2011 2nd International Conference on Environmental Science and Technology
IPCBEE vol.6 (2011) © (2011) IACSIT Press, Singapore

Criticism on Environmental Assessment Tools

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***Abstract*—Using environmental assessment tools to assess the sustainability of buildings, homes and mixed-use area is increasing. Environmental tools assign scores to projects using some sustainability (sub)aspects according to design and realization documents and evidences. Six European sustainable urban area development projects have been evaluated according to the aspects of BREAAM. The evaluation is compared with actual projects outputs. The study shows, however, that these tools still unable to estimate the actural project outputs of sustainable projects as sustainable measures and technologies can turn out differently in the use-phase. Also the influence of project end-users is underestimated and not considered properly in these tools.**

Keywords-environment assessment tools; criticism; sustainable building; BREEAM

I. INTRODUCTION

There are great challenges facing the construction industry; drinking water resources are very scare, fossil fuel resources are running up, levels of air pollution in urban environments are increasing rapidly and pressure is growing to achieve high levels of vital and green urban areas [1] and [2]. These challenges mean that our built environments need to evolve to meet the increasing demand on land-use and natural resources, while simultaneously reducing their contribution to green house gas emissions (GHG) and improving environmentally safety, economically productive and socially inclusive environments [3].

The demand for sustainable built environments has been increasing strongly the last years. In response, the need for well-understood planning and design processes of sustainable built environments has also been increased proportionally [4]. Sustainable urban environments projects are quite complicated projects [5]. They require highly specialized teams working in a well cooperative and integrated way. To assess and facilitate those complicated planning and design process, sustainable assessment tools have been developed.

In the last years, a series of environmental assessment tools have been developed by commercial and governmental research organizations. These tools aim at assessing the performance of building and dwellings with regards to energy consumption, environment and ecology, considering technology as well as social aspects of projects based on a life-cycle perspective [6]. Building environmental assessment tools could be divided into two categories; assessment and rating tools. The difference between the these two tools categories is that the first category provides quantitative performance indicator for design alternatives and the second one provides rating tools determine the performance level of a building in stars [6].

Although all environmental assessment tools have been developed to evaluate buildings according to their sustainability at the end of the design stage, the most assessment tools have being used to support the design teams as a design tool [7].

The typical environmental assessment tools include BREEAM (Building Research Establishment Environmental Assessment Method, UK), LEED (Leadership in Energy and Environmental Design, USA), SBTool (Sustainable Building Tool, international), CASBEE (Comprehensive Assessment System for Building Environment Efficiency, Japan), Green Globes, Green Calc, Eco-profile, HK-BEAM (Hong Kong Building Environment Assessment Method, Hong Kong), BCA-GM (Building and Construction Authority Green Mark, Singapore), Green Star (UK), NABERS (National Australian Building Environment Rating System), GOBAS (Green Olympic Building Assessment System, China), ESGB (Evaluation Standard for Green Building).

BREEAM is the first real environmental assessment tool worldwide. Other assessment tools such as LEED, SBtool have been greatly influenced or derived by BREEAM [8]. Almost all assessment tools, with the exception of CASBEE, consider all life cycle stages and ignore the demolition stage. However, all these tools include the same sustainability issues; Water & Energy Efficiency, Materials & Resources, and Indoor Environmental Quality [8].

Despite of all mentioned assessment tools are developed to serve the same aim, cultural and market diversities have influenced the rating and weighting system of each tool and subsequently the way that the tools have been introduced in the market [6].

BREEAM

The British Research Establishment Environmental Assessment Method (BREEAM) was introduced in 1990 by the Building Research Establishment (BRE) in the United Kingdom. BREEAM is the leading and most widely used environmental assessment method for buildings including a broad series of building schemes; BREEAM Communities, Courts, Domestic Refurbishment, Eco-Homes, Education, Healthcare, Industrial, International, Multi-residential, Offices, Prisons and Retail [9]. BREEAM has been distinguished by flexibility of use worldwide, applicability on the community scale and not regarding the financial

aspects of the projects. The last aspect is very relevant in this study as we will not consider project budget as a success criterion. The aim of this study is to find to what extent environmental assessment tools can predict the actual project outcomes as evaluated in the post occupancy phase.

II. METHODOLOGY

The method used in this study is based on using the British Research Establishment Environment Assessment Method (BREEAM) to set the theoretical design measures in six sustainable urban development projects alongside their actual performances. By comparing theoretical inputs and actual outputs a conclusion can be drawn on the effectiveness of environmental assessment tools in predicting how sustainable buildings actually perform.

Based on BREEAM Communities as framework, a questionnaire has been designed to investigate which sub aspects of BREEAM have been considered in each case study. Also the actual impact of each sub aspect has been investigated. Data used in this study consist of official publications six project organizations and interviews with project key persons who were directly involved in this project. Case studies have been mutually compared according to the number of BREEAM sub aspects considered and how they turned out in the occupancy phase. The result of this comparison can reveal to what extent match a BREEAM score the actual resident's satisfaction, and the environment impact. However, there was no intention to give a BREEAM score for each case study.

Three criteria were used to select the BREEAM as environment assessment tool: (1) applicability on the community scale, (2) flexibility to be used internationally, and (3) not considering financial aspects in evaluating areas. For the selection, six prevailing sustainable assessment tools have been compared; LEED, BREEAM, SBTool, CASBEE, BCA-GM, and ESGB [8]. The comparison of the assessment tools have been shown in table I.

TABLE I. SELECTION OF ENVIRONEMENT ASSESSMENT TOOL

Tool	**Comparison criteria**		
	Applicability on the community	***Flexibility; not regionally***	***Considering financial aspects***
BCA-GM	Not applicable	Not applicable	Not applicable
BREEAM	Applicable	Applicable	Applicable
CASBEE	Not applicable	Not applicable	Not applicable
ESGB	Not applicable	Not applicable	Not applicable
LEED	Applicable	Applicable	Not applicable
SBTool	Applicable	Applicable	Not applicable

TABLE II. SELECTION OF CASE STUDIES

Case study	***Country***	***City***	***Area type***
BedZED	United Kingdom	London	Redeveloped [a]
Bo01	Sweden	Malmo	Redeveloped
Eco-Viikki	Finland	Helsinki	New city area
EVA-Lanxmeer	The Netherlands	Culemborg	Redeveloped
Kronsberg	Germany	Hannover	New city area
Vauban	Germany	Freiburg	Redeveloped

a. redeveloped existing city area

The selection of the case studies was based on four criteria: (1) living-work case studies, (2) project is already achieved and post occupancy data are available, and (3) case study is European well-known and is mentioned as best practice by Secure Project [10] as well as by Energy-Cites [11]. These cases studies have been shown in table II.

III. RESULTS

Table III reveals that, when using BREEAM, Vauban, Kronsberg and EVA-Lanxmeer have dealt with more sustainability sub aspects and therefore will have the highest BREEAM score.

TABLE III. COMPARISON OF SUB ASPECTS MENTIONED IN THE SIX CASE STUDIES

Case study	**Number of BREEAM sub aspects that**		
	Clearly mentioned	***Not Clearly***	***Clearly not mentioned***
BedZED	39 (76%)[a]	7 (14%)	5 (10%)
Bo01	37 (73%)	3 (6%)	11 (22%)
Eco-Viikki	37 (73%)	5 (18%)	9 (10%)
EVA-Lanxmeer	44 (86%)	4 (8%)	3 (6%)
Kronsberg	45 (88%)	2 (4%)	4 (8%)
Vauban	49 (96%)	2 (4%)	0 (0%)

a. percentages of sub aspects compared to total 51 sub aspects

TABLE IV. COMPARISON OF ACTUAL PERFORMANCE OF THE CONSIDERED SUB ASPECTS IN THE SIX CASE STUDIES

Case study	**Number of considered BREEAM sub aspects that**		
		Work well	***Do not work well***
BedZED	39	32(82%)	7 (18%)
Bo01	37	32 (86%)	5 (14%)
Eco-Viikki	37	33 (89%)	4 (11%)
EVA-Lanxmeer	44	36 (82%)	8 (18%)
Kronsberg	45	41(91%)	4(9%)
Vauban	49	47 (98%)	2 (2%)

a. percentages of sub aspects compared to total considered sub aspects

Data in table IV reveal that although all projects have considered unconsciously almost all BREEAM issues during the planning and construction stages, the project did not achieve the desired end result.

IV. Discussion

This study has faced some difficulties. The approach has been chosen in this study was to focus on sustainable urban development from all sustainability aspects as used in BREEAM. On the one side, this choice was very useful to get broad insight into sustainable measures taken in six European case studies and how they turned out in the use phase. On the other side, it was very difficult and sometimes impossible to collect all needed data for the six case studies. Another approach, and maybe a better one, could focus on one aspect in the six case studies or on all aspects in one case study. Also projects as Kronsberg, Malmo and Viikki are very difficult to be analyzed as one project as these projects consist of sub projects using different technologies and sustainability measures.

Case studies have dealt with all categories of BREEAM communities. However, case studies dealt differently with the sub issues of BREEAM communities. Data show that case studies Vauban, Kronsberg and then EVA-Lanxmeer have the highest number of sub issues dealt with.

From the six case studies, BedZED and EVA-Lanxmeer have the highest number of considered issues that did not work satisfactory. This could be explained by the very ambitious, and maybe not realistic, project objectives. In the other case studies, where project objectives are realistic and well defined, BREEAM sub issues considered to work satisfactory. This result corresponds to the results found by [12] and [13].

The project scale seems to be an essential condition in dealing with sustainable issues. In large scale projects, water management issues, parking policy and renewable energy sources can be successfully designed and achieved.

In all case studies, affordable and social housing seems to be very difficult to be achieved. This could be explained by the perception that sustainable housing is unaffordable housing. This result corresponds to the results found by [14].

Very ambitious sustainability objectives have been formulated in case studies BedZED and EVA-Lanxmeer. In these two case studies, respectively 10 of 38 and 8 of 44 considered sub-issues did not work satisfactory. Generally, BREEAM score is given as the design phase has been finished and thus before any work has been achieved or houses have been used. In the evaluation process of BREEAM, no account is taken with how really measures (sub issues) will turn out in the use phase. That means that having high BREEAM score in the design phase does not ensure project quality outcomes to the same extent. This result corresponds to results found by Ding [15].

In the approach of this study we chose BREEAM because it does not use budget aspects to evaluate projects. Almost all case studies have higher budget and cost overruns as the original budget is exceeded. In spite of this, evaluating these projects could result in high BREEAM scores. This means that high BREEAM score does not ensure project success from a project management perspective. This corresponds to finding of Ding [15].

V. Conclusion

'BREEAM communities' is the world leading environmental assessment tool for building at the large scale. Using BREEAM in the very early phases of the project can support clients, designers and planners making living areas with high quality of life and low environmental impact.

The score given by BREEAM at the design phase cannot ensure good quality outcomes in the use phase. The outcomes of sustainability measures and low energy technologies could be turned out differently in the use phase then they were designed. Also the role of the project end-users is underestimated in the evaluation process. The BREEAM score this thus incomplete.

In some cases, BREEAM score has been given by evaluating only the design or realization phase. This evaluation could be seen as impulse for the building companies to compete with, but it still not enough to ensure good project outcomes.

BREEAM did not consider financial aspects to evaluate projects in the design phase. Projects could have relatively higher budget and in some times cost overruns in the construction phase. Expensive projects should get lower score compared to sustainable projects. Otherwise, introducing sustainable communities and rolling out sustainable measures will suffer perception of costly project additives.

Acknowledgment

As mentioned earlier, data in this study have been collected by interviews with key persons of the six projects. The authors would like to thank all those interviewees for their help.

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