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The Use of Exploratory Research in Addressing Knowledge Issues in Delivering Sustainable Retrofitted Building Projects.

Nnamdi Maduka[1], Chika Udeaja[2] and David Greenwood[3]

1Doctoral Student, Department of Mechanical and Construction, Northumbria University, Newcastle upon Tyne, NE1 8ST, United Kingdom

2Senior Lecturer, Department of Mechanical and Construction, Northumbria University, Newcastle upon Tyne, NE1 8ST, United Kingdom

3Professor of Construction Management, Department of Mechanical and Construction, Northumbria University, Newcastle upon Tyne, NE1 8ST, United Kingdom

Emails:nnamdi.maduka@northumbria.ac.uk;chika.udeaja@northumbria.ac.uk; david.greenwood@northumbria.ac.uk

This paper describes a proposed strategy of exploring the role of knowledge management (KM) in delivering retrofitted building projects. This is based on an on-going PhD project whose primary objective is to develop a decision support system (DSS) for the key stakeholders in sustainable building retrofits. A brief review of sustainable construction and knowledge management and its application in construction were discussed. The ways in which knowledge is managed in retrofitted building projects is then examined to provide the basis of a conceptual approach for reflecting both organisational and human dimensions. Qualitative approach adopted in this study is to help the researcher gain full understanding of the knowledge issues in sustainable construction. The choice of case study as the research strategy is necessary in order to understand the dynamics and contemporary phenomenon present in the industry as regards to sustainable retrofitted building projects. The case study involves the use of semi-structured interviews and documentary evidence and these will help in capturing relevant project knowledge that will be useful in delivering the research aim(s) and objectives and also answering the research questions. The case study process will build on the literature works; investigates on the current practices in sustainable construction; the barriers in the uptake of sustainable retrofitted building projects; what knowledge means to an individual stakeholders in delivering sustainable retrofitted building projects and the role of knowledge management in making appropriate sustainable choices in sustainable retrofitted building projects. The research design employed five steps that will be applied in collection of data. The collected data would be analysed and the outcome will be a modelling of sustainable building process for retrofits hence the development of a decision support system (DSS) prototype through managing of project knowledge. The testing of the prototype will ensure its refinement to fit for purpose.

Keywords: Qualitative approach, research strategy, sustainable construction, sustainable retrofits, knowledge management, key stakeholders, decision making.

Theoretical and Conceptual Underpinnings

The global attention given to climate change that led to the clamour for sustainable development in the 21st century is a laudable development. Efforts of different governments world-wide geared towards mitigating the climate change effects have been widespread and documented (European Commission, 2007, Kapsalaki *et al*., 2012, McManus *et al*., 2013). The need to reduce and mitigate climate change effects was propelled by the Brundtland's report 'Our Common Future' which charged national and international bodies to promote the course of sustainable development through three sustainability

concepts; environmental, economic and social in order to reduce climate change (WCED, 1987). The report further described sustainable development as the development that meets the need of the present generation without undermining the ability of the future generations to meet their own needs (Brundtland, 1987). In a related view, the IPPC Fourth Assessment Report reaffirmed that climate change which is predominantly caused by human activities is inevitable due to increase of greenhouse gas emission (e.g. CO_2) in the atmosphere (IPCC, 2007). These have put the United Kingdom (UK) under a commitment to champion the concepts of sustainable development in the built environment particularly the construction industry due to its impacts in the society (McManus *et al.*, 2013).

The impacts of construction due to its activities has significant positive and negative effects in the UK and the entire globe (Pietrosemoli and Monroy, 2013). Some of the positive impacts includes: contribution of about 7% to the UK Gross Domestic Product (GDP) or about £110 billion in annual income; job creation: producing of different types of building and facilities to meet human needs (ICRIBC, 2002, Winch, 2010, Pietrosemoli and Monroy, 2013). The negative impacts of construction are well documented for its contribution to greenhouse gas emissions, which has impacted on climate change effect (Stern, 2006, IPCC, 2007, Weight and Rawlinson, 2007, Levin, 2008, Stolarski *et al*., 2010). Furthermore, the built environment worldwide contributes about 30 to 40 per cent of CO_2 emission to the atmosphere and as well consume about 40% of the total energy usage (Boardman, 2007, Dixit *et* al., 2010, Kapsalaki *et al.*, 2012). European Union (EU) estimates that the European countries contribute about 50% of CO_2 to the atmosphere (Rai *et* al., 2011). In the United Kingdom (UK), it is established that buildings consume over 45% of UK energy usage and generate approximately 50% of greenhouse gas (GHG) emissions (Stern, 2006). These negative impacts have made the industry come under public; regulators' and government scrutiny more than ever before and have necessitated the industry to increasingly recognise the need to achieve sustainable development by engaging in sustainable construction (Zuo *et al*., 2012). Sustainable construction has been argued to be the application of sustainable development concepts and principles to construction processes and practices (Sage, 1998, Carpenter, 2001, ICRIBC, 2002, Shellbourn *et al*., 2006, European Commission, 2007, Winch, 2010). Sustainable construction in building projects exists in new build and retrofitted building projects. New build involves demolition and construction of an energy efficient building while retrofitted involves sustainable refurbishment of an existing building to deliver an energy efficient building. The government has stated that by 2016 every new building must be energy efficient or built on a carbon neutral basis and non-domestic buildings must be constructed on a neutral carbon basis from 2018 (Kelly, 2009).

However, it has been argued that 80% target reduction of greenhouse gas emission in the atmosphere by 2050 can be achieved in the UK if the industry recognises the need for sustainable retrofitted building projects (Glass *et al*., 2008, Kelly, 2009, Pietrosemoli and Monroy, 2013). This is because only about one-third or 30% of new energy efficient buildings would have been constructed in response to the target and this cannot contribute significantly to GHG reduction by 2050 (Glass *et al*., 2008). This is due to the fact that about two-third or 70% of buildings existing today in the UK will still be standing and in use by 2050 (Glass *et al.*, 2008, Kapsalaki *et al*., 2012). In view of this, it is evident that engaging in sustainable retrofitting of existing buildings is inevitable and will contribute substantially in greenhouse gas reduction by 2050 (Glass *et al.*, 2008, Lockwood, 2008, Kelly, 2009, Jenkins, 2010, McManus *et al*., 2013, Stevenson, 2013).

Nevertheless, delivering a sustainable retrofitted building project remains a challenge in the industry due to lack of managing knowledge in sustainable construction projects. It has been argued that there is a possibility for substantial carbon emission reduction through appropriate approaches to sustainable retrofit, however, achieving it presents a multifaceted and difficult problem to the industry due to lack

of knowledge management (KM) (Stafford *et al*., 2012, McManus *et al*., 2013). Shellbourn *et al*. (2006);Shari and Soebarto (2012) argued that the slow uptake experienced in delivering sustainable retrofitted building projects is due to the fact that the industry has failed to realise the importance of managing knowledge in construction activities. Shellbourn *et al*. (2006) argued that to attain the goals of sustainable development via sustainable construction, it is essential to realise the need for managing knowledge to be properly adopted in the industry. This can be improved if the industry recognises the need to capture and reuse project knowledge in sustainable construction in order to avoid reinventing the wheel. The need for managing knowledge in the process of delivering a sustainable retrofitted building is vital in order to have an improved understanding of sustainable issues in the built environment and to enhance key stakeholders' understanding of the existing wide-range of technologies in appropriate decision making (Yudelson, 2009). Eliufoo (2008) reiterated that sustainable retrofitted buildings can be realized if construction activities are informed by new resources of knowledge and expertise.

Furthermore, to attain the required energy performance level in existing buildings, it is imperative to explore knowledge issues that will facilitate decision making process for primary stakeholders in achieving sustainable construction. This has necessitated the demand for an effective knowledge evaluation tool for the selection of sustainable technologies that would assist stakeholders in making informed sustainable choices (Pan and Dainty, 2012, Davoudpour *et al*., 2012). Consequently, there is a need to explore KM to develop a decision support system to enhance key stakeholder's decision capabilities in having the required knowledge to make informed decisions as regards to delivering retrofitted building projects has been suggested (Pan and Dainty, 2012).

Choice of Research Approach

A research approach can be classified as quantitative and qualitative or a combination of the both which is called the triangulation (Fellows, 2008, Silverman, 2010, Neuman, 2011, Bryman, 2012). Quantitative research is concerned with explaining a phenomenon by collecting numerical data that is analysed using mathematical methods such as statistics (Aliaga and Gunderson, 2006). Qualitative research is designed to explore the human elements of a given topic, where specific methods are used to examine how individuals see and experience the world (Given, 2008). Triangulation approach is the combination of both quantitative and qualitative research approaches (Bryman, 2012). It is essential to be aware of the methodological philosophies and paradigms or debates that exist in order to understand the reason for the choice of research method. The paradigm of choice depends on the nature of the research (Dainty, 2008, Saunders *et al*., 2012). The need to be clear with the appropriate research method used in any research has been suggested (Wilson, 2014). Having considered the nature of the research which deals with key stakeholders in the industry the research adopted qualitative research method. The reason for adopting qualitative research approach is because the researcher has to gain full understanding of the current practices due to the nature of the research which deals with key stakeholders and knowledge issues in delivering sustainable retrofitted building projects. Fellows and Liu (2003);McKie (2002) argue that qualitative method remains the most relevant because it will enable the researcher to gain understanding of the knowledge issues in order to collect relevant information and data such that theories will emerge. Dainty (2008); Sutrisna (2009); Bryman (2012) argue that qualitative research is the best used in the generation of theory and also where the research takes the position of knowing the natural reality of things as they exist. Furthermore, qualitative methods have been considered capable of studying complex situation and yielding rich findings and particularly suitable when involving human subject finding (Sutrisna and Barret, 2007). The research will explore in-depth the barriers and drivers in delivering sustainable retrofits; what knowledge means to individual key stakeholders; the need for managing knowledge in delivering projects in the industry especially in

sustainable retrofits, explore on the decision support systems available in the industry and how it has been of relevance to achieving sustainable construction.

Proposed Research Strategy

In order to achieve the research objectives, the following research activities will be undertaken in order to capture and present relevant knowledge and these are presented in five stages as discussed below in accordance with the research design as illustrated in Figure 1.

Stage One: Literature Review

An extensive review of literatures on Sustainability and Sustainable construction has been undertaken using published sources (journals, books, reports and online publications) and this delivered Objective 1. Through this review, many themes emerged which became the basis that assisted the researcher to develop theoretical framework for this research. The theoretical framework contributed in identifying theories essential to the research and also, identified the gaps in existing knowledge in sustainability and sustainable construction. This contributed to the development of sections and chapters of the review hence become the basis of the specific research investigation. Additionally, the review assisted the researcher to gain full insight of the research problem thereby establishing the status quo of sustainability, sustainable construction and its drivers and barriers and best practices in the industry.

To deliver Objective 2, an extensive literature review will be conducted to explore the role of managing knowledge in making appropriate decisions in sustainable retrofitted building projects. It is necessary to explore knowledge management (KM) to underpin the need to inculcate it into sustainable construction especially in retrofitted building projects. Due to the challenging nature of delivering sustainable retrofitted building projects the review will discuss some existing kinds of knowledge such as tacit and explicit knowledge in order to understand their relevance in expediting project delivery. This review will also be explored to ascertain the importance of managing knowledge in the area of knowledge creation; capture; reuse; sharing; collaboration and knowledge identification and representation in sustainable construction especially in sustainable retrofitted building projects.

Furthermore, this stage will involve the review of the existing decision support systems (DSS) models, frameworks and tools which will be useful in identifying gaps in knowledge as it regards to stakeholder management predominantly in sustainable retrofitted building projects. It will also assist the researcher to have a clear picture of the kind/type of prototype to be considered for development. The completion of this literature investigation will be useful in delivering relevant interview questions that will be pursued during data collection through case studies.

Case Studies:

Case studies approach will be used to collect data and this will build on the literature works that has been conducted. This strategy seeks to answer ‘why’ ‘how’ and ‘what’ in relation to issues behind reality of research investigations (Calzadilla *et al*., 2012). It is argued that the use of case studies is considered appropriate since ‘depth of insight’ will be more appropriate to the development of a strategy that reflects the opinions of individuals and key stakeholders (Petty *et al*., 2012). It has also been argued that case studies focuses on understanding of the dynamics present in the industry as regards to sustainable construction (Amaratunga *et al.*, 2002). Furthermore, Yin (2009) argues that it is an empirical investigation into contemporary phenomenon operating in a real-life context. This will help to identify the current practices in sustainable construction in the industry as it relates to sustainable retrofitted building projects. The case studies will be implemented using analysis of documentary evidence and semi-structured interviews with key stakeholders from the case organisations. The need for documentary review is due to the possibility of providing valuable information that may not be

accessible by other means and also it can generate ideas for questions that can be pursued through interviews (Petty *et al*., 2012). Scott (1990); (Berger, 1991); Bryman (2001) argued that the use of documentary evidence is essential in order for the researcher to extract the relevant information that can be deemed as statement of facts to validate individual's research objectives. The documentary evidence can be captured in the form of public records; the media; official gazettes; minutes of the meetings; reports and blue prints; visual documents. This will help the research to identify what knowledge means to the individual stakeholders and key stakeholders which will lead to the categorisation of the different knowledge that exist in sustainable construction particularly in retrofitted building projects. However, the choice of semi-structured interview is valued for its accommodation to a range of research goals, typically reflects variations in its use of questions, prompts and accompanying resources to draw the participant more fully into the topic under study (Galletta, 2013). It is also argued to have a pre-determined set of questions or issues that will be explored in-depth during the interview in order to capture project knowledge. This approach helps the interviewer/researcher the opportunity to pursue the interview in greater depths with flexibility while the interview remains conversational (interactive) (Wilson, 2014). This will enable the research to ensure that same information is obtained from different number of participants hence enabling logical gaps in the collected data to be closed easily (Longhurst, 2009).

Furthermore, the idea of using both semi-structured interviews and documentary evidence is because knowledge in organisations can exist as both tacit or explicit knowledge (Nonaka *et al*., 1996). Smith (2001) further explained that explicit knowledge deals with an academic document or 'know-what' that is described in a formal language often based on established work process documented by individuals. Describing tacit knowledge the author revealed that it to be an existing practical, action-oriented or 'know how' based on practice, acquired by individual experience rarely expressed openly.

Stage Three: Map and Model Sustainable Building Process

In this stage Objective 4 will be achieved and this will involve mapping and modelling sustainable building process. This will be delivered using data collected from case studies and literature reviews to synchronise results using qualitative result inferences. The mapping will be delivered in a way of illustrating knowledge that will inform primary stakeholders in making appropriate decision for sustainable building projects. The mapping and modelling of sustainable building process will also assist in the development of the DSS prototype.

Stage Four: Development of the Prototype

To develop the prototype, the researcher will integrate results and this will be achieved by making use of the mapped and modelled sustainable building processes and literature that has been reviewed. This will assist to determine the prototype layout. Furthermore, an approach which incorporates necessary tools and technologies (e.g. search engines, sustainable technology options, decision variables etc.) will be adapted to contribute in developing the prototype that will elucidate knowledge to assist primary stakeholders in making enhanced decision towards delivering sustainable retrofitted building projects. This will deliver Objective 5 hence the testing of the prototype.

Stage 5: Prototype Testing

The testing exercise will deliver objective 6. This will involve testing of the developed prototype with primary stakeholders and industry professionals. The potential types of testing to be considered in this research to validate the prototype include;

System Integrated Testing (SIT): this testing method will be used to test the prototype components and detect interface defects. It also involves a high-level software testing process in which testers verify that all related systems maintain data integrity and can operate in coordination with other systems in the construction industry. This testing ensures that all sub-components are integrated successfully to provide anticipated results and after this testing the prototype undergoes user acceptance testing (Binder, 1999).

Modular Testing: the prototype will undergo an assessment to ensure the operational functionality based on individual components. This testing is to ascertain the reliability of the final product given (Frankl *et al*., 1998). This procedure will be used so that statically valid inferences may be drawn about the overall system from the result of the component test.

User Acceptance Testing (UAT): this test is usually put in view or considered before prototype development begins so as to enable the developer have a better and clearer idea of the system to develop (Goethem and Pauline, 2013) and this was reviewed in Section 1.4.1 where existing decision support tools were to be reviewed. The testing of the prototype components will be done by the developer, industry professionals, focus groups and key stakeholders to determine if it is fit for purpose. It has been argued that this test usually measures whether the system has satisfied the acceptance criteria of the stakeholders in the industry (Black, 2009, Goethem and Pauline, 2013).

The outcome of the tests will assist to enhance the ability of the researcher to present a refined, useful and more acceptable DSS to fit for purpose. The benefits of the DSS prototype and its limitations will be considered for future research development and this will contribute to recommendations that would be generated.

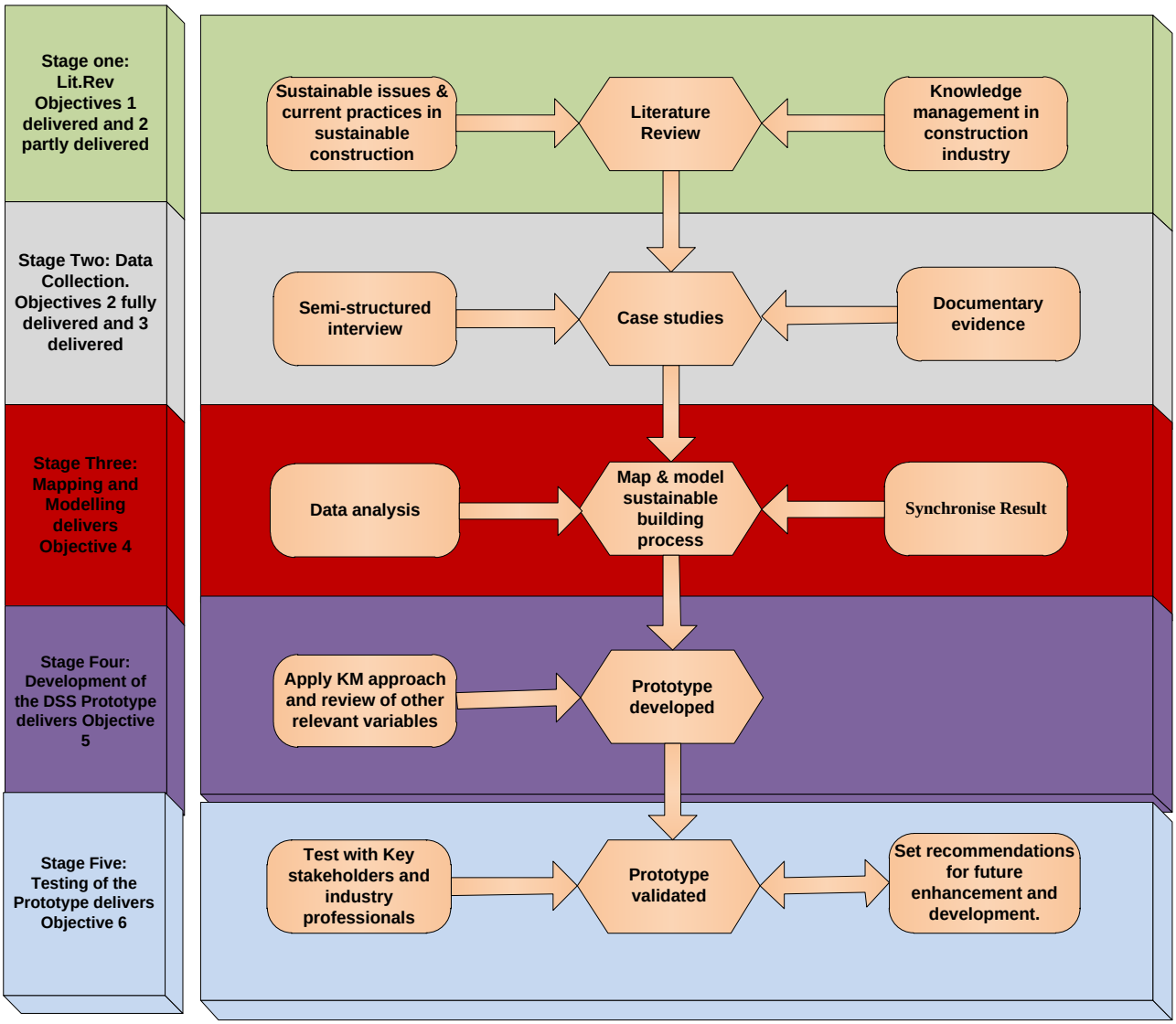

Figure 1 Research design

Conclusion:

Qualitative research approach has been considered capable of studying complex situations, specifically when human beings are involved hence yielding rich findings. This has resulted in the increase of its popularity, particularly in the built environment (Sutrisna, 2009). This paper has demonstrated the need for the adoption of qualitative research approach and strategy in this study. The adoption has been considered appropriate because it is capable of generating great in-depth of data that would be relevant when analysed for the delivering of the research aim(s) and objectives and also answer research questions. The discussion in this paper has provided an insight on the stages that would be employed and applied to collection of data. It has also demonstrated on how the empirical evidence (collected data) will be analysed and presented to elicit knowledge towards delivering retrofitted building projects in the UK. The outcome of the empirical evidence would be realised in mapping and modelling of sustainable building process which will help the key stakeholders in managing project knowledge. The key contribution of the research which involves the development of DSS prototype has been revealed to be essential to the key stakeholders in the industry in order to help them make informed decisions in delivering of sustainable retrofitted building projects in the UK. The testing of the prototype is necessary to ascertain its fit for purpose for the industry and also provide opportunity for refinement and acceptance of the DSS.

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