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BARRIERS IN IMPLEMENTING SUSTAINABLE CONSTRUCTION

RENARD Y. J. SIEW[1], SAMAD M. E. SEPASGOZAR[2], and ALI AKBARNEZHAD[2]

[1]*Group Sustainability, Sime Darby, Kuala Lumpur, Malaysia*
[2]*Dept of Engineering Construction and Management, University of NSW, Sydney, Australia*

The construction sector lags other industries when it comes to the implementation of sustainability. This paper highlights some of the key barriers in implementing sustainability within the construction industry sector and proposes recommendations to address them. The paper suggests that the four main barriers faced by the construction industry in implementing sustainability are unclear definitions of sustainable construction, ineffectiveness of sustainability reporting tools (SRTs), slow adoption of 'green' technology and the negligence of human resource management. This paper provides an original perspective and challenges current practices (or lack thereof) which hinders the successful implementation of sustainability in construction. It will be of interest to project owners, contractors, academics and other construction practitioners who are interested in the outlook of sustainability within the property and construction industry.

Keywords: Sustainability reporting tools (SRTs), Barriers, Green technology, Implementation, Uncertainty.

1 INTRODUCTION

Many scholars claim that the construction industry is slow in terms of the adoption of sustainability (Carmichael and Balatbat 2009; Siew *et al.* 2013b). McKnight *et al.* (2010) report that the real estate and construction companies possess limited environmental management systems and supply chain monitoring standards, have a significant opportunity to reduce their carbon footprint but appear to be following a wait-and-see approach when it comes to adopting sustainable building practices. Chong *et al.* (2009) find that the spread of sustainability in the construction industry is extremely slow citing less than 1,500 LEED certified buildings, less than 1 million energy star labelled new homes and less than 25,000 U.S. DOE's Building America program certified homes. These scholars argue that more effort is required to eliminate environmental and social footprints, and reverse climate change from construction activities than what the industry is doing now. While much is known about the current state of the construction industry sector, the barriers faced by this industry sector in implementing sustainability is less discussed. Understanding these barriers is pivotal so that relevant solutions can be proposed to make significant progress in sustainable development. This paper addresses the gap in the literature.

The remaining sections of the paper discuss some of these barriers confronting the construction industry in implementing sustainability such as the unclear definition of

scope/boundaries, ineffectiveness of sustainability reporting tools (SRTs), slow adoption of 'green technology', and the negligence of human resource management. Recommendations to address these barriers are then proposed followed by a conclusion.

2 BARRIERS

Four key barriers have been identified in the implementation of sustainability in the construction industry. Each of these barriers are discussed in this section.

2.1 Multiple Definitions of Sustainable Construction

The term 'sustainable construction' is poorly defined in many aspects of the literature, often with ambiguous words, leading to much confusion, large inconsistencies and multiple interpretations. Discourse associated with sustainable development becomes challenging with the involvement of parties with varying backgrounds working together on a project. There is ongoing debate about what is to be sustained, at what scale (boundary conditions) and how this is to be done. Ofori (1998, p. 142) adds that due to the lack of agreed definition, there is difficulty in 'providing guidance for good practice in construction based on well accepted and understood concepts and ideas. Practitioners wishing to persist in their old ways can cite the lack of a convincing case for action.' Real estate developers involved with marketing 'green' real estate might encounter issues trying to communicate with potential clients. Publications in the area of construction via a few search engines (Google scholar; Science Direct; Scopus) reveals that there are different variations in the use of the term 'sustainable construction'. This is documented in Table 1.

Table 1. Different definitions of sustainable construction.

Authors	Journal/ Report	Definition of sustainable construction
Ortiz et al. (2009)	Construction and Building Materials	Enhancing quality of life and thus improve social, economic and environmental conditions for future generations
Edum-Fotwe and Price, (2009)	International Journal of Project Management	Meet the needs of the present and future generation without compromising our and their living standards.
Oyegoke et al.(2009)	International Journal of Procurement Management	Encompasses diverse areas covering construction process (supply chain) and business development
Kibert (1994); Bourdeau (1999)	First International Conference of CIB Task Group 16 on Sustainable Construction.	Creating a healthy built environment using resource-efficient, ecologically-based principles.

2.2 Ineffectiveness of Sustainability Reporting Tools (SRTS)

SRTs have their own unique criteria, scoring scales and different weightings which make comparability difficult (Siew *et al.* 2013a). An important question when considering the use of SRTs, however, is whether these tools are effective. Even

though, SRTs may help quantify sustainability but if what is being measured is inaccurate and imprecise, the discourse associated with sustainability issues is flawed. Siew *et al.* (2013a) reframes the debate in this area by emphasizing that the quality of measurements is just as important, raising concerns that current SRTs (see Siew *et al.* 2013a) may be flawed due to lack of scientific benchmarks, inadequate differentiation among projects, and lack of published reasoning behind the allocation of scores and weights.

2.3 Negligence of Human Resource Management to Promote Sustainability

According to Sezer (2011), one of the barriers to change management is employee's resistance to changes. Resistance determines whether attempts at making changes fail or fall short of expectations. Although there has been much emphasis on human resource management in the construction industry in the last decade, it has not been widely used as a platform to promote sustainability practices. There is hardly any evidence available in the literature which shows an attempt to leverage on HRM to promote sustainability behaviour among workers/employees. The lack of attention on HRM as a platform to promote sustainability in the construction sector is hence a challenge that needs to be addressed.

2.4 Slow Adoption of 'Green' Technology

Continuous use of a technology for a task means that the technology has been adopted by the company. In terms of accelerating the adoption of a new technology, understanding how construction companies make purchase decisions is important.

2.4.2 *Influential factors*

Figure 1 shows four main factors which affect green technology adoption: a) vendors attributes such as after sales support (Sepasgozar and Davis 2014); b) technology attributes in terms of functionality and its' effect on productivity; c) project attributes such as size and cash flow; d) organization attributes such as the adoption of green concepts and other considerations.

An interview conducted with 10 Australian based contractors reveals that they still are not confident about the capacity, functionality, and ability of green technologies compared to other similar non-green technologies. The technology cases are shown in Table 2.

In order to compare the importance of carbon emission and sustainability aspects of the technology with other factors, the interviewees were asked to evaluate a set of influential factors in the adoption decision. Results are presented in Table 3.

The comparison shows that carbon emission ranked as having the lowest importance to decision makers. The importance of the emission factor is even less important for advanced technologies. Table 3 shows that emission factor (F5) for conventional technology is more important for construction companies than advanced technologies possibly because they have more options (i.e. availability of green and

non-green technologies). Other factors apparently do not have substantial differences in importance.

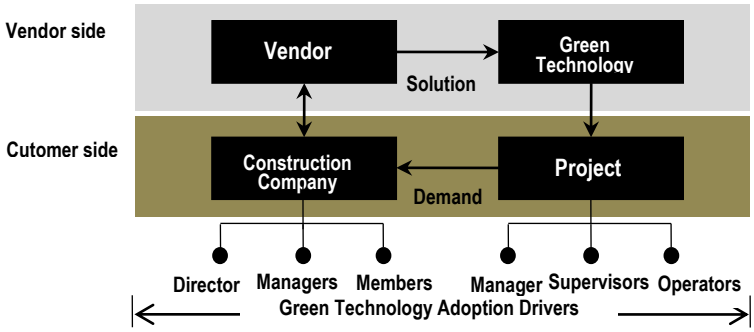

Figure 1. Classification of factors contributing green technology adoption.

Table 2. Profile of technology cases.

Technology cases	Number of cases	Number of GT[1]	Price $000s	Technology class[1]
Tunnel boring machine	2	1	15-45000	AT
Crane	2	1	750-2800	CT and AT
Concrete pump	2	1	90-1400	CT and AT
Truck	2	1	200-370	CT
Excavator	1	1	120	CT
Fronted loader	1	1	200	CT

[1]GT: green technology, AT: advanced technology; CT: Conventional technology

Table 3. Importance of key factors of technology attributes.

		% of times ranked "high"	
ID	Factors	Conventional	Advanced
F1	Ease of use	100	90
F2	Reliability	100	100
F3	Performance quality	83	100
F4	Durability	100	100
F5	Emissions (e.g. Carbon)	50	20

3 RECOMMENDATIONS

3.1 Development of a New Generation of SRTs

Given that sustainability is often related to planning for the future, a new generation of SRTs would need to be robust enough to account for uncertainty in measurements. A four-step framework is proposed to guide the development of new SRTs. The first step involves identification of the scope for sustainability evaluation. This is required as there are many phases in a construction project such as feasibility, design, construction,

operation and decommissioning. The second step involves identifying the appropriate criteria for the different phases of project. Typically, criteria are determined based on three dimensions of sustainability namely: economic, environmental and social. The third step is acknowledgement of uncertainty. There are many sources of uncertainty which need to be considered including (Uusitalo *et al.* 2015):

- Measurement error- this causes error about the value of measured quantity
- Systematic error- measurements which results from a bias in sampling
- Natural variation- as natural systems changes, so does the criteria of interest.

Despite measurements, there is always uncertainty about the natural conditions.

The fourth step is to identify appropriate methods to address sources of uncertainties. Some of the methods available include:

- Expert judgement- to obtain variance around criteria value
- Model uncertainty analysis- uncertainty analysis methods may include Monte Carlo simulation to test how output values would differ when input values are varied.

3.2 Measuring Performance

Most construction workers are often unclear about their roles and responsibilities when it comes to promoting sustainability within the construction industry sector. This is especially true given that the debate on sustainability often takes place at a global or national level. Much of the discussion revolves around policy making with little consideration for the role of individuals. One way of addressing this is to start measuring the contribution of workers towards sustainability outcomes in the construction industry. This can either take the form of key performance indicators (KPIs) or by measuring sustainability competencies.

3.3 Memorandum of Understanding

The proliferation of SRTs across different countries and the unclear use of the term ‘sustainable construction’ by various parties have made comparability difficult. Having a streamlined guidebook for terminology and standards would assist in benchmarking projects internationally. Perhaps the International Council for Research and Innovation in Building and Construction (CIB) could facilitate a memorandum of understanding to align SRTs and common terminology when it comes to discussing about sustainability in the construction industry sector.

4 CONCLUSIONS

There is no doubt that the construction industry plays a vital role in facilitating economic growth. Yet, despite its impact, the construction industry makes slow progress in achieving sustainability. This paper discusses the four key barriers towards the implementation of sustainable construction. These barriers include multiple

definitions of the term 'sustainable construction', the ineffectiveness of sustainability reporting tools (SRTs), slow adoption of 'green' technology, and the negligence of human resource management. Construction practitioners, academics and regulators may find the discussion on these barriers useful to focus their future efforts in the implementation of sustainable construction.

References

Bourdeau, L., Sustainable development and the future of construction: a comparison of visions from various countries, *Building Research and Information*, 27(6), 354-366, 1999.

Chong, W. K., Kumar, S., Haas, C., Beheiry, S., Cophen, L., and Oey, M., Understanding and interpreting baseline perceptions of sustainability in construction among civil engineers in the United States, *Journal of Management in Engineering*, 25(3), 143-154, 2009.

Edum-Fotwe, F. T., and Price, A. D. F., A social ontology for appraising sustainability of construction projects and developments, *International Journal of Project Management*, 27(4), 313-322, 2009.

Kibert, C. J., "Establishing principles and a model for sustainable construction" in *First international conference of CIB TG 16 on sustainable construction*, Tampa, Florida, 6–9 November, 1994.

Lingard, H., and Rowlinson, S., Behaviour-based safety management in Hong Kong's construction industry, *Journal of Safety Research*, 28(4), 243-256, 1997.

McKnight, B., Wood, M., and Bansal, T., "Sustainability trends in the construction and real estate industries", viewed on 12 May 2014, <http://www.ivey.uwo.ca/cmsmedia/183294/Construction_and_Real_Estate.pdf>

Ortiz, O., Castells, F., and Sonnemann, G., "Sustainability in the construction industry: A review of recent developments based on LCA", *Construction and Building Materials*, Vol. 23, No. 1, pp. 28-39, 2009.

Oyegoke, A. S., McDermott,P., and Abbott, C., Achieving sustainability in construction through the specialist task organisation procurement approach, *International Journal of Procurement Management*, 2(3), 288-313, 2009.

Selin, C., Trust and the illusive force of scenarios, *Futures*, 38(1), 1-14, 2006.

Sepasgozar, S. M., and Davis, S. R. "*Pioneers, Followers and Interaction Networks in New Technology Adoption*.", 28th Australian and New Zealand Academy of Management Conference, Australia, Sydney, 3 - 5 December 2014.

Sepasgozar, S. M. E., and Davis S., "*Diffusion Pattern Recognition of Technology Vendors in Construction*." Construction Research Congress 2014: 2106-2115, 2014.

Sezer, A. A., "Effects of rewards and reward systems on changes in safety", Master's Thesis, Chalmers University of Technology, Göteborg, Sweden, 2011.

Siew, R. Y. J. and al-Kilidar, H., An exploratory study of HRM: configurations and practices across publicly-listed Australian and Malaysian construction companies, *International Journal of Knowledge, Culture and Management*, 10(1), 385-402, 2010.

Siew, R. Y. J., Balatbat, M. C. A., and Carmichael, D. G., "A review of building/infrastructure sustainability reporting tools (SRTs)", Vol. 2, No. 2, pp. 106-139, 2013.

Siew, R. Y. J., Balatbat, M. C. A., and Carmichael, D. G., "The relationship between sustainability practices and financial performance of construction companies", Vol. 2, No. 1, pp. 6-27, 2013.

University of Southampton, 2008, "Sustainable construction", viewed on 13 March 2014, http://www.southampton.ac.uk/susdev/documents/sustainable_construction.pdf.

Uusitalo, L., Lehikoinen, A., Helle, I. and Myrberg, K., An overview of methods to evaluate uncertainty of deterministic models in decision support, *Environmental Modelling and Software*, Vol. 63, 24-31, 2015.