

A review of sustainability in construction and its dimensions

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Abstract

Sustainability is becoming an increasingly important topic for construction research. It is a multi-dimensional topic involving social, economic, and environmental aspects. Sustainable construction generally refers to the application of the principles of sustainable development in the construction industry. Its definitions, interpretations and priorities will be largely dependent on the context of study. Despite the many claims to benefits that sustainable construction can bring, sustainability still seems not mainstreamed in the construction industry. Focusing on context of the UK construction industry, this paper provides an overview on the subject of sustainable construction and introduces some key knowledge gaps around the issues of conceptualisation, linkages to project life cycle, linkages to project management, implementation mechanisms and tools, and construction procurement. It is hoped that if the gaps are filled, there might be a better chance for sustainability to gain its due place in construction. Through a synthesis of the relevant literature, the paper reviews the criteria representing the social, the economic and the environmental dimensions of sustainable construction. Further research suggests the use of the Delphi Technique as a means of developing a common understanding and consensus among experts regarding sustainability criteria that public clients should address in developing a procurement strategy.

Keywords: sustainable construction, review, social, economic, environmental

1. Introduction

Sustainable development has gained an increasing importance in the construction industry. The application of its principles in this industry is generally described as sustainable construction. With the increasing recognition of the importance of the concept, huge number of definitions have emerged. One of the most common definitions of sustainable development is the one introduced by The World Commission on Environment and Development [1] “*Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present*

without compromising the ability of future generations to meet their own needs". Focusing on the UK context, this paper provides an overview on the subject of sustainable construction, explores some of the knowledge gaps related to the subject, and presents the criteria underpinning the social, the economic and the environmental dimensions of sustainable construction. Further research is suggested to obtain a consensus regarding sustainability criteria that should be addressed by public clients in developing procurement strategy.

2. Sustainable construction – an overview

In general, sustainable construction is about the application of sustainable development in the construction industry. Raynsford provides a detailed definition for sustainable construction [2] *"Sustainable construction is the set of processes by which a profitable and competitive industry delivers built assets (buildings, structures, supporting infrastructure and their immediate surroundings) which*

§ *enhance quality of life and offer customer satisfaction*

§ *offer flexibility and the potential to cater for user changes in the future*

§ *provide and support desirable natural and social environments*

§ *maximize the efficient use of resources."*

The definition offered by Raynsford puts emphasis on both the process and the product and introduces some aspects of social, economic and environmental sustainability. However, the definition does not fully capture all the aspects implied by the term. A more comprehensive definition is offered by Constructing Excellence [3] which introduces sustainable construction as the application of sustainable development in the construction industry and suggests that sustainable development is *"all about ensuring a better quality of life for everyone, now and for generations to come, through:*

§ *social progress which recognises the needs of everyone*

§ *maintenance of high and stable levels of economic growth and employment, whilst*

§ *protecting, and if possible enhancing, the environment, and*

§ *using natural resources prudently*

Sustainable development embraces the three broad themes of environmental, social and economic accountability, often known as the 'triple bottom line'." [3]

Regardless of the context, sustainable construction always integrates different dimensions, including social, economic and environmental dimensions. However, the interpretation and the

priorities of sustainable construction could be largely dependent on the context as the needs and the conditions of the developed countries are widely different from those of the developing world [4]. For example, the principles highlighted by Gibberd [5] have been developed to support sustainable construction in developing countries and in particular South Africa. Another example could be found in the comment offered by Ofori [6] on the paper of Hill and Bowen [7]. Ofori argued that the paper of Hill and Bowen was written to reflect, at large, the point of view of developed countries in spite of mentioning some issues that were relevant to the context of South Africa. Realizing the differences between developed and developing countries, CIB and other organizations published “Agenda 21 for Sustainable Construction in Developing Countries” [8]. According to this Agenda, such differences are related to the problems and their scale, development priorities, capacity of local industry and government, skill levels in addition to cultural and world view issues which influence the understanding and implementation of sustainable development and construction.

However, it seems that there is a lack of awareness about sustainable construction in both the developed and the developing worlds. In the Netherlands, for example, a survey which was carried out in 1998 showed that quarter of architects and half of the building contractors did not know what sustainable construction was [9]. In the US, Landman showed that lack of training and education in sustainable design/construction was one of the primary barriers to more widespread sustainable building practices [10]. Watuka and Aligula, in their study of sustainable construction practices in the Kenyan construction industry, reported that sixty four percent of the respondents on a questionnaire administered to Architects, Engineers, Quantity Surveyors and Contractors indicated lack of awareness about sustainable construction practices [11].

In the context of the UK, promoting awareness and understanding of sustainable construction was declared as one of the objectives of the UK strategy for more sustainable construction [12]. Although awareness within the construction professions and trades was increasing, it was not enough [13]. The need to raise awareness of sustainable development throughout the industry was also highlighted by the publication “Society, Sustainability and Civil Engineering” [14]. Lack of awareness might be attributed to lack of clear conceptualisation of sustainability, lack of clear case for sustainability benefits, lack of integration of sustainability issues in education and training programmes, the traditional perception that limits the understanding of sustainability within the environmental dimension, the dominance of economic drivers in the performance of businesses at the expense of social and economic issues, and lack of long term perspective.

But lack of awareness is not the only barrier to achieving sustainability, which still seems far from reach in an industry considered as “inherently defensive” for change [15]. There is evidence that the construction industry is falling behind other sectors in its attitude towards sustainability [16]. The progress in the field has been hindered by many barriers, such as the

industry's fragmented nature, lack of long term perspective, clients' unwillingness to share burden, lack of clear concept definition of sustainable construction and its benefits, regulatory constraints and inconsistent government policy, and lack of fiscal incentives [16, 17, 18].

3. Some knowledge gaps

3.1 Conceptualisation

Some of the recently published material in the literature perceives sustainability as an environmental problem. Consequently, the balance that needs to be created between the environmental dimension and other sustainability dimensions is not adequately acknowledged. There is also a noticeable lack of consensus on the issues underpinning sustainability and its dimensions. Hill and Bowen and Ofori point out that sustainability principles are still poorly defined and argue that these principles are subject to much confusion and disagreement [6, 7]. Ofori [6] argue that this could even be extended to the frequently quoted definition of sustainable development offered by The World Commission on Environment and Development. Lack of understanding and fuzziness of the concept present one of the barriers to the implementation of sustainable construction [17]. Further work, therefore, is still needed to better conceptualise sustainable construction.

3.2 Linking to the project life cycle

Sustainable construction could be better understood if it is aligned to the different phases of the project life cycle. From an implementation point of view, it would be more appropriate to provide such alignment [19]. Among the efforts that addressed sustainability within phases of the project life cycle are: Kibert [20], where the different project phases were integrated within a model for sustainable construction; the publication "Sustainability Accounting in the Construction Industry" [21], where a sustainability accounting plan considered the different phases of the project; Ashworth and Langston [22], where whole of life assessment was linked to the measurement of sustainability. However, there still seems lack of understanding regarding how the principles underpinning the different dimensions of sustainability could fit within the different phases of the project life cycle and what impact this issue could have on the different activities carried out within these phases.

3.3 Linking to project management

Project management could provide a suitable framework to implement sustainable construction, and project managers, through their leading role in the project, could be in an ideal position to promote it [19]. However, there is little evidence that sufficient research has been carried out to

establish clear linkages between sustainable construction and project management. An examination of a summary of the UK Association of Project Management's Body of Knowledge [23] would indicate that sustainability does not feature as one of the key topics in that body. It is important to mention here that some of the topics addressed there – such as safety, health and environment; and value management are closely related to sustainability. Yet, they do not provide sufficient coverage of all the issues underpinning it. One of the few attempts to link sustainability to project management was carried out by Uher who developed a project management model for achieving sustainable construction and presented the need to integrate sustainable construction into the traditional project delivery strategy, which is constrained by time, cost and quality objectives [19]. The model developed by Uher focused only on the conceptual stage of the project life cycle. Further work linking sustainability and project management and considering the different phases in the project life cycle is still needed.

3.4 Implementation Mechanisms and Tools

A significant part of the literature discussed the principles of sustainability without sufficient consideration of how they could be implemented, an issue that was also raised by Uher [19]. More work is needed to identify implementation mechanisms and tools and to identify how sustainability could be integrated in the decision making process.

Sustainability has different dimensions and criteria which might be in conflict sometimes. An assessment of sustainability needs to take into account the different criteria underpinning it. This could lead to the use of multi-criteria decision making techniques for assessment. Such techniques were used for solving problems in construction management [24] and selecting construction procurement strategy [25]. In some cases, multi-criteria decision making was used with sustainability provided the basis for choosing criteria for decision making, as in developing SWARD [26]. There is potential to use such techniques to make informed decisions that consider sustainability criteria in problems such as selection of contractor or choice of procurement system [4].

3.5 Sustainability and Procurement

The need for introducing sustainability principles to construction procurement has been increasingly acknowledged. Some publications have addressed many useful issues in the context of sustainability and procurement e.g. the Sustainability Action Plan [27] and Addis and Talbot [28]. However, there still seems a need for further research within that area. For example, the framework developed in the Sustainability Action Plan [27] is based on 10 themes for action. Although these themes provide many useful sustainability principles in general, they do not embrace other principles mentioned in the literature, such as those presented in Tables 1, 2, 3. A more comprehensive and up to date list of the criteria representing sustainable construction that should be addressed is therefore needed. In addition, there is a need to examine

procurement systems and strategies in terms of the extent of addressing the objectives of sustainability dimensions. Further research regarding the actions through which sustainability can be better addressed in developing procurement strategies and the barriers facing such actions is still needed. The gap was further discussed in Sourani and Sohail [4].

4. Dimensions of sustainable construction

Despite the variance between the different definitions of sustainability, there is a wide acceptance that sustainable development integrates, at least, three dimensions: social, economic and environmental. Some publications in the literature have mentioned other dimensions of sustainability such as technical sustainability [7, 26], cultural sustainability [6, 15], community sustainability [6] and managerial sustainability [6]. However, in the context of the UK construction industry, the concept of the triple bottom line, which focuses on social, economic and environmental sustainability, remains dominant. Some of criteria underpinning such dimensions are presented below. However, they are rather general guidelines to explore the areas of focus within these dimensions. More effort is still needed to reach a common understanding of the issues representing these dimensions, highlighting the relevance of such issues to the different parties, linking them to the project life cycle and defining how they can be addressed within this cycle. Further research is suggested below to contribute to the effort needed to achieve these targets.

Table 1: Criteria representing the social dimension of sustainable construction

Social sustainability criteria	Sources
Protecting and promoting human health through a healthy and safe working environment	[7, 17, 26, 27, 29]
Participation of stakeholders – including community involvement	[15, 17, 26, 27, 28, 30]
Improving the quality of human life including poverty alleviation	[7, 15, 31]
Making provision for social self determination/enhancement	[7, 15]
Training and development – including implementing skills training and capacity enhancement of disadvantaged people	[7, 12, 29]
Seeking fair or equitable distribution of the social costs and benefits of construction – including equal opportunities among different ethnic and social groups	[7, 31]
Seeking intergenerational equity and reducing cost for future generations	[7, 31]
Diversity - including making provision for cultural diversity in development planning	[7, 17, 29, 31]
Social inclusion	[15, 26, 28]
Improving image/reputation	[12, 29]
Employment – including equal employment opportunities	[12, 17, 30]
Recruitment and retention	[27, 29]
Equality	[15, 27, 29, 31]
Accessibility	[12, 28, 30]
Work in occupied premises	[17, 29, 32]
Working environment	[18, 27, 29, 32]
Security – including minimising crime	[17, 28, 30]
Satisfaction – including workforce satisfaction and user satisfaction.	[17, 18, 27, 28, 29]

Table 2: Criteria representing the economic dimension of sustainable construction

Economic sustainability criteria	Sources
Financial affordability for intended beneficiaries	[7, 26]
Maintaining high and stable levels of economic growth	[3, 12]
Using life cycle costing	[18, 26, 30, 32]
Creating and maintaining high and stable levels of employment	[3, 7, 12, 28, 31]
Support of local economies	[15, 18]
Investment – including investing some of the proceeds of non-renewable resources to meet the needs of future generations. Investment in green products and in the use of renewable resources.	[7, 31]
Use of Key Performance Indicators (KPIs)	[18, 32]
DQI - Functionality and Flexibility	[18, 30]
Viability	[18, 28]
Profitability	[2, 12, 17]
Competitiveness	[2, 12, 7, 17]
Productivity	[17, 18]
Value for money	[17, 18, 30]

Table 3: Criteria representing the environmental dimension of sustainable construction

Environmental sustainability criteria	Sources
Conserve energy	[7, 12, 17, 18, 28, 30, 31]
Conserve water	[7, 12, 17, 18, 28, 30]
Conserve land	[7, 12, 17, 18, 28, 30]
Conserve materials – reuse and recycling	[7, 12, 17, 18, 28, 30, 31]
Resource utilisation	[7, 26, 28, 30]
Consider renewable energy	[7, 17, 18, 30]
Minimise pollution – water, land and air pollution (including noise) – at global and local levels	[7, 12, 17, 18, 28, 30]
Preserve and enhance bio-diversity	[7, 12, 17, 18, 30]
Creating a healthy, non-toxic environment – including high indoor air quality	[7, 18, 20, 30, 31]
Protect and enhance sensitive landscapes including scenic, cultural, historical and architectural	[7, 17, 18, 28, 30]
Re-use existing built assets	[12, 18, 30]
Waste minimisation and management	[7, 12, 17, 18, 28, 30, 31]
Environmental Impact (process and product)	[18, 26, 30, 32]
Transport – including provision of public transport	[18, 30]
Visual impact	[17, 28]

5. Further research

Further research will focus on developing a common understanding of the criteria representing the social, the economic and the environmental dimensions of sustainable construction that public clients should address in developing procurement strategy. This will contribute to overcoming some of the knowledge gaps outlined above in terms of consensus and conceptualisation, linking to procurement as one of the stages in the project life cycle, and linking the to public clients as one of the parties concerned. The Delphi Technique will be used to confirm and evaluate criteria obtained from the literature review and the experts' responses and to derive a consensus, among sustainability experts, regarding the most important criteria

6. Conclusion

Sustainable construction describes the application of sustainable development in the construction industry. As the needs and the conditions of the developed countries are widely different from those of the developing world, the interpretation and the priorities of sustainable construction could be largely dependent on the context. However, regardless of the context, sustainable construction always integrates different dimensions, including social, economic and environmental dimensions. The progress in the field has been hindered by many barriers such as the industry's fragmented nature, lack of long term perspective, clients' unwillingness to share burden and lack of awareness, which seems to be problematic in both the developed and the developing worlds. The paper explored some of the knowledge gaps related to the subject including conceptualisation, linkages to project life cycle, linkages to project management, implementation mechanisms and tools, and construction procurement. It reviewed the criteria underpinning the social, the economic and the environmental dimensions of sustainable construction through a synthesis of the relevant literature. More effort is still needed to reach a common understanding of the criteria, to highlight the relevance of the criteria to the different parties, to link them to the project life cycle, and to identify how they can be addressed within this cycle. Finally, to contribute to achieving such targets, the use of the Delphi technique is suggested to obtain a consensus among experts regarding sustainability criteria that should be addressed by public clients in developing a procurement strategy.

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