

# Chapter 15

## Sustainable Construction Trends in Journal Papers

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**Abstract** Sustainable construction is gaining worldwide attention and has inspired research to identify and solve the problems involved in its implementation over a project lifecycle. While an impressive number of papers have been published on the topic to date, little has been done to review these papers to identify current research status or provide guidance for future research. This paper reviews existing sustainability papers in 12 internationally renowned construction journals. Based on a three-stage literature review, sustainability papers published in these journals from 2000 to 2012 are analyzed in terms of the annual number of papers published and the research interests involved. The number of sustainability-related papers in construction increases from 30 papers in 2000 to 127 papers in 2012, which shows an increasing trend in sustainability topics. A content analysis identifies seven major research interest in sustainability, including (1) sustainable project management; (2) sustainability assessment/evaluation; (3) sustainable technology/innovation implementation; (4) sustainable building/infrastructure performance; (5) government policy on sustainability; (6) enterprise sustainability; and (7) sustainability education. The results of this study provide a reference for scholars and

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academics to understand the current status of sustainability research in major construction journals.

**Keywords** Sustainability · Construction · Review · Research · Papers

## 15.1 Introduction

The construction industry has a major impact on the environment. It is estimated that one tenth of the global economy is dedicated to constructing, operating and equipping homes and offices. The activities involved in doing this account for 40 % of the material flows, much of the remainder being destined for roads, bridges and vehicles to connect the buildings (Roodman and Lenssen 1994). The construction industry has a responsibility to ensure the sustainability of both its products and processes. Sustainable construction is a realization of this responsibility (Hill and Bowen 1997), and it is generally used to describe a process that starts in the planning and design stage and continues after construction ends with a minimum impact on the environment.

The recurring theme of sustainability in the construction industry has motivated changes from its traditional nature and encouraged its modernization and adoption of collaborative and sustainable approaches. The industry is called upon to become more market responsive, reduce the number of accidents on site, put an end to its appalling pollution record, integrate all the stakeholders in the supply chain, and to create a far more ethical and enhanced sustainability profile (Myers 2005).

With the increasing importance of sustainable construction, an understanding of its current status is needed to help identify and solve the implementation problems involved. It has been suggested that this could be achieved by a systematic analysis of relevant recent papers published in academic journals (Tsai and Wen 2005). To date, no such analysis has been undertaken to the best knowledge of the authors. This motivates the analysis that follows of recent sustainability-related research topics published in major construction journals, to identify more clearly contemporary research issues and those in need of further treatment in future.

In this paper, we will provide an overview of the sustainability papers published in major construction journals from 2000 to 2012 in order to identify the research trends involved. In particular, it aims to reveal the main themes and interests of these publications over the prescribed period and provide a better understanding of previous studies and the development of sustainable construction. This will form a platform for future research in identifying areas in greatest demand.

## 15.2 Research Methods

A three-stage literature review was made to conduct a content analysis of sustainability papers in construction journals from 2000 to 2012 (see Fig. 15.1). Authors usually send their papers to journals with similar topics or areas of interests, so a list was made of journals publishing the most papers on sustainability during the period. This involved using several search engines, including SCOPUS, ScienceDirect, ASCE library and Google Scholar. A complete search focusing on “articles” was performed under the “title/abstract/keyword” (T/A/K search) field of the search engines. The keywords used include *sustainability*, *green construction/building*, *sustainable building* and *sustainability trends*. The result of this first stage identified the following 9 construction journals with the most sustainability papers:

- Automation in Construction (AC)
- Building and Environment (BE)
- Building Research and Information (BRI)
- Construction Management and Economics (CME)
- Energy and Buildings (EB)
- International Journal of Project Management (IJPM)
- Journal of Green Building (JGB)
- Proceedings of Institute of Civil Engineers (ICE)
- Renewable and Sustainable Energy Reviews (RSER)

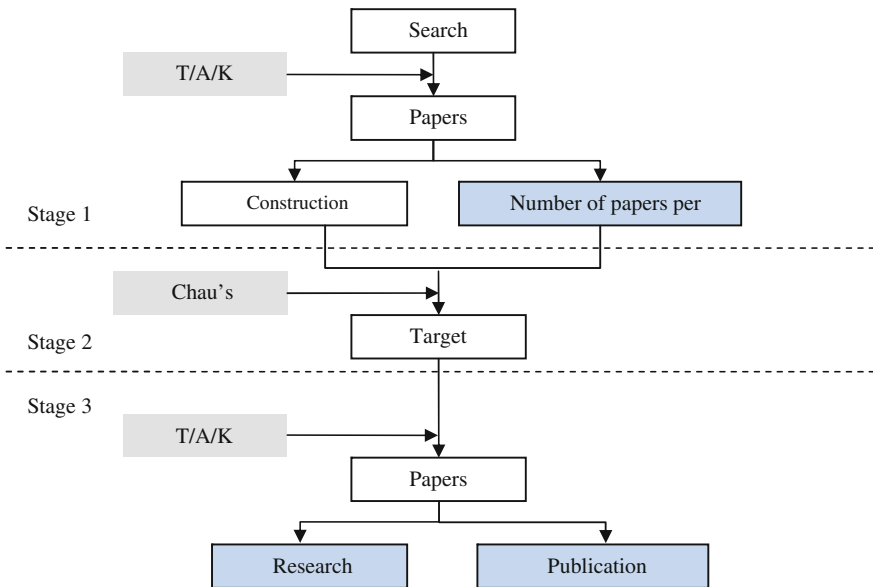


Fig. 15.1 Research framework [after Ke et al. (2009)]

Chau's famous ranking of journals of construction engineering and management (Wing 1997) ranking was used in the second stage to verify and validate the search. This also focused on construction journals with high impact factors and their number of sustainability papers. This results in the inclusion of three additional journals from Chau's ranking list:

- Journal of Construction Engineering and Management (JCEM)
- Engineering, Construction and Architectural Management (ECAM)
- Journal of Management in Engineering (JME)

The final 12 journals were progressed to the third stage of the work. This involved a closer look at the content of the papers in these journals to identify the authors' contributions based on researcher affiliations. The citation information for each paper and journal was also examined in the Scopus database. Finally, the main research topics were identified through a comprehensive content analysis. The research framework derived from Ke et al. (2009) is shown in Fig. 15.1.

## 15.3 Results and Findings

### 15.3.1 *Number of Sustainability Papers Published Annually*

The total number of papers published in the 12 target journals from 2000 to 2012 was 743, with an increasing trend in sustainability topics from 30 papers in 2000 to 127 papers in 2012. Table 15.1 shows the annual and total number of sustainability over the prescribed period.

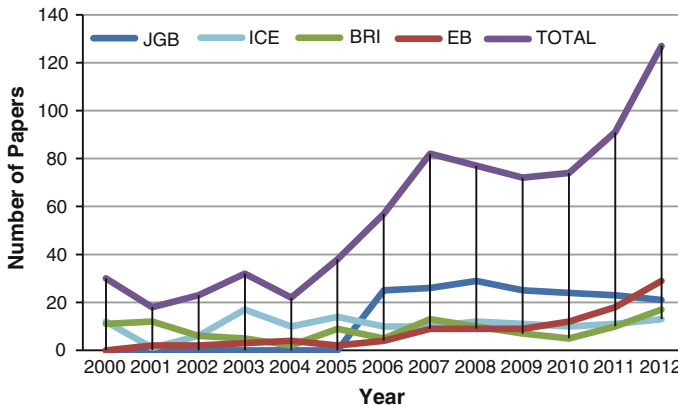
As summarized in Table 15.1, the journals JGB, ICE, BRI and EB published the most sustainability papers (173, 137, 112, and 103 respectively) within the prescribed period. Figure 15.2 shows the number of sustainability papers published by these four journals and total number of papers each year. Although a growing number of papers are published in sustainability topics, it is worth noting that the numbers during 2006–2012 in JGB and ICE are relatively stable, while the number in BRI fluctuated since 2007. With the exception of ICE and BRI, there were very few before 2006.

### 15.3.2 *Research Interests*

Content analysis was applied to identify major sustainability research interests in the samples. Content analysis is a way to help classify textual materials through reducing them to more relevant and manageable bits of data (Weber 1990). Content analysis is frequently adopted to determine the major facets of a set of data, by simply counting the number of times an activity happens or a topic is depicted

**Table 15.1** Sustainability papers published by 12 target journals from 2000 to 2012

Journal	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
AC	0	0	0	1	0	1	2	1	0	2	1	4	4	16
BE	3	2	3	2	3	4	4	17	8	9	14	11	13	93
BRI	11	12	6	5	2	9	5	13	10	7	5	10	17	112
CME	3	1	2	2	0	1	3	2	3	1	2	3	4	27
EB	0	2	2	3	4	2	4	9	9	9	12	18	29	103
ECAM	0	0	1	1	0	1	0	1	3	0	1	2	2	12
IJPM	0	0	0	0	1	1	0	1	0	1	0	0	1	5
JCEM	0	0	0	0	1	0	2	1	2	2	3	4	12	27
JGB	0	0	0	0	0	0	25	26	29	25	24	23	21	173
JME	0	0	0	0	0	1	0	0	0	2	0	2	4	9
ICE	12	1	6	17	10	14	10	10	12	11	10	11	13	137
RSER	1	0	3	1	1	4	2	1	1	3	2	3	7	29
Total	30	18	23	32	22	38	57	82	77	72	74	91	127	743



**Fig. 15.2** Number of sustainability papers published by four journals with most sustainability publications

(Fellows and Liu 2009). Several steps are involved in content analysis. The first step is to identify the materials to be analyzed. The second step is to determine whether to use qualitative or quantitative content analysis. The choice depends on the nature of the research project and known issues to be addressed. In qualitative content analysis, emphasis is placed on determining the meaning of the data (i.e. grouping data into categories).

Qualitative analysis was carried out in this research and categorized the paper topics into several main themes. The title, keywords and year of each paper were first marked down. Content analysis was then applied to identify and assemble similar topics. Different main themes of research topics were finally crystallized from the results. For a paper covering more than one theme, the best fit was chosen. As a result of the analysis, seven categories were identified, including (1) sustainable project management; (2) sustainability assessment/evaluation; (3) sustainable technology/innovation implementation; (4) sustainable building/infrastructure performance; (5) government policy on sustainability; (6) enterprise sustainability; and (7) sustainability education. These topics are examined in more detail below.

### 15.3.2.1 Sustainable Project Management

Over the last fifteen years, there has been a growing attempt to deal with sustainability issues in construction and their practical implementation (González and Echaveguren 2012; Hill and Bowen 1997; Martínez et al. 2000). According to Wu and Low (2010), project management in sustainable construction should focus on processes such as stakeholder management, organizational structure/s and commissioning quite distinct from practice (e.g. technologies). A sustainable construction framework should cover various processes including urban planning, production development and design, manufacturing and construction, operation and deconstruction (Bourdeau 1999).

The papers collected for this topic cover issues of project management in pursuing sustainability at different stages of construction projects, such as design, planning, decision-making, development, construction, material planning and management, cost management, construction supply chain management, and building operation and facility management. Sustainability strategies are often discussed. Barriers and drivers of construction sustainability are identified. Ways to improve sustainable project management are studied including simulation and modeling of sustainable construction operations and delivery, the appropriate selection of sustainable project teams, stakeholder engagement, sustainable value management and risk management.

### **15.3.2.2 Sustainability Assessment/Evaluation**

Sustainability assessment is a procedure used to ascertain whether environmental and societal changes arising from human activities and use of resources are decreasing or increasing our ability to maintain long-run sustainability (Forbes 2008). The design of built structures, their location within an urban system, the use of materials and energy resources in construction, operation and maintenance, and the waste and emissions occurring, all have an impact on the sustainability of the environment. The methods of assessing the impact of buildings on the environment are required to promote economy through the processes of building design, construction, management, operation and maintenance (AlWaer and Kirk 2010). Since the early 90s, many countries and international organizations have been working on sustainable development assessment by means of specific indicators (World Bank 1997; Segnestam 2003). The indicator approach is useful to provide information on the current sustainability situation and make prediction of future sustainability trends (Bottero and Mondini 2003; Winston and Pareja Eastaway 2008).

The sustainability assessment/evaluation summarized here is based on the sustainability papers of the target construction journals dealing with the assessment or evaluation of the environmental performance of buildings and infrastructures, their materials and service parts, their related design and construction activities and post-occupancy situations. This involves development of indicators, criteria, benchmarks or computer-based modeling programs as tools for sustainability assessment/evaluation. Some papers consider financial and risk issues in sustainability assessment criteria and indicators. Life cycle assessment/evaluation is also commonly discussed.

### **15.3.2.3 Sustainable Technology/Innovation Implementation**

Innovation is the creative implementation of the new that takes place against a resistant background of path-dependent everyday activity (Binder 2008). With the ongoing campaigns for sustainable buildings, such as energy efficiency and greenhouse emission reduction, the relevance of implementing sustainable technologies and innovations is now gaining the attention of building practitioners

around the world. It has provoked an increased awareness and willingness to strive for technologies that provide ameliorating measures that increase the sustainability of the building stock (West 2001).

Papers in this topic area mainly discuss the energy efficient and climate control technologies applied in building design and construction activities, including indoor climate and building service technologies, energy analytical modeling of building services and material innovation for building design, technologies of robotic systems, noise reduction and waste collection for on-site construction activities. Some papers target organizational approaches for promoting sustainable technology and innovation. Discussion of the ways to meet the requirements of sustainability rating systems is also popular. Field studies or case studies are often used to illustrate the successful application of sustainable technology/innovation.

#### **15.3.2.4 Sustainable Building/Infrastructure Performance**

Buildings/infrastructure worldwide contribute significantly to the high and still increasing fossil energy and resource consumption. There is an urgent need to apply sustainability concepts to the design and construction of buildings/infrastructure in order to minimize their environmental impact and amount of embodied energy (Lehmann et al. 2010). More builders have been using sustainable building materials, recycling construction debris, and incorporating environmentally-friendly and efficient architecture in building designs (Smith 2009). Sustainable buildings/infrastructure can be defined as those that have a minimum adverse impact on the built and natural environment in terms of the buildings/infrastructures themselves, their immediate surroundings and the broader regional and global settings. They involve considering the whole life of buildings, taking environmental quality, functional quality and future values into account (John et al. 2005).

This topic area includes discussions on the modeling of energy and resource flows of buildings and infrastructures for their performance simulation and measurement. Case studies on specific projects and markets of different country backgrounds are also extensively conducted to study existing building/infrastructure conditions and potential future trends for sustainable development.

#### **15.3.2.5 Government Sustainability Policy**

Many national, state, regional and local governments are currently attempting to address environmental and sustainability issues through establishing sustainable building programs and recruiting officers for sustainable building. Policies and initiatives have been developed with the aim of promoting a sustainable built environment at local, regional, national and international levels (Van Bueren and De Jong 2007). Existing experience has shown that governments are probably the best placed and equipped to implement policies that create more sustainable communities and buildings (Theaker and Cole 2001).



The papers in this topic area mostly study the sustainability policies of government from specific countries and discuss their applicability to other countries. These studies are conducted on the successes and failures of government policy, institutional regimes to motivate changes, and government challenges to promote sustainability and drive sustainability investment.

#### **15.3.2.6 Enterprise Sustainability**

The construction industry plays an important part in contributing to everyone's quality of life. Industry not only helps determine the nature, function and appearance of towns and countryside, it contributes to the formation of communities and has a significant environmental impact (Fairclough 2002). There is a need to encourage responsible construction firms to address the poor public and political image of the industry by meeting new requirements of sustainability (Myers 2005). Although sustainability is gaining favor worldwide, there is still skepticism over its business value. The impact of the social and economic development aspects of sustainability needs to be integrated with the concept of environmental prudence before any business value analysis can be performed (Beheiry et al. 2006).

Issues discussed in the topic of enterprise sustainability include company attitude to sustainability, corporate strategy and approach to sustainability, owner commitment to sustainability, business sustainability innovation, obstacles and rewards of enterprise sustainability, and sustainable organizational management.

#### **15.3.2.7 Sustainability Education**

The understanding of sustainability issues should be a key component of degree programs as it is widely regarded as being a central attribute of professional practice and responsible global citizenship (Brewer et al. 2008). Building and construction professionals make decisions that have a critical impact on the environment and society. This makes sustainability considerations including environmental, social and economic concerns a very important for the building and construction profession (Riley et al. 2007). Papers in this topic area are mainly concerned with sustainability teaching in design and engineering education and relevant model and tool development.

### **15.4 Conclusions**

Sustainability is an increasingly important issue in the delivery of construction projects. It is also a topic that has received significant attention, with many studies reported in the past decade. This paper provides the results of an analysis of related journal publications. Twelve leading construction journals were first identified by use of search engines and an existing published list. A total of 327 papers relating to

sustainability have been published between 2000 and 2012 in these journals, with the annual number of papers steadily increasing. A content analysis of the title and keywords of each paper identified seven major topic areas of sustainability research to date. These comprise: (1) sustainable project management; (2) sustainability assessment/evaluation; (3) sustainable technology/innovation implementation; (4) Sustainable building/infrastructure performance; (5) government policy on sustainability; (6) enterprise sustainability; and (7) sustainability education.

The results of this study provide a reference for scholars and academics to understand the current status of sustainability research in major construction journals. The discussion of existing research interests assists researchers and practitioners in exploring new sustainability research ideas and ways to provide sustainable development in the construction industry.

In terms of limitations, the overview provided is restricted to sustainability research in 12 major construction journals. The journals surveyed in this study may not fully reflect the whole picture of research in this area. Future work would benefit from a more detailed discussion of existing research on construction sustainability in consideration of a wider range of journals.

## References

- AlWaer H, Kirk D (2010) Building sustainability assessment methods. In: Proceedings of the institution of civil engineers (edited)
- Beheiry SM, Chong WK, Haas CT (2006) Examining the business impact of owner commitment to sustainability. *J Constr Eng Manag* 132(4):384–392
- Binder G (2008) Understanding innovation for sustainability within the Australian building industry: an evolutionary social learning model. *J Green Build* 3(3):119–132
- Bottero M, Mondini G (2003) The construction of the territorial performance index for testing the environmental compatibility of projects and plans. In: Proceeding of the international conference on smart and sustainable built environment, Brisbane, Australia (edited)
- Bourdeau L (1999) Sustainable development and the future of construction: a comparison of visions from various countries. *Build Res Inf* 27(6):354–366
- Brewer G, Gajendran T, Landorf C, Williams T (2008) Educating for urban sustainability: a transdisciplinary approach. In: Proceedings of the institution of civil engineers: engineering sustainability, pp 185–193. ICE Publishing, London (edited)
- Fairclough J (2002) Rethinking construction innovation and research—a review of the government's R&D policies and practices
- Fellows RF, Liu AMM (2009) Research methods for construction. Wiley-Blackwell, Hoboken
- Forbes D (2008) Identification and analysis of risks in the sustainability assessment of housing. PhD thesis, Division of civil engineering, The University of Dundee, Dundee
- González V, Echaveguren T (2012) Exploring the environmental modeling of road construction operations using discrete-event simulation. *Autom Constr* 24:100–110
- Hill RC, Bowen PA (1997) Sustainable construction: principles and a framework for attainment. *Constr Manag Econ* 15(3):223–239
- John G, Clements-Croome D, Jeronimidis G (2005) Sustainable building solutions: a review of lessons from the natural world. *Build Environ* 40(3):319–328
- Ke Y, Wang SQ, Chan AP, Cheung E (2009) Research trend of public-private partnership in construction journals. *J Constr Eng Manag* 135(10):1076–1086

- Lehmann B, Güttinger H, Dorer V, van Velsen S, Thiemann A, Frank Th (2010) Eawag Forum Chriesbach—Simulation and measurement of energy performance and comfort in a sustainable office building. *Energy Build* 42(10):1958–1967
- Martínez P, González V, Dafonseca E (2000) Green-Lean conceptual integration in project design, planning and construction. *Revista Ingeniería de Construcción* 24(1):5–32
- Myers D (2005) A review of construction companies' attitudes to sustainability. *Constr Manag Econ* 23(8):781–785
- Riley DR, Grommes AV, Thatcher CE (2007) Teaching sustainability in building design and engineering. *J Green Build* 2(1):175–195
- Roodman DM, Lenssen N (1994) Our buildings, ourselves. *World Watch* 7(6):21–29
- Segnestam L (2003) Indicators of environment and sustainable development: theories and practical experience. World Bank, Washington
- Smith L (2009) Sustainability of an industry: green buildings and green events. *J Green Build* 4(2):63–89
- Theaker IG, Cole RJ (2001) The role of local governments in fostering 'green' buildings: a case study. *Build Res Inf* 29(5):394–408
- Tsai CC, Wen ML (2005) Research and trends in science education from 1998 to 2002: a content analysis of publication in selected journals. *Int J Sci Educ* 27(1):3–14
- Van Bueren E, De Jong J (2007) Establishing sustainability: policy successes and failures. *Build Res Inf* 35(5):543–556
- Weber RP (1990) Basic content analysis, vol 49. Sage Publications, Thousand Oaks, Incorporated
- West S (2001) Improving the sustainable development of building stock by the implementation of energy efficient, climate control technologies. *Build Environ* 36(3):281–289
- Wing CK (1997) The ranking of construction management journals. *Construction management and economics* 15(4):387–398
- Winston N, Pareja Eastaway M (2008) Sustainable housing in the urban context: international sustainable development indicator sets and housing. *Soc Indic Res* 87(2):211–221
- World Bank, Washington, DC (1997) Expanding the measure of wealth: indicators of environmentally sustainable development. Environmentally sustainable development studies and monographs series (World Bank) (17)
- Wu P, Low SP (2010) Project management and green buildings: lessons from the rating systems. *J Prof Issues Eng Educ Pract* 136(2):64–70