

## The Use of Knowledge Management Approach in Delivering Sustainable Retrofitted Building Projects: A Conceptual Decision Support System for Key Stakeholders

Nnamdi Maduka<sup>a</sup>, Doctor Chika Udejaja<sup>b</sup> and Professor David Greenwood<sup>c</sup>

<sup>a</sup>\*Doctoral Student, Northumbria University, Faculty of Engineering and Environment, Department of Mechanical and Construction, Northumbria University, Newcastle upon Tyne, NE1 8ST, United Kingdom, nnamdi.maduka@northumbria.ac.uk

<sup>b</sup>\*Senior Lecturer, Northumbria University, Faculty of Engineering and Environment, Department of Mechanical and Construction, Northumbria University, Newcastle upon Tyne, NE1 8ST, United Kingdom, chika.udeaja@northumbria.ac.uk

<sup>c</sup>\*Professor of Construction Management, Northumbria University, Faculty of Engineering and Environment, Department of Mechanical and Construction, Northumbria University, Newcastle upon Tyne, NE1 8ST, United Kingdom, david.greenwood@northumbria.ac.uk

### Abstract

The growing interest and awareness of sustainable development in the last decade has been remarkable. The construction industry has taken the centre stage in driving sustainable development through sustainable construction due to its impacts in the society. It has been argued that 80% target reduction of greenhouse gas emissions in the United Kingdom (UK) by 2050 can be realised if the industry recognises the need for sustainable retrofitted building projects. It has been revealed that there is a possibility for substantial reduction of greenhouse gas emissions in the environment through sustainable retrofitted building projects. However, the challenges of delivering sustainable retrofitted building projects are enormous and complex in the industry particularly with key stakeholders' lack of managing project knowledge in making informed and appropriate decisions. This can improve if the industry recognises the need of a knowledge system that will enable key stakeholders to make informed decisions in the delivery of sustainable retrofitted building projects. This paper presents a conceptual framework that would assist key stakeholders in managing project knowledge in making an informed decision towards delivering of sustainable retrofitted building projects. This was achieved through the review of literatures. The conceptual framework recognises the need to understand the social, economic and environmental issues and aspects of sustainability in delivering sustainable retrofitted building projects. It also considers some decision components such as of measurement such as problem identification determine the objective; identification; knowledge learning procedures for key stakeholders; knowledge maps; sustainability assessments; identify and compare alternatives; estimating of weights; evaluation of choice in making an informed decision. The framework was formulated through critical literature review in consideration of some existing decision support frameworks.

Keywords: Sustainability, managing knowledge, climate change, key stakeholders, sustainable retrofitted building project, decision support.

### 1. Introduction

It has been documented that a lot of research has been undertaken into sustainable development as it relates to sustainable construction and a number of decision tools developed for sustainable construction (Poch *et al.*, 2004, Du Plessis, 2007, Udejaja *et al.*, 2008, Blackwood *et al.*, 2014) . However, this paper justifies and reports on the application of making an informed decision for sustainable retrofitted building projects. This framework was formulated through a critical review of relevant literatures that investigated on decision support tool; sustainable development concepts; current practices in sustainable construction; the barriers and drivers of delivering sustainable retrofitted building projects; aspects of managing project knowledge. The components of the conceptual framework which include; identification of the problem, determining the objectives; knowledge learning procedures for Key Stakeholders; Knowledge maps; sustainability assessment, identification of alternatives to be compared, estimation of weight of alternatives, evaluation of choice of alternatives hence making an informed decision. These components will be further elaborated, described for clearer understanding of the decision process. This paper is an ongoing doctoral research which aims is to develop a decision support system prototype for delivering sustainable retrofitted building projects.

## 2. Theoretical Underpinnings

Climate change consequences around the world has become widespread with significant increase in global temperature and extreme weather conditions (Stern, 2006, IPCC, 2007, Nelson *et al.*, 2010, Stolarski *et al.*, 2010). The United Kingdom (UK) government and other governments worldwide are taking actions to fight climate change and remedy its adverse effects (Sayce *et al.*, 2007, Pitt *et al.*, 2009). The construction industry has been identified to be one of the major contributors of greenhouse gas (GHG) emissions given that it consumes a large amount of energy (Low *et al.*, 2014). It has been documented that the building sector is responsible for 40 per cent of energy consumption and one-third of all GHG emissions worldwide (UNEP, 2009). In the UK it is estimated that buildings consume over 45% of UK energy usage and generate approximately 50% of GHG emissions (Stern, 2006, Boardman, 2007). These figures are evidence to how significantly building can impact on energy consumption and its substantial negative effects in our environment. The consequences of GHG emissions have made the demand for sustainable construction inevitable. This has made the call for sustainable retrofitted building projects a necessity. It has been argued that sustainable construction particularly on building retrofits is one of the most effective ways or strategies to achieving sustainable development (Stafford *et al.*, 2012, McManus *et al.*, 2013). It is widespread that the need for sustainable retrofitted buildings particularly in the UK is essential (Ma *et al.*, 2012, Booth and Choudhary, 2013, Owen *et al.*, 2014, Dixon *et al.*, 2014). It has been revealed that the retrofit market is not only large, but provides the perfect opportunity to improve the energy performance of the buildings (Boardman, 2012). One other major reason for the demand for sustainable retrofitted building projects is because of the UK government's ambitious target of 80 per cent reduction in greenhouse gas emission by 2050 (DCLG, 2008, Boardman, 2012). If this ambition is to be achieved, it is evident that embarking on sustainable retrofitted building projects is unavoidable because an estimated 70% of buildings existing today in the UK will still be in use or standing by 2050 (Kapsalaki *et al.*, 2012). Sustainable retrofitted building has been defined as an improvement made to an existing building that leads to an increase in the overall efficiency of the building (SMA, 2011, Fulton *et al.*, 2012). BCA (2010) also defines sustainable retrofitted building as the 'the provision, extension or substantial alteration of the building envelope and building services in an existing building in order to reduce CO<sub>2</sub> emissions'. It has been revealed that embarking on this projects can contribute greatly to tackling climate change and fostering the concepts (economic, social and environment) of sustainability (WBCS, 2008). Additionally, delivering sustainable retrofitted building projects have been acknowledged to have tremendous economic, health, social and environmental benefits (Dong *et al.*, 2005, Verbeeck and Hens, 2005, USEPA, 2010, Syal *et al.*, 2014).

However, notwithstanding that the aforementioned benefits of delivering sustainable retrofitted building projects are well established and documented yet

delivering the projects has faced a lot challenges and obstacles particularly with key stakeholders lack of managing project knowledge in making an appropriate and informed decision (Duah *et al.*, 2014). Decision making can have negative effects if not appropriately made due to its possible negative impacts on building performance and stakeholders' satisfaction (British Retail Consortium, 2012, IEA, 2012). These existing challenges in the industry points to the fact that KM is a necessity in attaining sustainable construction (Shellbourn *et al.*, 2006, Shari and Soebarto, 2012) particularly in sustainable retrofitted building projects. The need to manage knowledge in delivering a these projects is vital in order to have an improved understanding of key knowledge issues in the built environment and to improve on key stakeholders' understanding of varied technologies in achieving sustainable construction (Yudelso, 2009). Eliufoo (2008) argued that sustainable buildings can be achieved if construction activities are informed by new resources of knowledge and expertise. The identification of key stakeholders' need can assist in making informed choices by providing answers to their questions, requirements and satisfaction (Newcombe, 2003, Olander and Landin, 2008, Yang *et al.*, 2009, Macharis and Turcksin, 2012, De Brucker *et al.*, 2013). Therefore, the need for a well-managed project knowledge representation presented in a good format that could help key stakeholders in making appropriate decision in delivering sustainable retrofit projects has been emphasised and suggested (Duah *et al.*, 2014). Furthermore, it is essential to explore knowledge management principles to develop a decision support system to enhance key stakeholder's decision capabilities in having the required knowledge to make informed decisions as it regard the issues surrounding retrofitted building projects (Pan and Dainty, 2012).

## 3. Conceptual DSS Framework for Key Stakeholders

It has been revealed that the demand for systematic and effective evaluation tool for the selection of sustainable technologies that would assist stakeholders in making informed sustainable decisions have been suggested (Pan and Dainty, 2012, Davoudpour *et al.*, 2012). The need for stakeholders in the built environment to adopt implementation strategies that promote and support sustainable decisions through knowledge-based decision criteria has been documented (Pan and Dainty, 2012). Reddy and Painully (2004); (Wang *et al.*, 2009); Pan and Dainty (2012); Dangana and Pan (2013) argue that one of the main problems of achieving sustainable construction is due to the nature of the multifaceted decision making tasks of choosing sustainable technologies from different range of options with stakeholder needs. Factors like lack of skills, uncertainties, higher cost, risks, multi-disciplinary profession with conflicting interests and huge number of different technological options have complicated the decision making process for stakeholders (Reddy and Painully, 2004, Dainty and Ison, 2005, Wang *et al.*, 2009, Buchholz *et al.*, 2012). These factors have influenced

stakeholders into tried and tested sustainable decisions instead of assisting in making informed choices. It has also contributed to reinventing the wheel always in the industry.

However, different studies have developed methodologies/framework to support management of key stakeholders in construction projects. For example, Bourne and Walker (2005) developed a framework for visualising and mapping stakeholder influence in the construction industry, Yang *et al.* (2009) developed a framework which explore critical factors for stakeholder management in construction projects, Bourne (2011) developed stakeholder circle methodology to identify and prioritise the influences of the project stakeholders and Isaacs *et al.* (2013); Blackwood *et al.* (2014) developed SAVE framework for knowledge integrated approach based on assessment, visualisation and enhancement. Pan and Dainty (2012) developed a systematic approach for the UK house building organisations to identify value based decision criteria and quantified their relative importance for accessing building technologies systematically. These research studies have dealt on

stakeholder management in the construction industry, but they have not developed a Decision Support System (DSS) that would assist key stakeholders in making an informed decision for delivering of sustainable retrofitted building projects. Therefore, there is a great need for a tool to assist decision makers in the industry to systematically select sustainable technology which addresses different issues in order to obtain a holistic decision output (Wang *et al.*, 2009). DSS when developed is to assist stakeholders to classify available information, consider the consequences and minimise the possibility of decision dissatisfaction or mistakes. The use of sustainable technology decision tool can significantly reduce or eliminate the negative impact of buildings on the environment and as well achieve key stakeholders' satisfaction in the long term (Yudelson, 2009). However, a conceptual DSS framework has been formulated and this is illustrated in Figure 1. This conceptual framework will be needful for collection of empirical data that will result to development of a decision support prototype.

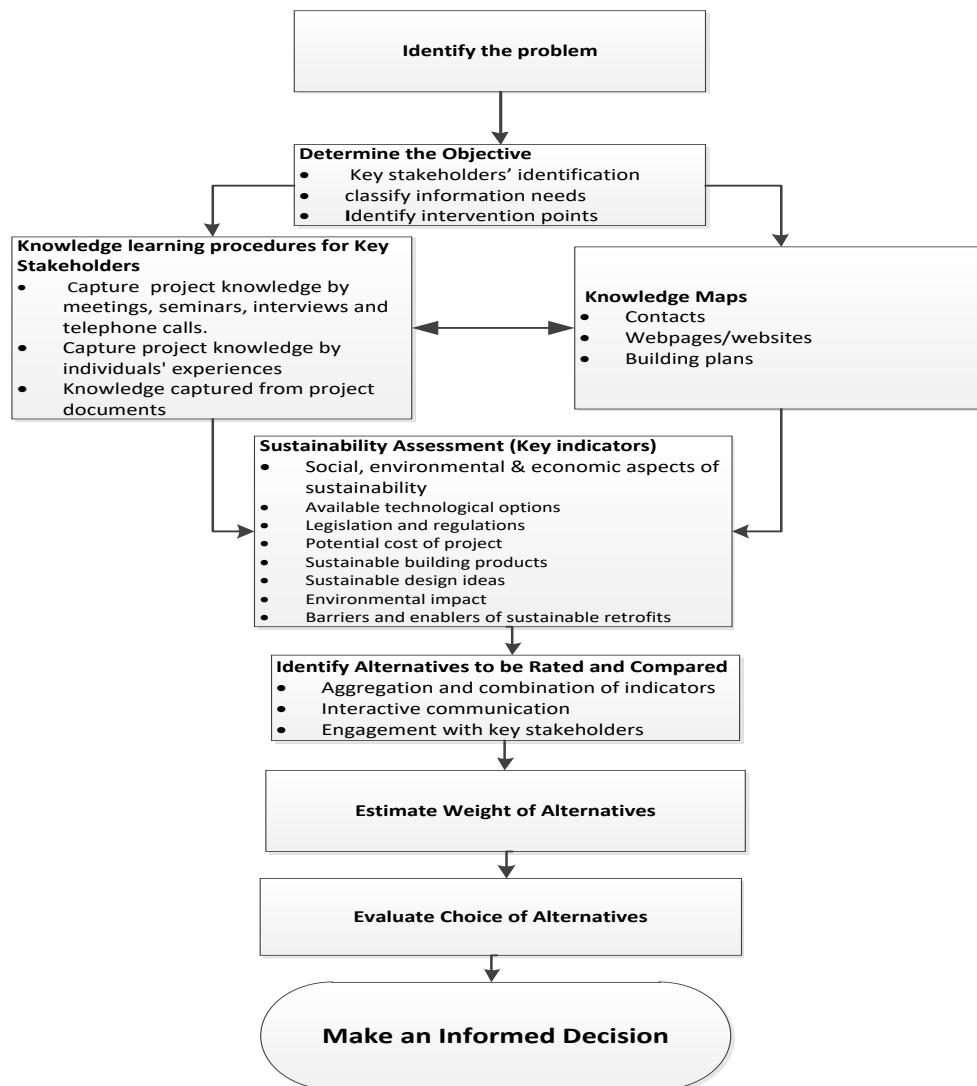


Figure 1: Conceptual Decision Support System Framework

### 3.1. Identification of the problem

Building evaluations usually starts from identification of a problem then formulating attributes, objectives and goals (Van Pelt, 1993, RICS, 2001). The problem is structured to provide adequate specification of objectives so that attributes can be identified (Akadiri, 2011). The problem with the key stakeholders in decision making has been identified to be due to lack of managing project knowledge in delivering sustainable retrofitted building project. The key stakeholders in the sustainable retrofitted building projects include; the client; government; design engineers (architects, electrical and mechanical engineers), civil engineers, the builders, project managers, producers and suppliers of sustainable building projects.

### 3.2. Determine the objectives

The key stakeholder's objectives in the project have to be determined. Key stakeholders and their information needs will be identified using a set of procedures, developed by authors, including those drawn from information-technology and knowledge management fields (Blackwood, *et al.*, 2004, Butler *et al.*, 2003, Gilmour and Blackwood, 2006). The literature works of (Baldwin *et al.*, 1999, Gilmour *et al.*, 2005, Which and Carr, 2001) were used to identify the key stakeholders involved in the project and their means of interaction and classify their information needs and intervention points (Blackwood *et al.*, 2014). Each of the identified key stakeholders will be involved in the information flow documents such as: knowledge capture in reports; phone calls; meeting minutes; documentary data analysis; individual experience and these will be examined by the key stakeholder's to understand the use of relevant information in making informed decision in delivering retrofitted building projects.

### 3.3. Knowledge Learning Procedure for Key Stakeholders

Knowledge has been described as the product of learning, which is personal to an individual or organisation (Orange *et al.*, 1999). Patel *et al.* (2000) argue that knowledge is a body of information, coupled with understanding and reasoning. It has also been stated that there is no single repository for project knowledge in the industry (Udeaja *et al.*, 2008) hence the need to capture project knowledge during construction activities. The key stakeholders will capture knowledge in the learning procedures (Udeaja *et al.*, 2008) to enable an informed decision. The learning procedure will contain information relating to the 'project knowledge' (Udeaja *et al.*, 2008, Blackwood *et al.*, 2014) but this process will focus on knowledge that can enable or assist key stakeholders in making an informed and appropriate decision. The knowledge learning procedure as aforementioned to be an information flow includes captured knowledge during meetings, phone calls, interviews, seminars, individual experience, and documentary analysis. The information will be reviewed by the key stakeholders and its use discussed. Hence the key decision points where information was used to support a decision will be identified and established.

### 3.4. Knowledge Maps

Wilcox (2008) argues that knowledge map has been identified to be one of the most effective processes in managing project knowledge in making an informed decision. Knowledge maps such as contacts, web pages and building plans related to the projects will be considered by the key stakeholders to assist them in managing the required projects knowledge for appropriate decision making. After the consideration of the knowledge maps then the need to review sustainable assessments is necessary for informed decisions.

### 3.5. Sustainability Assessment

This sustainability assessment is a key indicator that would help inform and manage knowledge before appropriate decisions are made. It will avail the key stakeholders the opportunity to avoid decision dissatisfaction. In delivering sustainable retrofitted building project, it is necessary to incorporate and manage the information that is necessary in order help identify key decision points before making an informed decision.

### 3.6. Identify Alternatives to Be Rated and Compared

This stage is to identify alternatives and compare them. This step has been argued to be based on the decision project components and structure (Van Pelt, 1993). There is no limit to number of alternatives, but policy makers have suggested that to facilitate decision making process the number of alternatives should not be more than seven in order avoid confusion (Van Pelt, 1993, Akadiri, 2011). The list of alternatives concerns the aggregation of the identified components already discussed in this paper and also, interactive communication and engagement with the key stakeholders.

### 3.7. Estimate Weight of Alternatives

Having identified and aggregated alternatives, it is important and instructive that it is weighted to avoid decision mistakes. Akadiri (2011) argued that in any list of items that some items may be more important than the others. In this aspect the knowledge gathered through some of the components discussed will enable the key stakeholders to consider and facilitate the most appropriate decisions in delivering sustainable retrofitted building projects. Additionally, the need to consider the three aspects of sustainability in weighing decision alternatives or options which incorporate social, economic and environmental at this stage is necessary.

### 3.8. Evaluate Choice of Alternatives and Make an Informed Decision

The need to evaluate choice of alternatives has been suggested (Bharati and Chaudhury, 2004). The evaluation of choice of alternative has been argued to help in facilitating appropriate decision making and also help in decision satisfaction (Akadiri, 2011). The key stakeholders as the decision makers will evaluate the information provided in the system. Some studies have

considered quality of information and steps provided in a DSS as an integral part of user decision satisfaction, effectiveness and confidence (Bailey and Pearson, 1983, Bharati and Chaudhury, 2004, Iivari, 1987). The evaluation of alternatives provided in the system precedes an informed decision.

#### 4. Discussion and Conclusion

It has been acknowledged and documented that sustainable retrofitting process remains a very complex process in the industry (Pitt *et al.*, 2009). Considering some of the challenges slowing the delivery of sustainable retrofitted building projects particularly lack of managing project knowledge, it is clear that knowledge management has been neglected in sustainable construction (Shellbourn *et al.*, 2006, Pietrosemoli and Monroy, 2013). This has pushed the key stakeholders in industry to keep reinventing the wheel in new projects because they do not acknowledge the need to capture and reuse of project knowledge in the past and present project life styles (Egan, 1998). It is demonstrated in this paper and revealed that the role of Knowledge Management (KM) in the industry remains a potential advantage and solution in delivering sustainable retrofitted building projects if adopted fully in the industry (Shellbourn *et al.*, 2006, Pietrosemoli and Monroy, 2013).

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This paper has presented a proposed DSS conceptual framework which addresses a key knowledge issue in making informed and appropriate decisions in delivering sustainable retrofitted building project which hitherto had not been adequately addressed in the industry. This was due to the absence of knowledge based decision support system in delivering sustainable retrofitted building projects. The developed conceptual DSS framework also addresses the increased issue of key stakeholders' lack of managing project knowledge which has resulted to lack of informed decision making in delivering retrofitted building project. However, having reviewed the literatures to formulate a DSS conceptual framework, it is imperative to state that good knowledge management strategy aimed at elucidating knowledge in making an informed decision in delivering sustainable retrofitted projects is a priority in for the industry. The need to incorporate knowledge steps in technological options as regards to delivering of projects in the industry is important and should be encouraged in order to achieve informed decisions which in turn will facilitate the uptake of more retrofitted building projects which will result in reduction of greenhouse gas house emission in the UK especially with the UK target by 2050.

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