Environmental Impact Assessment Review 58 (2016) 34–47

Contents lists available at ScienceDirect

Environmental Impact Assessment Review

journal homepage: www.elsevier.com/locate/eiar

Sustainable building assessment tool for project decision makers and its development process

Hyeyon Kang [a], Yeunsook Lee [a], Sunkuk Kim [b,*]

[a] Department of Interior Architecture & Built Environment, Yonsei University, 50 Yonsei-ro Seodaemun-gu, Seoul, Republic of Korea
[b] Department of Architectural Engineering, Kyung Hee University, 1732 Deogyeong-daero, Giheung-gu, Yongin-si, Gyeonggi-do, Republic of Korea

ARTICLE INFO

Article history:
Received 9 June 2015
Received in revised form 18 February 2016
Accepted 18 February 2016
Available online 4 March 2016

Keywords:
Sustainable building
Assessment tools
Project decision makers
Socio-economic impact
Regional context
Cognitive problem-solving
Information system
Interdisciplinary approaches

ABSTRACT

The primary purpose of Sustainable Building Assessment (SBA) tools is for behavioral changes in public building practice. In the Web 3.0 era, even non-experts may have the capacity to select and use Information & Communication Technology (ICT) tools to solve complicated problems in sustainable building decision making without any expert help. It is clear that the R&D of these tools which directly target project decision makers is a significant project for researchers and policy makers who are tasked with the challenge of changing individual building practice for regional sustainability. The purpose of the study is to suggest a tool and its development process for sustainable building assessment by project decision makers, especially targeting non-expert groups. This study defines an SBA tool for project decision makers based on a typology and suggests a "3-layer development process framework". For the theoretical Background, we integrate interdisciplinary methods and principles such as cognitive problem-solving and sustainable building delivery, including long-term community benefits in a region and an information system development process. This framework is based on Boehem's spiral model for information system development processes and especially emphasizes the first cycle to develop a core set of indicators fit for the non-expert user's problem solving process. This presents an iterative and gradual process with the aim of approaching the tool type from passive tools such as checklists and guidelines, to interactive software, especially interactive DSS (Decision Support Systems) online ICT platforms. The development process is comprised of 8 stages: This includes the use of mixed-method sequential design, including interviews, workshops, the Delphi survey technique, FD-AHP weight analysis, and scenario analysis. In addition, the study presents a case study of the application of the first cycle to develop a core set of indicators and discusses its effectiveness. This study may help researchers by providing a clear and effective method to understand interdisciplinary approaches to develop appropriate tools for sustainable building practice in a regional context.

1. Introduction

The building industry is the largest sector in creating value and jobs, and consuming resources. It has a large impact on the economy, society, and the environment. For the growth of global society, the building industry's sustainability must be considered (ISO 21929, 2011). The assessment of a building's sustainability involves an examination of the environmental, social, and economic impact on the building's local community, the nation, and the planet. SBA (Sustainability Building Assessment) tools are strategic tools for making laypeople's building practices more sustainable (Cole, 2005; Kaatz et al., 2006; Williams and Dair, 2007).

An SBA tool is an information system for the evaluation of a whole building's sustainability. More than 600 sustainability assessment rating systems are available worldwide including BREEAM, LEED, ABGR (Australian Building Greenhouse Rating), HKBEAM (Hong Kong Building Environmental Assessment Method), Chinese Three Star, the SBAT (South African Sustainable Building Assessment Tool) and G-SEED (Green Standard for Energy and Environmental Design in Korea) (BREEAM, 2008; Berardi, 2012). Because of differences of system boundaries in different regional contexts, not all tools are equal (ANNEX31, 2004a, 2004b, 2004c).

Despite all these effort, tools have been criticized for their poor adaptation, meaning they have not affected sustainable building practice and dissemination (Cole, 2005; Kaatz et al., 2006). From case studies, Williams and Dair (2007) found the root cause of this failure was that sustainability measure was not required by clients; other stakeholders had no power to enforce or require sustainability measure when clients perceived it as too costly. Additionally, Häkkinen and Belloni (2011) point out a lack of client understanding; clients perceive tools are too complicated and time consuming to use. Kaatz et al. (2006) blame stakeholder perceptions and interest, and technical language barriers.

* Corresponding author.
E-mail addresses: hyeyongo73@naver.com (H. Kang), yeunsooklee@yonsei.ac.kr (Y. Lee), kimskuk@khu.ac.kr (S. Kim).

http://dx.doi.org/10.1016/j.eiar.2016.02.003
0195-9255/

Cole (1999) and AlWaer et al. (2008) point to different viewpoints of stakeholders in the judgment and interpretation of assessment results. Consequently, tools, as Lützkendorf and Lorenz (2006) asserted, do not serve today's clients; decision maker.

In the Web 3.0 era, even non-experts may have the capacity to select and use Information & Communication Technology (ICT) tools to solve complicated problems without any expert help (Friedman, 2005). Despite current technology advances and changes in the capacity of laypeople, most SBA tools have been developed for trained assessors. *Laypeople* refers to stakeholders who represent building demand and make decisions about private and public buildings without expertise in architecture, urban planning, or in other building-related fields. SBA tools for laypeople have not been systematically developed.

In practice, those likely to be most interested in these tools are the laypeople. Especially clients who have difficulty hiring building assessors for their small building project may need these information tools. Ding (2008) pointed out that only lager projects can afford external expertise. The small-scale construction determined by these laypeople accounts for a substantial amount of regional construction. In particular, they require a trade-off solution to resolve the conflict between expenses and benefits, productivity and quality, and personal versus public benefit in major phases requiring decision-making (Carlile, 2004). However, laypeople can scarcely find the tools that can meet the needs of these non-expert users.

Furthermore, difficulties still exists in the tool development process; it is especially still hard to define the appropriate scope of SBA tools for a regional level of sustainability (Cole, 2005). The importance of the appropriate scope of SBA tools was mentioned in IEA Annex31 (2001) as system boundaries. Cole (2005) pointed out that though the exchange and borrowing of methods has been greatly assisted in developing countries, these international programs reduced sensitivity to the acknowledgement and promotion of regionally appropriate design strategies. In particular, the interests of developing countries in a building lead them to overlook the long-term impact of the process and the consequences on the region's construction-related industries, employment, services, welfare, etc. Instead, they prioritize the potential short-term economic impact in the region (Cooper, 1999; Kaatz et al., 2006; Ugwu and Haupt, 2007; Ding, 2008). To develop appropriate scope of SBA tool, developer expertise and financial investment with a long-term perspective are required, making development on a regional level difficult.

Consequently, sustainable building information needs to be open and easily assessed to the laypeople in a simple and comprehensible way with tools. SBA tools directly targeting project decision makers, non-expert user group can be the most effective solutions to change individual building practice for regional sustainability. For this tool development, developers need a clear vision of a scientific output and an optimized method which can guide such large scale R&D with a long-term perspective (Cole, 1999; Ding, 2008; Venkatesh et al., 2013). A clear and effective method is crucial to save cost and effort for appropriate tool development, especially in developing countries. A method of tool development processes, as Lützkendorf and Lorenz (2006) address, is needed to reduce a mismatch of information supply and comprise an on-site experimental research process by which relevant experts and users can share their experience and knowledge for tool usability.

This study suggests an SBA tool for decision-makers and its development process. A tool is defined based on classifying typology for a decision maker, especially non-expert users for individual building projects on a regional level. A development process framework was constructed based on interdisciplinary methods and theories, such as cognitive problem-solving, sustainable building delivery and information systems. This framework might help researchers to get a better understanding of basic knowledge and learning for the interdisciplinary research and development of an SBA tool.

This study emphasizes a process for building a set of indicators, representing the first step of tool development. A set of indicators is an integrated trade-off solution for end users, and is the most important step in the development of tools such as evaluation sheets, manuals or interactive software. Chapter 2 explores interdisciplinary research for developing an SBA tool for intended non-expert users. Chapter 3 defines an SBA tool based on a typology and suggests a "3-layer development process framework". Chapter 4 presents an application case in Korea and Chapter 5 discusses its results.

2. Preliminary study

2.1. What is the extent of the scope?

Scope should be defined on the initial phase of tool development. Mulvihill and Jacobs (1998) mention that scoping produces a framework that informs the assessment process by addressing issues of content, philosophy and methodology. Scope makes information users focus on the specific system boundaries of assessment issues related to a building and the environment or other product systems (Mulvihill, 2003; ISO 14050). The system boundaries from a full-fledged scoping process can be determined with detailed methodological guidance about the intended use of the methods of assessment, about the intended users and beneficiaries of the method, about the intended stages of the building life cycle to which the methods are applied, and about the assumptions underlying an assessment. (Mulvihill, 2003; ISO 21931-1) But scoping, as Mulvihill (2003) asserts, should be limited to identifying, listing and categorizing relevant issues for the benefits of expanded scoping later.

First of all, scope of SBA tool must be identified with common values of global society (Mulvihill and Jacobs, 1998; Kaatz et al., 2006). Developers can easily define what extent of assessment should be address within the scope of standardization activities at ISO and CEN. Todd and Geissler (1999) mention that this international criteria is to address global concerns such as economic globalization and global environmental burden. Especially, ISO 21929-1 (2011) presents the scope of the sustainability assessment of the building's multi-dimensional impact. This core criteria serve as a clear starting point for developing customized methods for specific intentions such as micro-level decision making tools (Ugwu and Haupt, 2007). The main scope of sustainable building assessment and core indicators that should be taken into account when assessing sustainability of buildings are described as shown in Table 1. The main scope of impacts is comprised as follows: Environmental issues should be categorized with Impacts to Environment and Resources. Economic issues should be categorized as Economic Value and Productivity. Social issues should be categorized as Health, Satisfaction, Equity, and Cultural Value. The core indicators can be developed related to this scope.

Then, regional benefits based on these global concerns should be added to the tool scope. As the general principles presented in ISO 15392 mention, the strategies for sustainable building practice and dissemination are essentially local and differ in context and content from region to region. A building project's goals and priority issues, as well as the relationship between the stakeholders, can change according to the social, economic, and institutional contexts of the region (Cole, 2005; Cooper, 1999; Ding, 2008; Kaatz et al., 2006). Moreover, the dominant building forms, long-term impact, and context and scope of the total number of each form, vary by region. ISO 21929-1 (2011) emphasizes the scope of sustainable building assessment specified according to the regional context of building procurement (Lutzkendorf and Lorenz, 2006; Ugwu and Haupt, 2007; Todd and Geissler, 1999). But it is still hard to define the regional level of scope, as Ugwu and Haupt (2007) point out that the process of translating sustainable strategy into concrete action at the micro level remains a difficult task (Ding, 2008). To solve these difficulties in scoping, Todd and Geissler (1999) suggest that international standards could be adapted to regional conditions through customizing the criteria used to assess building sustainability in particular setting. They mention that this adaptation makes