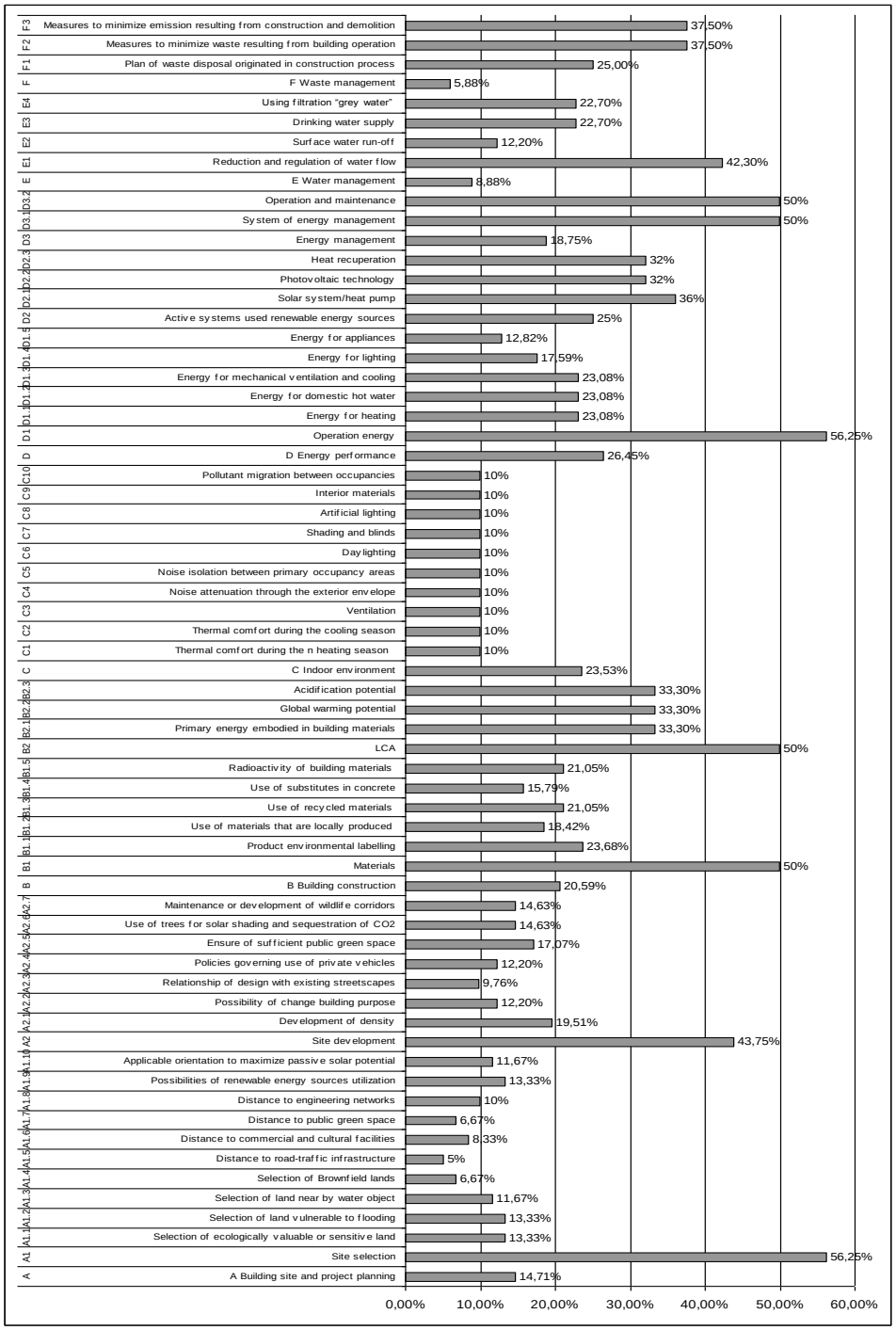
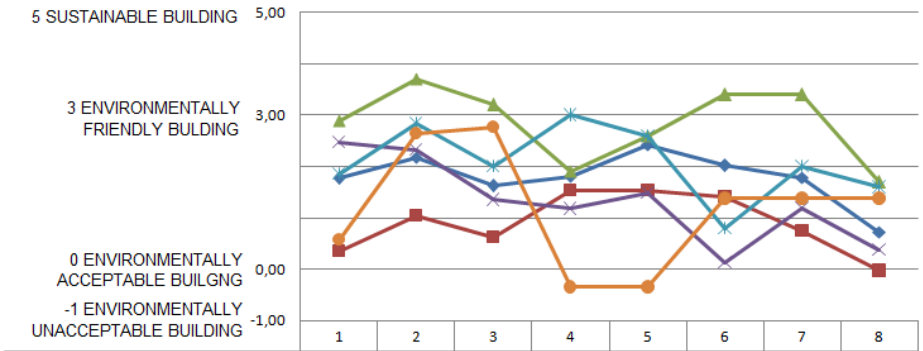


Fig. 1. Description of figure



	1	2	3	4	5	6	7	8
A Site Selection and Project Planning	1,77	2,18	1,62	1,80	2,43	2,02	1,79	0,73
B Building Construction	0,36	1,05	0,62	1,54	1,54	1,42	0,75	-0,03
C Indoor Environment	2,90	3,70	3,20	1,90	2,60	3,4	3,4	1,7
D Energy Performance	2,47	2,32	1,35	1,18	1,48	0,14	1,19	0,38
E Water Management	1,85	2,85	2,00	3,00	2,60	0,8	2	1,6
F Waste Management	0,58	2,65	2,77	-0,35	-0,35	1,38	1,38	1,38

Fig. 2. Results of office buildings assessment

4. Results

In the Fig. 3 there is presented average result of assessment in column graph. The field „Site selection and project planning" obtained average value of 2,01; field „Building construction" value of 0,95; field „Indoor Environment" value of 3,21; field „Energy performance" value of 1,62; field „Water

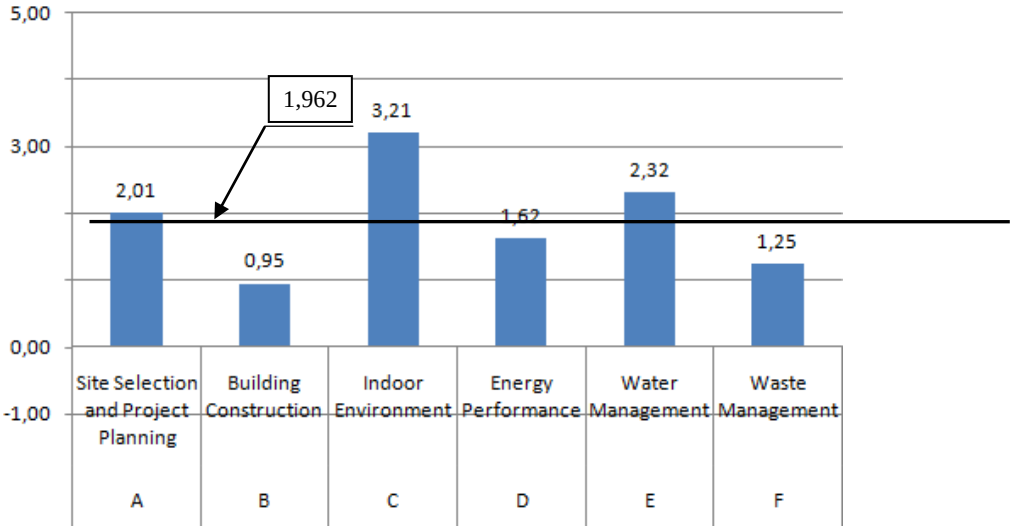


Fig. 3. Results of office buildings assessment

management" value of 2,32 and field „Waste management" value of 1,25. The total weighted buildings score is 1,96 which is classified as „Environmentally acceptable building" on the base of classification key shown in the Table 1. The results from the comprehensive environmental assessment of selected office it can assert, that it is necessary to propose measures to improve the environmental suitability and safety of the evaluated office buildings in all assessed fields.

Table 1. Classification key

Score	Category
–1	Environmentally unacceptable building
0	Environmentally acceptable building
3	Environmentally friendly building
5	Sustainable building

5. Conclusion

This paper presents the development of a building environmental assessment methodology and system that is intended to assist the design process. The proposed environmental assessment system of buildings applicable in Slovak conditions consists of 6 main fields and 52 relevant indicators. The basis of system development consists of systems and methods used in many countries, especially SBTool. The main fields are building site and project planning (14,71%), building constructions (20,59%), indoor environment (23,56%), energy performance (26,47%), water management (8,88%) and waste management (5,88%). The proposed fields and indicators respect Slovak standards, rules, studies and experiments. The weighting coefficients were developed to suit local conditions such as climate or to reflect the prioritized policies and will be modified for various type of buildings. This paper introduced a comprehensive method of identifying indicators for assessment in office buildings applying feasibility, completeness, effectiveness and multi-attribute decision making rules. The aim of this paper was also introduced the proposal and verification of BEAS. The percentage weights of significance were determined for proposed sub-fields and relevant indicators. The selected office buildings were evaluated from this point of view. The average score of assessed buildings is 1.96 which is classified as „Environmentally acceptable building".

This study was supported by European Union Structural Funds (*Grant code: ITMS 26220220064*) *and the Grant Agency of Slovak Republic to support of project No 004TUKE-4/2011, on the base of which the results are presented.*

References

[1] Kibert C.J.: Sustainable construction: Green building design and delivery, John Wiley & Sons, New Jersey, United States of America 2005.

[2] Mateus R., Bragança L.: Sustainability assessment and rating of buildings: Developing the methodology SBToolPT, Building and Environment, 2011.

[3] Nagy R., Senitková I: IAQ and distribution systems in school buildings, Roomvent 2007, FINVAC, Finland 2007.

[4] Haapio A., Viitaniemi P.: A critical review of building environmental assessment tool, Environmental Impact Assessment Review, no 28, pp. 469-482.

[5] Malmqvist T., Glaumann M.: Environmental efficiency in residential buildings: A simplified communication approach, Building and Environment, no 44, 2009, pp. 937-947.

[6] Fowler K.M., Rauch E.M.: Sustainable building rating systems summary, Pacific Northwest National Laboratory, 2006.

[7] Seo S.: International review of environmental assessment tools and databases, CRC Construction Innovation Building our Future, 2002.

[8] Vilčeková S., Krídlová Burdová E.: Building environmental assessment, Science Monograph, 2010.

[9] Yang Y., Li B., Yao R.: A method of identifying and weighting indicators of energy efficiency assessment in Chinese residential buildings, Energy Policy, no 38, 2010, pp. 7687-7697.

[10] Vilčeková S., Krídlová Burdová E., Šenitková I.: Indoor environmental quality assessment, Selected Scientific Papers, Slovakia, vol. 3, no 2, 2008, pp. 25-33.

[11] Krídlová Burdová E., Vilčeková S.: Verification of new building environmental assessment system in Slovakia, Clima 2010: 10th REHVA World Congress „Sustainable energy use in buildings", 9-12 May, Antalya, Turkey 2010, pp. 1-8.

[12] Vilčeková S., Krídlová Burdová E.: New approach to integrated assessment of buildings, International Scientific Conference „People, buildings and environment 2010", 10-12.11.2010, Křtiny, Czech Republic – Brno, Akademické Vydavatelství CERM, pp. 317-323.

[13] Saaty T.L.: Decision making with the analytic hierarchy process, International Journal of Services Sciences, no 1/1, 2008, pp. 83-98.

[14] Wang N., Chang Y., Nunn Ch.: Lifecycle assessment for sustainable design options of a commercial building in Shanghai, Building and Environment, no 45, 2010, pp. 1415-1421.