The Uptake and Implementation of Sustainable Construction: Transforming Policy into Practice

by

Sachie Gunatilake

A thesis submitted in partial fulfilment for the requirements for the degree of Doctor of Philosophy at the University of Central Lancashire.

February 2013

University of Central Lancashire

Student Declaration

I declare that while registered as a candidate for the research degree, I have not been a registered candidate or enrolled student for another award of the University or other academic or professional institution.

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School **: School of Built and Natural Environment**

ABSTRACT

There is a continuously growing interest on 'Sustainable Construction (SC)' both within the UK and globally. In the UK, a myriad of policies and guidance have been published in this regard by various government offices, departments and other industry related institutions. However, similar to sustainable development, SC is without an agreed upon definition. There is lack of agreement on the interpretation of SC, both within the industry and in academic literature. Further evidence point at a gap between the technological abilities of the construction industry and what is actually achieved in terms of SC. Therefore, it appears that the problem may lie with the understanding of and the effective implementation of SC at project level. The aim of this research therefore, was to understand the interpretations of SC and to develop a framework that can assist in its effective uptake and implementation within construction project environments.

A more qualitative research approach was used to achieve the aforementioned aim. An analysis of 18 advisory documents (chosen using criterion sampling) was carried out using qualitative content analysis to ascertain how SC was interpreted in these documents. Case study methodology and the principles of grounded theory analysis were used in order to allow for an understanding on the interpretation of and the process of implementing SC to emerge at project level. Three case studies were selected and semi-structured interviews were conducted with representatives from four different stakeholder groups (i.e. client, contractor, design team and facilities management) within each case.

Through the advisory document analysis, a view of SC at strategic level was developed comprising of 15 characteristics and 80 objectives of SC. The study found that there was a strong focus on the environmental element of SC within the advisory documents. At the construction project level, there was a tendency to focus upon the issues that are capable of bringing in tangible, 'quick-wins' in terms of cost savings.

The proposed framework for uptake and implementation of SC within a construction project environment consists of four main sections. The first section addresses the contextual considerations in developing SC agendas for construction projects. The second section provides a comprehensive view of the nature and objectives of SC. This provides the basis upon which SC objectives can be set for a particular construction project. The third and fourth sections of the framework address the implementation of SC at project level. The actions for SC implementation are presented within the third section divided into four lifecycle phases. The internal and external influence factors affecting the said process are presented within the fourth section of the framework. The developed framework also highlighted the need for feedback at two levels (i.e. within the construction project level and from project level to strategic level).

The findings of the research emphasise the need for streamlining the development of advisory documents on SC and increasing the level of comparability between the existing advisory documents. Further attention should also be given towards providing more conceptual understanding on SC, especially for those project team members, who do not possess specific educational backgrounds or experience in addressing SC. At project level, there is a need to consider SC as an integral part of the construction process itself rather than something superfluous or extra that has been necessitated through mandatory legislations. The project level SC objectives should align with the national and sector level policies and guidance on SC. However, the ultimate applicability of these SC objectives for projects should be decided taking into consideration the specific requirements of each project.

The study was limited to PPP/PFI projects in the healthcare sector. Hence, opportunities for further investigation exist by expanding the number of case studies to widen the scope of the research; for example by including projects in other sectors and using other types of procurement. The outcomes of the research can be used by the project level stakeholders, particularly clients, in adopting pro-active approaches in the uptake and implementation of SC within construction project environments.

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ACKNOWLEDGMENT

First and foremost, I would like to thank my Director of Studies Dr. Champika Liyanage for her guidance, support, patience and encouragement throughout the course of my PhD. She has been the best advisor I could have hoped for and her work ethic and professionalism has been an inspiration. I am also grateful to her for encouraging and supporting me to start my PhD here.

I would also like to thank my co-supervisors Prof. Joe Howe and Prof. Akintola Akintoye. They have provided direction when needed and their experience and insight have been invaluable to the research process. I would like to further extend my gratitude to all the interview participants for taking time out from their busy schedules to share their views and experiences.

A further thank you goes out to my friends in room KM002 for creating a happy and stimulating research room. A special thank you goes out to Ms. Nalika Rajapaksha, who has been like a big sister to me, Mr. Jonathan Cooper, for his assistance with printing and Dr. Celine Germond-Duret and Dr. Basil Germond for their informal input, guidance and friendship during these past three years. I would also like to thank the academic and support staff in the School of Built and Natural Environment for all their assistance in a variety of ways. I am also grateful to all my friends in the UK and back home in Sri Lanka, who have been supportive and helpful during this period.

Last but definitely not the least, I owe a special thank you to my dear parents, Mr. Wijitha Gunatilake and Mrs. Ramani Samarakone. If not for their love, support and sacrifices along the way, I would not be where I am today. I would also like to thank my wonderful little brother, Harinda, for the support, encouragement and laughs throughout the years.

ABBREVIATIONS

BERR:	Department for Business Enterprise and Regulatory Reform
BIS:	Department for Business Innovation and Skills
BRE:	Building Research Establishment
BREEAM:	Building Research Establishment Environmental Assessment Method
CAQDAS:	Computer-Assisted Qualitative Data Analysis Software
CEEQUAL:	Civil Engineering Environmental Quality Assessment and Award Scheme
CERT:	Carbon Emissions Reduction Target
CIB:	Conseil International du Bâtiment (International Council for Research and Innovation in Building and Construction)
CIC:	Construction Industry Council
CIEF:	Construction Industry Environmental Forum
CII:	Construction Industry Institute
CIPS:	The Chartered Institute of Purchasing and Supply
CIRIA:	Construction Industry Research and Information Association
CO_2:	Carbon Dioxide
CPA:	Construction Products Association
CPD:	Continuous Professional Development
DECC:	Department of Energy and Climate Change
DEFRA:	Department for Environment, Food and Rural Affairs
DETR:	Department of the Environment, Transport and the Regions (before reorganisation in 2001)
DoH:	Department of Health
EF:	External Factor
EU:	European Union
EU ETS:	European Union Emissions Trading System
FM:	Facilities Management
GDP:	Gross Domestic Product
GHG:	Green House Gases
HBN:	Health Building Notes
HTM:	Hospital Technical Memoranda

ICE:	Institution of Civil Engineers
IF:	Internal Factor
IISD:	International Institute for Sustainable Development
IPCC:	Inter-governmental Panel on Climate Change
JCT:	Joint Contracts Tribunal
NAO:	National Audit Office
NEAT:	NHS Environmental Assessment Tool
NHS:	National Health Service
ODPM:	Office of the Deputy Prime Minister
OGC:	Office of Government Commerce
OJEU:	Official Journal of the European Union
PCT:	Primary Care Trust
PFI:	Private Finance Initiative
PPP:	Public Private Partnership
QCA:	Qualitative Content Analysis
RIBA:	Royal Institute of British Architects
RICS:	Royal Institution of Chartered Surveyors
SC:	Sustainable Construction
SD:	Sustainable Development
UK:	United Kingdom
UNCED:	United Nations Conference on Environment and Development
UNCHE:	United Nations Conference on Human Environment
UNEP:	United Nations Environment Programme
UNFCCC:	United Nations Framework Convention on Climate Change
USA:	United States of America
VFM:	Value for Money
VM:	Value Management
WCED:	World Commission on Environment and Development
WSSD:	World Summit on Sustainable Development
WRAP:	Waste and Resources Action Programme

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The need to incorporate Sustainable Development (SD) principles within the construction sector practices has been increasingly acknowledged during the past few decades, both at the academic research and the national policy development levels. Herein, the term ‘Sustainable Construction (SC)’ refers to the responsibility of the construction industry in attaining SD. For several years, SC has been a popular policy issue with various government departments and other non-governmental institutions directly involved in the construction industry in the UK. This has led to the development of a vast number of policies and other advisory documents aimed at providing guidance for the industry stakeholders on the uptake and implementation of SC. The UK government’s ‘Strategy for Sustainable Construction’ (HM Government, 2008) for example, has been developed recognising the need for radical changes necessary towards SC. In addition to this, a myriad of other policies, guidance, reports, etc, have been published on SC by various government offices/departments and numerous industry related institutions (such as, Building Research Establishment - BRE) intending to guide the construction industry in achieving SC goals.

Construction Products Association (2007) states that the UK and EU legislations, UK, EU and international product standards and government policies are amongst the drivers of SC in the UK. An industry consultation carried out by the Joint Contracts Tribunal (JCT) has revealed that a majority of the respondents (i.e. 84%) felt that SC performance of the industry could be improved by industry specific documentation (JCT, 2009). However, other parties such as, GVA (2011), Innovation and Growth Team (2010) and UK Green Building Council (2009) have observed that the sheer number of documents available is actually a barrier for implementing SC at project level. Indeed, as Carter and Fortune (2008) point out, the delivery of SC at construction project level in the UK is founded upon ‘a quickly evolving environment, with constantly changing legislation, guidance and policy’. Compounding the issue is the fact that the development of these documents has taken a scattergun approach with the policy responsibility for SC in the UK being shared by several different government departments. The uncoordinated nature between these various policies and regulations has made the uptake and implementation of these at project level often confusing and inefficient (UK Green Building Council, 2009). The range of different advisory documents available, as well as the rate of change of developments being made, has led the Innovation and Growth Team (consisting of members from both the construction industry and the government) in its spring 2010 report to note that,

> *'the plethora of policies, reports and initiatives undertaken by a variety of government departments or by NGOs or other special interest groups... are incapable of absorption by businesses who need to focus... on the more immediate interests of their clients and shareholders'* (Innovation and Growth Team - IGT, 2010)

Similar observations have been made by GVA (2011) and UK Green Building Council (2009) as well.

Despite the availability of numerous advisory documents, SC is thus far without a comprehensive, generally accepted definition (Cooper, 2006; Du Plessis, 2007; Hill and Bowen, 1997; Ofori, 1998). An international project had been carried out by the CIB Working Commission W082 to compare the visions and perceptions of SC in different countries. The project revealed a wide range of views and interpretations of SC in developed, transition and developing countries (see Bourdeau, 1999). The Pearce report (Pearce, 2003), therefore, has argued that before the construction industry can proceed towards contributing to SD, it needs to adopt a more holistic definition for SC.

Whilst the construction industry is fundamentally linked to efforts to achieve SD targets, the changes and improvements in the industry practices that are needed to realise this are not happening fast enough (GVA, 2011). Reviews of SC activity within England have found that only a small proportion of buildings can claim to be sustainable in any way (Halliday, 2008). Therefore, despite the availability of numerous policies and guidance, the impact they seem to have appear low (Innovation and Growth Team - IGT, 2010; Walker and Brammer, 2009). This could be attributed to several reasons such as, the lack of understanding or poor interpretation of these policies and guidance by stakeholders at project level (Cox et al., 2002), the lack of integration in decision making systems, poor linkages between policy and on-the ground realities and a narrow base of participation (Du Plessis, 2007).

Considering the attention towards developing advisory documents and the lack of a generally accepted definition, at the very outset, a research need arises to establish how SC is interpreted in the various advisory documents and by those involved in its actual delivery at project level. Even if the perceptions of the stakeholders are found to be similar to what is stated in the advisory documents, not adopting a clear, robust process for implementing SC at construction project level could leave the whole effort fruitless. Given the nature of the concept, implementation of SC requires decision processes that are integrated across various project level interfaces demarcated by different phases of a construction project. However, achieving this has proved to be a very challenging task due to a number of factors such as, fragmented nature and complexity of the construction sector (Myers, 2005), the multi-dimensional nature of SC, the lack of a structured methodology and the lack of information at various hierarchical levels (Ugwu and Haupt, 2007). There is further evidence that even the commercially available and proven technologies that could deliver SC (such as, smart designs, improved insulation, low energy appliances, and high efficiency ventilation) are under-utilised. Cheng et al. (2008) for example, have found that utilising these commercially available and proven technologies to their full potential can result in lowering the industry’s energy usage by an estimated 30-50% without causing any significant increase in investment costs.

Therefore, it appears that the problem may lie with the management processes associated with the implementation of SC rather than the technological capabilities of the industry. Rydin and Vandergert (2006) in ‘Sustainable construction: a social science research agenda’ have identified understanding the decision-making processes and actors, as well as the inter-relationships between them in addressing SC, as a key, yet poorly explored area for social science research. In light of the above discussions, two research needs can be identified, in relation to the practice of SC within the UK construction industry. Firstly, given the lack of a uniform understanding, there is a need to explore how SC is interpreted within the industry. Secondly, there is a need to explore how these interpretations are transformed into practice through project level implementation. This research therefore, tackles these two issues of ‘uptake’ (i.e. interpretation) and implementation of SC. As a result, the research is unique in scrutinising the above issues through both the strategic level and construction project level perspectives.

1.2 RESEARCH QUESTIONS, AIMS AND OBJECTIVES

The research aim, objectives and questions have been developed to address the above identified gaps in literature. The aim of this research is to understand the interpretation of SC and to develop a framework that can assist in its effective uptake and implementation within construction project environments.

The above stated aim was accomplished by achieving six (06) objectives. These objectives were as follows;

i. To review the concept of SD and its impact and application within the construction industry (i.e. SC).

ii. To develop a conceptual framework to illustrate the concept of SC and its implementation within a construction project environment.

iii. To analyse and report on how the concept of SC is set out in government policies and other advisory documents.

iv. To ascertain and report on the perceptions of construction project stakeholders regarding the concept of SC.

v. To analyse and detail the actions and influence factors in implementing SC within a construction project environment.

vi. To refine and validate the framework for uptake and implementation of SC in light of the findings from objectives (i) to (v) above.

The research questions lay out the specific queries that are to be addressed under the above mentioned objectives of the research. These research questions, which are given in Table 1.1 below, help set the boundaries of the research study and determine the methods to be used in data collection and analysis (Corbin and Strauss, 2008).

Table 1.1: Research Objectives and Research Questions

Research Objectives	**Research questions**
(i) To review the concept of SD and its impact and application within the construction industry (i.e. SC).	
(ii) To develop a conceptual framework to illustrate the concept of SC and its implementation within a construction project environment.	RQ1: Is there a need for a framework to address the uptake and implementation of SC within a construction project environment?
(iii) To analyse and report on how the concept of SC is set out in government policies and other advisory documents.	RQ2: What are the different advisory documents available addressing SC? RQ3: How is SC interpreted in these different advisory documents produced for the industry?
(iv) To ascertain and report on the perceptions of construction project stakeholders regarding the concept of SC.	RQ4: How do the actors involved in implementing SC at construction project level understand the concept of SC?
(v) To analyse and detail the actions and influence factors in implementing SC within a construction project environment.	RQ5: How is SC addressed and implemented at construction project level? RQ6: What factors influence the decisions made in implementing SC at project level?
(vi) To refine and validate the framework for uptake and implementation of SC in light of the findings from objectives (i) to (v) above.	

1.2.1 Research programme

The research programme comprised of four stages as shown in Figure 1.1 below. Each of these research stages and the research approaches adopted to address the objectives of each stage are further explained in Chapter 4. The research outputs from each stage are discussed in the remaining chapters.

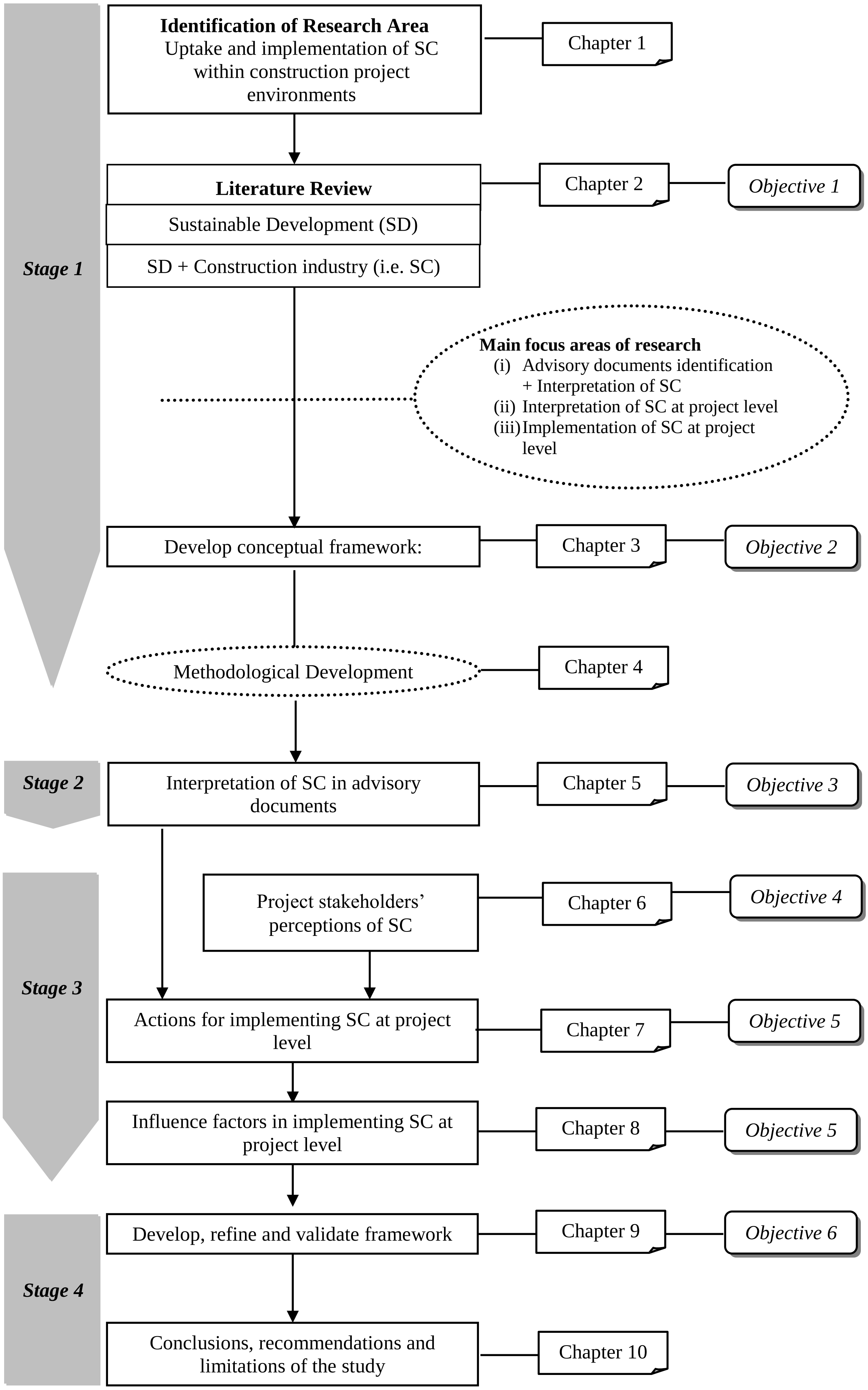


Figure 1.1: Research flow and outputs

1.3 SCOPE AND LIMITATIONS OF THE STUDY

As previously mentioned, there have been a large number of advisory documents produced to provide guidance for the construction industry stakeholders on the uptake and implementation of SC practices. Out of these, 18 advisory documents were chosen using criterion sampling for in-depth analysis during stage 2 of this research. The rationale for selecting these 18 documents is given in section 4.7.

Furthermore, during the case study stage, three cases were selected from Public Private Partnerships (PPP)/ Private Finance Initiatives (PFI) projects in the healthcare sector. The focus on PPP/PFI projects was mainly due to the promotion of this type of procurement by the government and the academia alike, for their enhanced capabilities to incorporate sustainability requirements (refer to section 4.8.2.3). Particular attention on the healthcare sector was due to the high proportion of PPP/PFI projects that are being undertaken and the domination of a single public sector provider within this sector (refer to section 4.8.2.4). Furthermore, there is a high level of attention from the NHS to incorporate SD into its practices, however, relatively less attention has been given to incorporating SD principles to the procurement of the NHS built environment.

1.4 CONTRIBUTION TO KNOWLEDGE AND ORIGINALITY

There has been an increased level of focus on the application of SD principles to the activities of the construction industry, particularly within the last two decades. However, a large portion of research in this area has focused on providing technological solutions to the issue. This research on the other hand focuses on the non-technological, managerial issues in the uptake and implementation of SC. The research resulted in several important outputs contributing to furthering the existing body of knowledge.

Firstly, the research developed a comprehensive view of strategic direction for SC within England. At strategic level, the concept of SC is characterised by 15 attributes (or characteristics) and 80 objectives. These objectives include 46 environmental objectives, 23 social objectives and 11 economic objectives. This strategic level interpretation of SC has not been developed to this extent previously in literature.

Secondly, the research also provides improved awareness and understanding on the process of implementing SC 'grounded' in the realities and complexities at construction project level.

Thirdly, from a practical point of view, the research developed a framework that enables project parties to develop a common understanding of SC keeping in line with the strategic level objectives and in turn, guide pro-active measures for implementing SC. This fulfils an identified gap in literature for a holistic, integrated framework addressing the issues relating to both the uptake and implementation of SC. Interviews with industry practitioners, as well as members of the academic community, established that there is a good level of coverage in terms of the main sections that constitute the framework and the content within each of the constituent sections of the framework. The developed framework was also found to be clear in terms of the flow or logic between different sections.

Finally, from a methodological point of view, the research successfully used a more qualitative research approach to gain in-depth understanding of the above issues in a field that is generally considered to be dominated by quantitative methodologies.

Overall, this research employed a combination of top down and bottom up perspectives to investigate the interpretation of SC that has so far received little attention in the existing literature. The outputs of the proposed research will add value to government's SD agenda in the construction sector. The intended outcome will also allow the public clients and contractors to adopt a pro-active approach in applying SC strategies within construction project environments.

1.5 STRUCTURE OF THE THESIS

This thesis consists of ten (10) chapters. The contents of each of these chapters could be summarised as follows.

- **Chapter 1** provides the introduction to the thesis. It gives the background and justification for selecting the particular research topic for this study. This chapter also lays out the research questions and aim and objectives of the research. An outline of the research flow throughout the four stages of the study is also presented.

- **Chapter 2** provides a review of available literature on the broad topic area of sustainability and SD. A review of origins and evolution of the concept is provided along with an examination of various international level developments that have contributed to the advancement of the concept. A review is presented on the prevailing confusions around the use of terminology surrounding SD, as well as the concept itself. It also establishes the significance of the construction sector in achieving SD. A critical review on the various terminology used to describe application of SD within the construction industry is also included within this chapter. As a result, Chapter 2 fulfils objective 1 of this research (refer to section 1.2).

- **Chapter 3** discusses the development of the conceptual framework that guides the remaining stages of the research. The need for the developed framework is justified using the findings from the initial literature review. The conceptual framework focuses on three main areas of focus. The reasons for selecting these focus areas are also given within this chapter. This chapter therefore addresses objective 2 and the first research question (RQ1) of the research (refer to section 1.2).

- **Chapter 4** presents the research methodology used throughout this research to achieve the aim and objectives stated in 1.2. The philosophical stance of the researcher is explained in this chapter. An overview of different research approaches and methods used throughout the research process along with the rationale for selecting the same are also given. The advisory documents selected for analysis in stage 3 and case studies selected for stage 4 of the research process are also introduced in this chapter.

- **Chapter 5** presents a discussion and synthesis of findings from stage 2 of the research process. These findings discuss how the concept of SC is interpreted in the analysed advisory documents. A review of the stated aims or purposes of the analysed documents is provided at the beginning of the chapter. The inferences made from the findings are also discussed therein. Overall, this chapter addresses objective 3 and the second (RQ2) and third (RQ3) research questions of the research (refer to section 1.2).

- **Chapter 6** presents some of the findings from the grounded theory analysis of case study interviews. These findings relate to the project stakeholder perceptions on the concept of SC. A comparison of the project stakeholder and advisory document interpretation of SC is also presented. The issues encountered by project stakeholders in using the available advisory documents are also discussed. Accordingly, this chapter fulfils objective 4 and the fourth research question (RQ4) of the research (refer to section 1.2).

- **Chapter 7** discusses the findings from the analysis of case studies in relation to the implementation of SC within construction project environments. The emerging framework for implementing SC is presented with detailed discussions on the actions for implementing SC during the different phases of the construction life cycle. This fulfils the fifth research question (RQ5) and part of objective 5 of the research.

- **Chapter 8** presents the remaining findings from the case study analysis in relation to the factors influencing the uptake and implementation of SC. The internal and external influence factors that have been identified are discussed in detail within this chapter. The implications of these findings are also discussed towards the end. As a result, this chapter fulfils the sixth research question (RQ6). Together, the chapters 7 and 8 fulfil objective 5 of this research.

- **Chapter 9** presents the final framework developed (which is the final output of the study) based upon the findings from the previous stages of the research. The validation of the framework through qualitative interviews conducted with members of the industry and the academic community are also discussed. This fulfils the sixth and final objective of this research.

- **Chapter 10** is the final chapter of the thesis and thereby, presents the conclusions of the research. A summary of the overall research process adopted is also presented, demonstrating how each of the objectives set in section 1.2 were achieved throughout the course of the research. Recommendations for different parties i.e. the government, industry practitioners and the academic community (for further research), are also presented in this chapter.

CHAPTER 2: SUSTAINABLE DEVELOPMENT AND THE CONSTRUCTION INDUSTRY

2.1 INTRODUCTION

The main focus area of this research is the uptake and implementation of SC within construction project environments. Accordingly, this research draws from two main bodies of literature: i.e. (i) literature on SD and (ii) construction management literature (see Figure 2.1). Construction industry is considered as a key sector for achieving SD goals. For instance, the UK government expects the construction industry to make a significant contribution in achieving its target of reducing Green House Gas (GHG) emissions by 80% by the year 2050. This has led to an emphasis on the need to adopt SC. However, this poses a concern as the terms 'sustainable' and 'construction' are both complex concepts, open to much debate. The placing of these two terms together to form a new phrase further magnifies this 'interpretive dilemma' (Du Plessis, 2007). In order to address this, the literature review presented within this chapter is mainly divided into two sections. The first section addresses the concept of SD. The second section reviews different outlooks on the boundaries of the construction industry and its impact and role in attaining SD. A review of the concept of SC is also provided. Chapter 2 mainly fulfils objective 1 of this research.

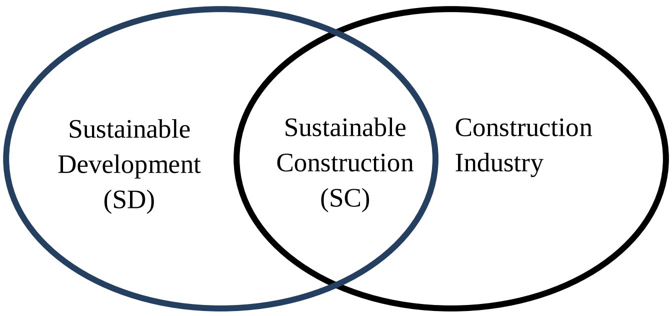


Figure 2.1: Main areas of literature reviewed

2.2 ORIGINS AND EVOLUTION OF SUSTAINABLE DEVELOPMENT

Various scholars have described SD as *'the central'* (Jabareen, 2004) or *'the most fundamental'* (Sustainable Development Research Network, 2002) challenge facing the world as of today. Consequently, SD has now become an overarching policy goal for governments around the world (UN Department of Economic and Social Affairs, 2012). Despite this increased level of attention, disagreements still prevail in relation to defining SD and what it should aim to achieve. Awareness of the origins and historic development of SD is viewed as essential for gaining understanding of the concept (Bebbington, 2001; Elliot, 1999). As Adams (1990 cited Elliot, 1999) states, SD cannot be understood in a *'historical vacuum'*. Various authors such as, Mitcham (1995), Pezzioli (1997), Mebratu (1998), Robinson (2004), Dresner (2008), and Elliot (1999) have provided comprehensive discussions on the origins and evolution of SD with the aim of providing greater clarity and understanding of the concept.

Most discussions on SD (see Mehta, 2009; Sobol, 2008) originate with references to the work of the Brundtland Commission (see section 2.3). However, although the Commission's work played a significant role in bringing SD to global prominence, the origins of the concept could be traced back to much earlier days. Of particular importance to this discussion on historic development of the concept are the changing ideas about what constitutes 'development' (including how to go about achieving it) and the role and significance of the environment (Bebbington, 2001; Dresner, 2008; Mebratu, 1998). It is this literature that resulted in raising the profile of the concept, placing it at the forefront of today's 'main stream policy agenda' (Bebbington, 2001).

Mebratu (1998) presents a historical over view of human development and how it affected man's relationship with the environment. He focuses on how the fundamental values of man underwent changes during key stages of human development, resulting in a continuous devaluation of the early importance placed on nature. The advent of the industrial revolution, which began in the UK, is considered to mark one such key stage, leading to drastic changes to social structure and population distribution. The success of this transformation has led to 'ecological scarcities', 'not only in terms of natural resource supply, but also [in terms of] the absorptive capacity of the natural sinks' (Mebratu, 1998). Concerns were raised as early as 1798 by the likes of Malthus, who in his 'Essay on population' raised alarms regarding the rate of population growth and the adequacy of food supply. Later, during the 1960s and 1970s, further criticisms were raised regarding the ‘indiscriminate use and exportation’ of technologies and man-made chemicals and their ability to harm the environment (Bell and Morse, 2008). Evidence of these criticisms can be found in certain well-known publications such as, *Silent Spring* by Rachel Carson, published in 1962 and *Small is beautiful* by Schumacher, published in 1973. It has also been noted that hazards of pollution, deforestation, land degradation and chemical food adulteration have all been affecting humanity for most of its existence (Hill and Bowen, 1997; Ofori, 1998).

The difference between these concerns in relation to issues such as, population growth, environmental degradation and technological developments in the past and today is that in the distant past, these changes all took place at a relatively slow pace, making the changes often imperceptible during an individual life span (Meadows, 1994). Moreover, the slow pace of change also meant that there was reasonable time for either the problems to disappear or for solutions to be found (Bossel, 1999). This however, has not been the case during the past two centuries. Issue of SD arises as the rate of the above mentioned changes exceeds the ability of the earth’s response rate. It is now generally accepted that the current development patterns are contributing to the regular degradation of resources and mounting world poverty. The ability of the present economic and social transformation patterns to address the needs of the population into the future, providing higher standards of living has therefore, been brought under serious doubt (Elliot, 1999). Herein, SD moves beyond from being a mere environmental movement, bringing concerns of social and economic wellbeing into the equation as well. In this sense, some authors (such as Elliot, 1999) view SD as an alternative development pattern to meet the needs of the global community. Since the early 1970s, efforts have been made at an international level to develop a world approach to SD (see Appendix 1). The next section goes on to discuss some of these key developments at the international level.

2.2.1 International Policy Developments

The UN Conference on Human Environment (UNCHE) (also known as the Stockholm conference) in 1972 was the first to acknowledge and bring into prominence the polarisation between the need for economic development and environmental concerns between the developing (i.e. 'southern') and developed (i.e. 'northern') countries. The 'southern' countries have emphasised the fact that they are not willing to accept limits to growth that the 'northern' countries have not enforced themselves (Langhelle, 1999). This was evident for example, in the opposing views of 'pollution' expressed by Sweden (in relation to the pollution of their lakes) and India (Indira Gandhi, the then Prime Minister of India, stating that 'poverty is the worst pollution'). Despite these differences the conference was a noteworthy success, as it managed to bring the environmental issues to the international arena for the first time (Dresner, 2008; Kates et al., 2005).

In 1974, the ecumenical study conference on 'Science and Technology for Human Development' held by the World Council of Churches came up with the idea of a 'sustainable society' (Dresner, 2008). Their main emphasis was on social concerns rather than environmental concerns with calls for equitable distribution and democratic decision making. However, the council also identified the importance of physical sustainability by recognising the need for functioning within the limits of the earth's carrying capacity (Dresner, 2008). Most of these ideas were later taken up by the Brundtland Commission and was used in describing their own concept of 'SD' (see section 2.3).

The World Commission on Environment and Development (WCED) or The Brundtland Commission was formed in 1984 and constituted of 22 members representing both the developed and developing world. The Commission was tasked with formulating 'a global agenda for change' incorporating, *inter alia,* proposals and recommendations for long term strategies for achieving SD (WCED, 1987). The Commission's report 'Our Common Future' therefore, laid out the most widely quoted definition of SD to date, as a proposed 'new development path' for sustaining human progress into the distant future (see section 2.3). The report is acknowledged for providing a political opening for the concept of SD to evolve (Daly, 1991).

By the late 1990s, SD had gained recognition surpassing the boundaries of various environmental organisations (Elliot, 1999). Contributing to this wide spread recognition was the United Nations Conference on Environment and Development (UNCED) or the 'Earth Summit' held in 1992. The summit, which took place in Rio de Janeiro, Brazil, had the central aim of identifying the main actions to be undertaken towards SD in the future. The realisation of the need for highest level consensus to achieve this resulted in the gathering of heads of state for the first time to consider the environment (Elliot, 1999). As a result, the conference was attended by representatives of 178 national governments, including over 100 heads of state, as well as, numerous representatives of non-government organisations. The conference also marked the first instance, where the need for strategies for SD for countries was recognised. At the summit, the heads of government from around the world adopted Agenda 21, calling all countries to develop national SD strategies.

Afterwards, in 1997, the United Nations Framework Convention on Climate Change (UNFCCC) led to the development of the Kyoto Protocol, which was an international and legally binding agreement aimed at reducing the emission of GHGs. The protocol is based on the principle of 'common but differentiated responsibilities'. Therefore, a heavier burden has been placed on the industrialised countries recognising that they are more responsible for the current high levels of GHG emissions through more than 150 years of industrial activity (UNFCCC, 2012). The protocol requires its parties to implement policies and measures to minimise the adverse effects of climate change, international trade and social, environmental and economic impacts on other parties. A major feature is that the protocol presents a binding target for reducing GHG emissions. During its first commitment period from 2008 to 2012, this target was set to an average of 5% against the 1990 levels for 37 industrialised countries and the European community (UNFCCC, 2012). In the G8 summit held in 2009, this was converted to a global long-term goal of reducing global emissions by 80% or more for developed countries by 2050.

In 2002, the World Summit on Sustainable Development (WSSD) was held in Johannesburg, South Africa. The summit delivered three main outcomes; a political declaration, a plan of implementation and the establishment of numerous partnership initiatives around the key commitment areas of sustainable consumption and production, water and sanitation, and energy (DEFRA, 2011b). To the criticism of some parties, the focus was given mainly to the implementation of existing agreements with the cooperation of the private sector rather than the formulation of new mandatory agreements.

Since then a steady flow of organised movements in the form of international conferences, treaties and action plans have continued (see Appendix 1 for a more comprehensive list of these international level conferences). The latest amongst these was the Rio+20 conference held in June, 2012, which marked the 20th anniversary of the 'Earth Summit'. According to the United Nations Secretary General Ban Ki-moon, this conference has affirmed the fundamental principles of SD and renewed the essential commitments towards it (UN Department of Public Information, 2012). The final agreements of the conference, which were put forward in a document entitled 'The Future We Want' called for a wide range of actions including, launching a process to establish SD goals, establishing a new forum for SD and recognising the importance of voluntary commitments towards SD (United Nations Conference on Sustainable Development, 2012).

Likewise, the realisation that the sustainability of the human society is at stake has now made SD into an issue, which is rarely out of international and national level discussion. While the majority recognise the concept to be of utmost importance, it remains poorly understood and the source of much debate and disagreement (Blair and Evans, 2004; Daly, 1991; Halliday, 2008; Hopwood et al., 2005). The following sections go on to discuss some of the different attempts at defining SD as well as some disagreements and debates surrounding the concept.

2.3 DEFINING SUSTAINABLE DEVELOPMENT

The need for a fairly detailed definition for SD has been stressed by many authors (see Pezzey, 1992, Kates et al., 2005). According to Elliot (1999), definitions play the important role of providing a basis for developing the means to achieve SD in future. Following the different international developments discussed in the previous section, as well as academic interest, a large number of definitions of SD are now in circulation. Indeed, some authors have observed the number of available definitions to be over 200 (see Parkin, 2000). The range and diversity of these definitions indicates that SD is a concept that 'everyone agrees, but no one defines consistently' (Pezzey, 1992).

One of the most commonly cited definitions of SD has been put forward in the report of the Brundtland Commission. As mentioned in section 2.2, the Commission envisioned a new development path that,

> *'sustained human progress not just in a few places for a few years, but for the entire planet into the distant future' (WCED, 1987).*

This new path was called 'SD' and it was defined as,

> *'development, which meets the needs of the present without compromising the ability of future generations to meet their own needs'* (WCED, 1987).

Following the years that passed since the report first came out, this phrase has been 'repeated, misquoted and rewritten' countless times (Dresner, 2008) giving rise to a plethora of criticisms, arguments and various strategies and policies. One of the often cited criticisms alludes to the simplicity and vagueness of the above statement. However, authors such as, Langhelle (1999), Lafferty (1999) and Dresner (2008) all stress that this criticism is often related to 'selective reading' of the text. Dresner (2008) for instance, notes that the paragraphs subsequent to the above stated definition within the report clearly show the complexity and the comprehensiveness of the Commission's notion of SD. Three main aspects are highlighted within this explanation of SD by the Commission. These are;

- *The focus on needs:* The report emphasises that SD requires;

> *'meeting the basic needs of all and extending to all the opportunity to fulfil their aspirations for a better life' (WCED, 1987).*

The report further highlights that ecological and other catastrophes cannot be effectively addressed unless the problem of poverty is first resolved. However, the Commission recognises that just a new form of economic development would not be sufficient to address this issue of widespread poverty. In order to provide an effective sustainable solution, this new form of development would have to be reinforced with political systems that encourage effective participation of citizens in decision making (Dresner, 2008). Consequently, more democracy is called for in international decision making.

- *The idea of limitations:* The limits implied here are those imposed by, (a) the present state of technology and social organisation on the environment, and (b) the ability of the biosphere to absorb the effects of human activities. The report goes on to explain that, ultimately SD is a 'process of change' as opposed to a 'fixed state of harmony'. Political will is paramount in managing this change process within the above mentioned limitations. For instance, the report states that SD requires,

> *'...a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change*

are made consistent with future as well as present needs' (WCED, 1987).

- *The idea of equity:* The Brundtland report also emphasises that equity (both inter-generational and intra-generational) is a crucial aspect of SD even at its narrowest definition. Bebbington (2001) notes that this emphasis placed on inter-generational and intra-generational equity is a notion that is often overlooked in subsequent debates on SD.

The Commission's work has been explained as a *'way of catching and taking seriously, the growing scepticism in developing countries toward the environmental concerns of the West'* (Langhelle, 1999). Accordingly, the Commission's report has been largely credited for successfully giving economic and social significance to an issue, which was previously conceived as being largely environmentally biased (Carter and Fortune, 2008).

Another commonly used approach of defining SD is to use economic terms. Herein, sustainability (refer to section 2.3.1) is viewed in terms of 'non-declining capital' (Pearce et al. 1989), where the term 'capital' refers to 'natural' as well as 'economic' and 'human' capital. This concept has been further refined to describe a spectrum of different levels of sustainability ranging from 'very strong sustainability' to 'very weak sustainability' (Dresner, 2008). 'Very strong sustainability' does not allow any man made capital to be substituted for natural capital. This implies that natural capital cannot be utilised at all and is therefore, impractical. 'Moderate strong sustainability' however, allows the depletion of natural capital given that they are compensated with some form of human-made capital (for example, investing the income from exploiting oil reserves to develop renewable forms of energy). On the other hand, 'very weak sustainability' means natural capital can be substituted infinitely by human-made capital. 'Moderate weak sustainability' conserves 'critical natural capital' recognising that there are certain forms of natural capital (such as, the Ozone layer) that cannot be easily substituted (Dresner, 2008; Pearce et al., 1994).

A number of reasons have contributed to the popularity of this economic approach to defining sustainability. Firstly, this approach allows the concept to be rigorously defined in a quantitative manner, thereby overcoming an often cited difficulty in operationalising the concept. This approach also makes it easier to derive the conditions necessary to achieve sustainability and develop measurement indicators (Pearce, 2006).

However, the main drawback of this approach is that it places emphasis on the environmental issues paying little to no attention to the socio-economic consequences (Hopwood et al., 2005). In addition, whilst the application of this approach is suited at national level (and indeed, has been effectively used at this level) its use in evaluating sustainability performance at industry level has been brought into question (Pearce, 2006).

In 1987, the Economist Ed Barbier postulated that SD rests on 'three pillars' or 'spheres of development' (Du Plessis, 2007). This perspective, which evolved from the WCED definition of SD, indicates a need to reach a balance between the social, environment and economic elements (also, referred to as People, Planet and Profit or 3Ps) in achieving SD. Today, this three pillar (or the triple bottom line) approach; which is usually depicted in a Venn diagram with three overlapping circles (see Figure 2.2); is one of the most commonly used ways of defining SD.

Figure 2.2: A generic graphical representation of the three-pillar approach to SD

This three pillar approach of defining SD is not without its criticisms. Lehtonen (2004) has criticised this depiction of SD due to four main reasons. Firstly, he states that such an approach could 'reinforce the status quo' by enabling the governments and other institutions to justify their own objectives in terms of sustainability. Secondly, there is concern that distinguishing 'social' from the 'economic' detaches the economic considerations from the wider social context. He notes that viewing SD in this manner could result in a false sense of consensus between the three elements reflecting flaws in the relationships between the elements. Lehtonen's third criticism is that the three pillar conception does not provide any guidance on how to consider the trade-offs and synergies between the potentially conflicting objectives within the environmental, social and economic elements. His fourth criticism is based upon the argument that the three pillars are not qualitatively equal and therefore, relates to the disagreements on the hierarchy of the three elements. In order to address these weaknesses, Lehtonen proposes the depiction shown in Figure 2.3 to illustrate the three pillars.

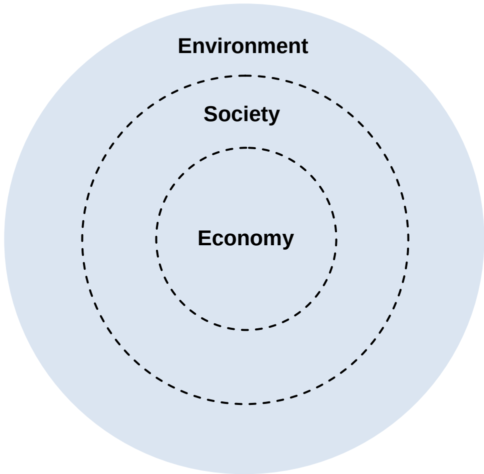


Figure 2.3: Modified depiction of the three-pillars of SD (Source: Lehtonen, 2004)

This model of illustrating SD clearly recognises that the activities of the human society should be retained within the environmental constraints and that the economic activities should be carried out to service the entire human society (Lehtonen, 2004). Gibson (2001) calls this a ‘deep green’ depiction, as it implies that the environment is the most significant element of SD. However, Lehtonen observes that the hierarchy of the three elements can change depending upon the relative importance attributed to the elements in different circumstances. This means that ‘environment’ does not have to remain as the most significant element always. Social or economic elements may be regarded as the most important at any relevant situation or time, given that their operation does not undermine the environment.

Several attempts have been made to categorise the available definitions on SD (see Hopwood et al., 2005; Kates et al., 2005; Mebratu, 1998; Pezzey, 1992). Mebratu (1998) has identified the definitions and conceptions of SD could be categorised into three main types according to their source of origin as; institutional, ideological, and academic. He provides a conceptual review of definitions falling into these categories, focusing on the questions of what is the identified source of the crisis?, what is the proposed solution?, what is the solution platform? and what is the key instrument for the solution?.

As noted by Hopwood et al. (2005), the differences in interpretation of SD often stems from different viewpoints on humanity's place on the planet. Accordingly, Hopwood et al. have mapped these various viewpoints on SD indicating the varied levels of attention given to environmental and socio-economic concerns within them.

Kates et al. (2005) and Parris and Kates (2003a) have noted that although the definitions of SD generally address concerns for development, environment and equity, there are differences within them with regard to the emphasis given to aspects such as what is to be sustained, what is to be developed, how to link environment and development and for how long a time (Kates et al., 2005; Parris and Kates, 2003a; Parris and Kates, 2003b). Accordingly, they state that defining SD can be viewed as ultimately a 'social choice' about what to develop, what to sustain and for how long (Parris and Kates, 2003b).

At this point, it is also important to differentiate SD from several other terminologies such as, sustainability, sustainable growth and environmental protection. These terminologies are sometimes taken to mean SD. However, further scrutiny reveals that the above mentioned terminologies have different meanings (Bebbington, 2001; Bell and Morse, 2008; Daly, 1991; Robinson, 2004). Sections 2.3.1, 2.3.2, 2.3.3 below, discuss these different meanings and establish why SD is the most suitable terminology for use within the context of this research.

2.3.1 Sustainability vs. Sustainable Development

O'Riordan (1988) distinguishes sustainability as a concept with primary focus on the environment and SD with primary focus on 'development'. Taking this view further, Robinson (2004) explains that SD seems to follow a conservationists' approach to natural area management, relying upon technology and efficiency improvements to address the problems of pollution and resource scarcities. On the contrary, he observes that the concept of 'sustainability' tends to prefer approaches that preserve the natural areas and advocates changes in the individual lifestyles and values as solutions to pollution and resource scarcity issues. Robinson further observes that while governments and private sector organisations prefer to use the term SD, academics and

NGOs seem more inclined towards using the term sustainability. This variance could be attributed to the association of the term 'development' with 'economic growth' (refer to section 2.3.3). Due to this, SD is sometimes perceived as being supportive of continuous economic growth, which is not favoured by the environmentalists, whereas, sustainability is seen to demonstrate more attention towards environmental constraints (Robinson, 2004).

In his report to the Balaton group, Bossel (1999) refers to the Webster Dictionary definition of 'sustain', which means, 'to maintain; keep in existence; keep going; or to prolong'. Bossel (1999) states that taken strictly in this sense, human society cannot be maintained at a particular rate forever. The human society is a complex system that continuously evolves and adapts itself to its surroundings. It exists within the natural environment, which is also a dynamic and possibly even more complex system. Hence, Bossel states that 'change and evolution is permanent... and must be maintained if the systems are to remain viable and sustainable'. He describes this as SD.

According to Bell and Morse (2008), the 'sustainable' part of the SD paradigm is both a descriptor of something and a target to achieve. In its broadest sense, it describes that our actions today should not harm the future generations (often expressed as 'don't cheat on your kids' in sustainability literature) (Bell and Morse, 2008). In the same way, Kiewiet and Vos (2007) stress the importance of asking the question 'sustainability of what?' as an essential step in bringing about sustainability. Laloe (2007) also states that 'sustainability' is something that is 'dependent on an object which must be described'. He goes on to state that no unique definition to sustainability alone can be proposed, as it is always dependent upon the 'object' being described. Similar explanations of the terms sustainability and SD have been given by Bhamra and Lofthouse (2007) and Lutzkendorf and Lorenz (2007) as well.

The concept of sustainability could therefore, be seen as transcending the concept of SD, cutting across various cultural and professional barriers. Accordingly, SD could be viewed as the process through which the end goals of 'sustainability' are achieved. Such an approach makes it plausible to apply any discussions on 'sustainability' to anything that has the term sustainable as an adjective such as, SD or SC (Bell and Morse, 2008). This allows for the application of the concept to be compared and contrasted across sectors, as well as, applying lessons learnt from one sector to another. However, Brandon and Lombardi (2011) highlight that achieving the goal of sustainability within this context should not be about maintaining status quo or reaching perfection. Moving forward, this research will use the term ‘sustainability’ in a broad, generic sense and terms such as, ‘SD’ and ‘SC’ will be used to describe its applicability in the respective arenas (in this case, development and construction respectively).

2.3.2 Sustainable Development vs. Environmental Protection

SD is sometimes used synonymously with ‘environmental protection’. Halliday (2008) views this as a fundamental misconception of the concept. Much of the initial antagonism towards SD has been driven by the view that it restrained development (Dresner, 2008; Halliday, 2008). However, the restraint is not upon ‘development’ per se, but on development that is inappropriate. In other words, rather than challenging development, SD asks for the strategies pursued in attaining it to be modified (Dresner, 2008), focusing on meeting the needs and expectations of people in a way that ensures harmonised development in terms of economic, social and environmental aspects. The conflict between environmental issues and the development concerns stem from the separation of the environment from the development challenge, which results from mainly a lack of knowledge on how to use the environment sustainably (Mehta, 2009). Beckerman (1994) notes that as past economic policies have generally been separate from environmental concerns, it is right to now give these concerns their proper place in policy development. However, he opposes the elevation of SD to an over-riding policy criterion in order to achieve this (as advocated for instance by, Parkin et al., 2003).

2.3.3 Sustainable Development vs. Economic Growth

A further ambiguous point in literature is the association of SD with economic growth. Shelbourn et al. (2006) postulate SD to be a term generally associated with achieving increased techno-economic growth whilst preserving the environment and natural resources. Hence, at first glance, the concept of SD seems to be concerned with the two seemingly contradictory objectives of economic development and the use of world’s natural resources in sustainable ways (Mehta, 2009). The Brundtland report for instance, calls for economic growth by a factor of 5 or 10, whilst respecting the earth’s ecological limits. According to Mitcham (1995) the vagueness surrounding the concept in this respect is useful to bridge the gap between ‘no-growth environmentalists’ and ‘pro-growth developmentalists’. For Daly (1991) however, this is a ‘glaring contradiction’ of objectives, used so that SD could be forced to the top of the United Nations and multilateral development banks' agendas.

Dresner (2008) observes that more often than not SD has been used to refer to old fashioned economic growth while paying 'lip service' to the environmental concerns. Meadows et al. (2005) note that most parties prefer to use the term 'growth' as it is generally viewed as a 'cause for celebration'. They state that;

> *'Individuals support growth oriented policies, because they believe growth will give them an ever increasing welfare. Governments seek growth as a remedy for just about every problem. In the rich world, growth is believed to be necessary for employment, upward mobility, and technical advance. In the poor world, growth seems to be the only way out of poverty (Meadows et al., 2005)'.*

Daly (1991) draws upon a crucial difference in meaning between the terms 'development' and 'growth' to differentiate SD from 'sustainable growth'. According to the Webster dictionary, 'grow' is defined as, 'increase in size by assimilation of material into the living organism or by accretion of material in a non-biological process'. The same dictionary defines the word 'develop' as, 'to work out the possibilities of or to create or produce especially by deliberate effort over time' (Merriam-Webster, 2012). Daly (1991) simplifies this difference by saying that growth refers to quantitative physical increase, and that development refers to more qualitative improvements, especially with regard to potential. Thus, he places greater emphasis on qualitative rather than quantitative improvements with reference to SD. He views the economy as a sub-system within the finite global ecosystem. The latter does not grow, but develops over time, making it impossible for the economy to grow in a sustainable manner over the long term. Therefore, the term 'sustainable growth' is viewed as a 'bad oxymoron' that must be rejected, as opposed to the term SD (Daly, 1991). Similar views are shared by Georgescu-Roegen (1988 cited Pezzey, 1992) and Brandon and Lombardi (2011). Georgescu-Roegen for instance, differentiates between growth and development as follows;

> *'Growth' is if you get just an increasing number of the same type of mail coaches and if you pass from travelling in mail coaches to travelling by railway that is 'development' (Georgescu-Roegen 1988 cited Pezzey, 1992).*

On the other hand, Pezzey (1992), who defines 'economic growth' as rising aggregate consumption of output, emphasises that 'growth' is measured in value rather than physical units. According to Pezzey, growth of economic output does not need to be always accompanied by growth in physical throughput. However, he acknowledges that 'growth' still has certain shortcomings such as, ignoring environmental quality and other social considerations, as well as distribution of income, which are addressed by 'development'.

From the discussions in sections 2.3.2 and 2.3.3 above, SD could be viewed as being more about the relationship between the environment and the social and economic dimensions of development, rather than being solely about protecting the environment or controlling economic growth (Sobol, 2008).

Given that all social transformations are 'messy', the above discussed linguistic confusions surrounding SD are viewed as being acceptable by Donella Meadows, who is one of the leading academic contributors to the area (Dresner, 2008). She perceives that although there are disagreements and contrasting views surrounding SD, this will not be a permanent state of affairs. The next section goes on to discuss these different views or perceptions in relation SD shared by different authors.

2.3.4 Different Perceptions and Criticisms of Sustainable Development

The review of literature uncovered a myriad of views and perceptions expressed by different authors on SD. On one hand, the proponents of SD have described the concept as 'a fashionable concept' (Beckerman, 1994) and 'a central idea and goal' for international bodies to achieve effective integration between development and environmental issues (Lafferty, 1999). On the other hand, its antagonists describe it as, 'an empty concept, lacking firm substance and containing embedded ideological positions that are, under the best interpretation, condescending and paternalistic' (Bell and Morse, 2008). For Harrison (2000 cited Jabareen, 2004) SD is a 'Holy Grail that does not exist'.

Mitcham (1995) acknowledges that the concept incorporates a level of 'studied or creative ambiguity'. For Robinson (2004) this ambiguity surrounding SD is a strength rather than a weakness of the concept. He refers to it as 'constructive ambiguity', and maintains that it provides an opportunity that could benefit the development and understanding of the term SD. A similar view has been expressed by O'Riordan, who has observed that ambiguity enables the concept to transcend the various tensions surrounding its meaning (Elliot, 1999). However, according to Parris and Kates (2003a) the ambiguous nature of the concept gives it an 'oxymoron-like' like character, ironing out what are considered as real conflicts between the different elements, as well as different temporal scales of SD. This provides an opening for people to pass off anything as SD and thereby, has the danger of reducing the term to meaninglessness. This is especially evident in many of the definitions put forward by different institutions for SD, which reflect their own institutional objectives and political positions rather than unambiguous and unbiased scientific views (Mebratu, 1998).

However, Dresner (2008) maintains that the above mentioned ambiguity or vagueness surrounding SD does not reduce it to a meaningless concept. Along the lines of this view, the vagueness surrounding SD has led Jacobs (1999) to refer to it as a 'contestable concept' rather than a meaningless one. This means that the interpretation of SD remains open to different conceptions. Accordingly, Jacobs' view SD is similar to concepts such as, liberty or justice; the basic meaning of which are generally accepted by all, although concerns remain with regard to how they should be interpreted and applied. Mitcham (1995) views SD to be an ideal, similar to love or patriotism, 'something necessary and even noble', which at the same time 'can become a cliché and be misused by ideologues. A similar view is expressed by Redclift (1997 cited Elliot, 1999), who states that 'like motherhood and God, it is difficult not to approve of it [SD]'. [However], at the same time, the idea... is fraught with contradictions'. Some even see it as an emerging meta-discipline that is beginning to define a whole new subject area (Fenner et al., 2006).

It is clear from the above discussions that there is no uniform understanding of SD in literature. Despite the immense attention and popularity of the SD concept, most authors agree that there is a lot of confusion surrounding its meaning, what it strives to achieve and how it should be achieved. Indeed one could argue that the lack of a uniform definition is an important political opportunity as a precise definition can exclude parties whose views are not represented in such a definition (Robinson, 2004). The definition of SD continuously keeps on developing conceptually, theoretically and methodologically. As Robinson (2004) implores, it seems unlikely that a coherent, universal conceptual approach to SD will emerge in the near future. However, while this conceptual development takes place, the principles of SD continues to be implemented at various levels. This 'street level' experience in turn fuels the conceptual development (Robinson, 2004). Therefore, the next section goes on to explore one such application of

SD, i.e. SD in the construction sector.

2.4 THE CONSTRUCTION INDUSTRY: NARROW AND BROAD INTERPRETATIONS

Defining construction is an complex issue (Innovation and Growth Team - IGT, 2010; Du Plessis, 2007). This is evident from the variety of ways in which 'construction' has been interpreted by different authors. As this research is particularly concerned with the uptake of SD in the construction industry (i.e. SC), it is important to establish what is referred to as the construction industry and what its parameters are. Irurah (2001 cited Du Plessis, 2007) presents four ways in which 'construction' can be interpreted. These are interpreting construction as;

- A site level activity,
- The comprehensive project cycle,
- Everything related to the business of construction and,
- The broader process of human settlement creation.

The first, which is the most commonly used definition of construction (Du Plessis, 2007), provides the narrowest interpretation. It interprets construction only as the site activities that lead to the development of constructed facilities. This view is adopted by Morton (2002 cited Bosher et al., 2007), who refers to the 'construction industry' as all the firms involved directly in the design and construction of buildings. It ignores other phases of the construction life cycle (such as planning, operation and maintenance and decommissioning) and excludes important stakeholders such as, materials manufacturers, suppliers and facilities managers that play integral roles in the construction industry. The concept of SC on which this research is based upon, perceives the construction industry in a much broader perspective, which necessitates the inclusion of the above mentioned aspects.

The second interpretation of construction (i.e. viewing construction as a complete project life cycle) incorporates the above mentioned. However, as Cooper et al. (2005) note, in the construction sector, there is a tendency to view the term 'project' as being tantamount to the physical construction works. This outlook has often resulted in marginalising the pre-construction and post-construction activities. Hence, it is important to highlight that the work in the construction industry includes both pre and post-construction activities. This whole life cycle view of the construction industry, which is further discussed in section 2.6.1 below, is comparable to Irurah's third interpretation of construction set out above.

Even a broader interpretation has been put forward in the 'Agenda 21 for SC in developing countries' (Du Plessis, 2002), which describes construction as;

> *'The broad process/mechanism for the realisation of human settlements and the creation of infrastructure that supports development. This includes the extraction and benefication of raw materials, the manufacturing of construction materials and components, the construction project life cycle from feasibility to deconstruction, and the management and operation of the built environment'.*

This is in line with the fourth level interpretation of construction given by Irurah (2001 cited Du Plessis, 2007). This view makes it apparent that the construction industry activities have a significant impact on determining the 'quality of life' of people. However, the problem here is that following ambitious construction programmes in the traditional manner to support improvements in quality of life would require large amounts of resources (such as, energy and money). This in turn would result in significant environmental and economic impacts, which would ultimately result in the detriment of rather than the intended improvements in relation to 'quality of life'. Therefore, the challenge facing the industry is meeting the construction targets for housing, education, industry, infrastructure, etc, without compromising the ability to do it again in the future (BRE, 2002; Construction Products Association, 2007; Waddell, 2008). In order to achieve this, the industry has to adopt SD practices.

There is much evidence within the built environment on links between the economy, environment and society (see sections 2.6.2.1, 2.6.2.2 and 2.6.2.3. These include; the complex problems of increasing traffic congestion and commute times, air pollution, inefficient energy consumption, loss of open space and habitat, inequitable distribution of economic resources and the loss of a sense of community (Augenbroe et al., 1998). All these have been identified as drivers calling for a change in the industry practices to adopt SD.

Following the logic of the discussions in section 2.3.1, SC appears as the suitable terminology to discuss the application of sustainability principles within the construction industry. However, several different terms were found to have been used interchangeably by different authors in addressing the same. For example, Robichaud and Anantatmula (2011) state that SC is also referred to as ‘green building’, ‘high performance building’, or ‘sustainable building’. A review of these different terminologies is provided in the next section.

2.5 SUSTAINABLE DEVELOPMENT IN THE CONSTRUCTION INDUSTRY: DIFFERENT TERMINOLOGIES

Review of literature revealed several different terms such as ‘green building’, ‘sustainable building’ and ‘high performance building’ have been used interchangeably with SC. The term ‘green building’, favoured by authors such as Dammann and Elle (2006), Kibert (2008), Rohracher (2001) have existed longer than the terms ‘sustainable building’ or SC (Ofori, 1998). However, the green building concept focuses more on the environmental issues. As noted by Circo (2008), ‘green’ buildings refer to the design, construction, and operation of constructed facilities while preserving the natural environment and protecting it for future generations. Accordingly, Kibert (2008) views green buildings as representing a sub-set of sustainable building. For him, achieving truly SC is impractical and is similar to reaching the ‘Holy grail’. He maintains this is where the term green buildings become important as a means of representing the current state of best practice in the quest to achieve SC. Green buildings are considered to represent the physical structures designed and constructed to address the environmental concerns, whereas, SC addresses the social and economic issues as well. Most authors (for example, Circo, 2008) have chosen to use this term due to its popularity in the literature.

Whilst, green building is seen to focus on the environmental element, use of the term ‘high performance’ (Baum, 2007; Circo, 2008; Kibert, 2008) implies consideration of the economic aspects, especially in terms of efficiency and business case. According to Kibert (2008) the high performance green building movement is considered as the most successful environmental movement in the USA.

John et al. (2005) cites a definition put forward by the OECD for the term ‘sustainable buildings’ as;

> *'Buildings that have minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global settings'.*

According to the above, the term 'sustainable building' (Anink et al., 1996; Bunz et al., 2006; John et al., 2005; National Audit Office - NAO, 2007; Rohracher, 2001) focuses specifically on the state of the end product, which is the 'building'. The concept considers environmental and functional quality and the functional value of a building during its whole life cycle. However, the process of achieving that end product has been neglected. As noted by Kibert (2008) a 'sustainable building' refers to the 'quality and characteristics of the actual structure created using the principles and methodologies of SC'.

'Smart' (Bell, 2005) is another term that is sometimes used together with 'sustainability' in the context of buildings. However, 'smart buildings' or 'smart construction' are not synonymous to 'sustainable building' or 'SC'. 'Smart' often refers to 'responsiveness of the building' (for example through the use of information technology or control systems) rather than to the 'use of materials and design in smart ways' (Bell, 2005). Bell stresses that SC do not always need to be 'smart'. Nonetheless, significant value could be added to such constructions (especially commercial buildings) through the use of smart technologies.

'Sutainable procurement' has also been used synonymously with SC by some authors. In order provide clarification between these two terms it is necessary to first explore and scrutinise the definition of procurement as applicable today, especially within the context of the construction industry.

Construction procurement has undergone significant transformations in the recent years with focus shifting to 'best value' from traditional 'least value' concepts. It is increasingly identified as a tool to deliver broad policy goals especially related to SD. The procurement systems available for construction clients have evolved over the years in terms of organisational, contractual, financial and technical structures to meet different client requirements. As Love et al. (1998) state building procurement has become a somewhat 'fashionable term' amongst industry practitioners and researchers today. Much of this popularity could be attributed to the increased emphasis on placed on procurement by various industry reports (for example, Latham, 1994) for increasing industry performance and the attention given at policy level to delivering SD agenda.

More often than not, the term 'procurement' is taken to be synonymous with 'purchasing'. Although this is more commonly an issue for the manufacturing industry rather than the construction industry, certain early attempts at defining construction procurement also seem to reflect this view. One such example is Abdul-Kadir and Price's (1995) definition of procurement strategy as a;

> *'strategy for proactive project hardware purchasing that is required to achieve complete project delivery in accordance with the project schedule'.*

In exploring the relevant literature it could be observed that, as expected, the definitions of construction procurement has also progressed over time with the evolution of procurement strategies. Most of the early definitions of procurement seem to be limited to the design and construction phases of a construction project. For instance, Franks (1984) states that procurement is 'the amalgamation of activities undertaken by the client to obtain a building'. Similarly, Mohsini and Davidson (1991) has defined 'procurement' as,

> *'…a 'process' term, which refers to the acquisition of new buildings or space within buildings either by directly buying, renting or leasing from the open market, or by designing and building the facilities to meet a specific need'.*

However, since then the definitions of construction procurement appear to have broadened to encompass the operational phases of the construction projects as well. For example, the CIB (W92) in its 1997 meeting has defined construction procurement as,

> *'a strategy to satisfy client's development and/or operational needs with respect to the provision of constructed facilities for a discrete life cycle'.*

Similarly, Mastermann (2002) defines the procurement system as 'the organisational structure adopted by the client for the implementation and at times, eventual operation of a project'. This definition embraces the fact that the term construction procurement in today's terms means not only the design and construction of a building project but also their financing, operation and facilities management. Accordingly, there appear to be some overlap between the terms SC and sustainable procurement. However, from the above discussions it could be postulated that sustainable procurement refers more to the process and organisational structure adopted in obtaining a constructed facility that would be considered as sustainable. On the other hand, SC, in addition to the above mentioned, also incorporates the features of the constructed facility. It therefore appears the most suitable and comprehensive term to discuss the application of sustainability practices within the construction industry. As a result, this research will use the term SC throughout in referring to the aforementioned. This is also keeping in accordance with the discussions in section 2.3.1 above. As the next section will go on to explain, the term is adopted in a holistic sense, giving consideration to the environmental, social and economic issues throughout the life-cycle of a construction.

2.6 SUSTAINABLE CONSTRUCTION - A REVIEW

The Pearce report (Pearce, 2003) had argued that before the construction industry can proceed towards contributing to SD, it needs to adopt a more holistic definition for SC. UK Green Building Council (2009) also observes that having an ‘applicable and universally understood’ definition is necessary for attaining ‘cross-sector buy-in’, which is needed to support the momentum required to create real, industry-shifting, changes towards SC. Nevertheless, attempts at developing a generally accepted definition for SC have been so far unsuccessful (Cooper, 2006; Du Plessis, 2007; Hill and Bowen, 1997; Ofori, 1998; Ofori et al., 2000). Table 2.1 below shows a number of different definitions found in literature for SC. Despite the lack of a common understanding, several key features of SC could be identified by reviewing these different definitions as follows:

- Consideration of the whole life cycle of construction.
- Incorporation of all three environmental, social and economic elements.
- Consideration of non-technological as well as technological solutions.
- Addressing the needs of present and future stakeholders.

These key features are discussed, in-depth, in the following sections.

Table 2.1: Definitions of SC

Reference	Definition
Hendriks (2001)	‘A way of designing and constructing buildings that support health (physical, psychological, and social) and which is in harmony with nature, both animate and inanimate’
Kibert (1994 cited Hill and Bowen, 1997)	‘Creating a healthy built environment using resource-efficient, ecologically-based principles’
Huovila and Richter (1997)	‘SC, in its own processes and products during their service life, aims at minimizing the use of energy and emissions that are harmful for environment and health, and produces relevant information to customers for their decision making’
Lanting (1998)	‘a way of building which aims at reducing (negative) health and environmental impacts caused by the construction processes or by building or by the built environment’
Augenbroe et al. (1998)	‘A possible strategy to better meet the needs of clients and owners while ensuring success in an increasingly competitive and constrained operational environment’
Habitat II (1996 cited Ofori, 1998)	‘SC will make use of resources within the carrying capacity of ecosystems and take into consideration the precautionary principle approach and by providing the people... with equal opportunities for a healthy, safe and productive life in harmony with nature and their cultural heritage and spiritual and cultural values and which ensures economic and social development and environmental protection’
Raynsford (2000)	‘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, 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 Agenda 21: SC for Developing Countries (Du Plessis, 2002)	‘The principles of sustainable development are applied to the comprehensive construction cycle, from the extraction and beneficiation of raw materials, through the planning, design and construction of buildings and infrastructure, until their final deconstruction and management of the resultant waste. It is a holistic process aiming to restore and maintain harmony between the natural and the built environments, and create settlements that affirm human dignity and encourage economic equity’
van Bueren and Priemus (2002)	‘The design, development, construction, and management of real estate such that the negative environmental effects of the construction, restructuring, and management of the built environment are reduced as far as possible’
UNEP (2003)	‘The use and/or promotion of a) environmentally friendly materials b) energy efficiency in buildings and c) management of construction and demolition waste’
Kibert (2008)	‘SC may best be defined as how the construction industry together with its product the built environment, among many sectors of the economy and human activity, can contribute to the sustainability of the earth including its human and non-human inhabitants’
Shen et al. (2010)	'SC practice refers to various methods in the process of implementing construction projects that involve less harm to the environment (i.e. prevention of waste production), increased reuse of waste in the production of construction material (i.e. waste management) and beneficial to the society, and profitable to the company'
Robichaud and Anantatmula (2011)	'a philosophy and associated project and construction management practices that seek to: (1) minimise or eliminate impacts on the environment, natural resources and non-renewable energy sources to promote the sustainability of the built environment; (2) enhance the health, wellbeing and productivity of occupants and whole communities; (3) cultivate economic development and financial returns for developers and whole communities; and (4) apply life cycle approaches to community planning and development'

2.6.1 Consider the Whole Life-Cycle of Construction

Brandon and Lombardi (2011) highlight that all SD related discussions are underlined by considerations of the period of time to be considered for decision making. This is also applicable to discussions on SC. In looking at SC, some authors, such as Hendriks (2001), in their definitions have referred to the design and construction phases only. However, according to Pearce (2003), a holistic definition of SC must include property and its management. Herein, the importance of realising that SC is concerned with the life cycle of the 'construction', rather than the lifetime of the 'project' (see Figure 2.4 below) has been emphasised (Parkin, 2000). In other words, as Hill and Bowen (1997) note, it is important to realise that although SC incorporates the word 'construction', it describes a process that starts well before the physical construction phase and continues after that as well.

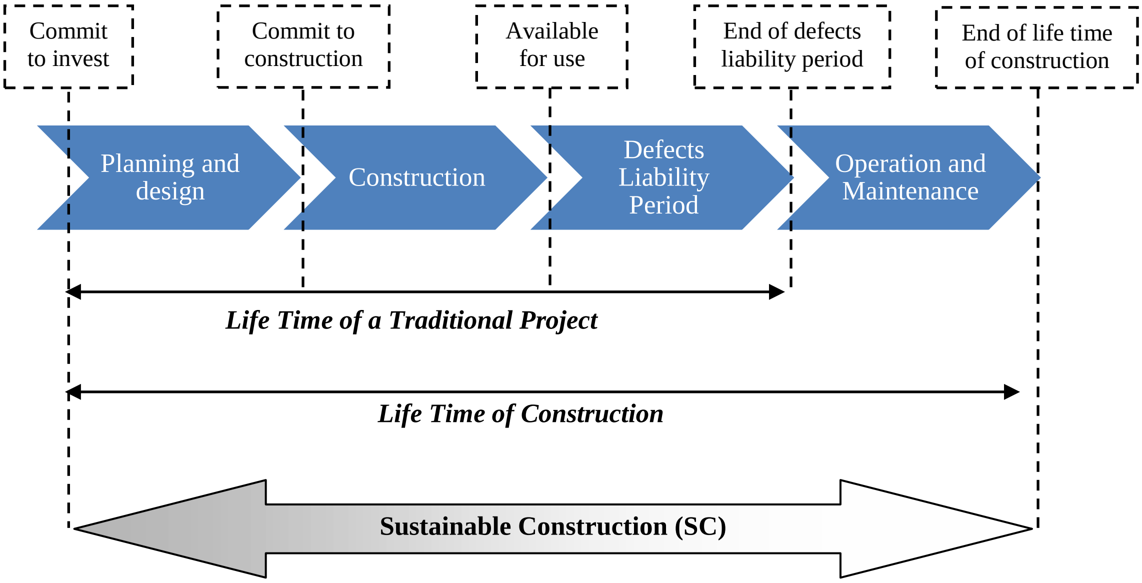


Figure 2.4: Life time of project vs. Life time of construction (Adapted from Parkin, 2000)

According to Edum-Fotwe and Price (2009) 'lifecycle' identifies the instance of existence for an entity within a selected scale. The Pearce report highlights the importance of considering the whole life-cycle of a construction from design until deconstruction if SC is to be properly achieved (Myers, 2005). Accordingly, lifecycle of a construction includes inception, design, construction, operation and maintenance and de-construction phases. A few authors have expanded this further, stating that the process commences from raw material extraction (Du Plessis, 2002), thereby stressing the importance of taking the material and component supply chains into consideration as well (Wyatt et al., 2000). Additionally, Cooper (2006) also brings in urban planning under the umbrella of SC. This recognises the need for the industry to work closely with planners to ensure the delivery of a holistic approach to SC ultimately leading to sustainable communities. This view is also reflected in the public consultation report on the Draft Strategy for SC (Department for Business Enterprise and Regulatory Reform - BERR, 2008), where the respondents have suggested the inclusion of the role of urban design within the scope of the strategy.

Likewise, many researchers such as, Hill and Bowen (1997), NAO (2007), Ofori (1998), Parkin (2000), Shi and Gong (2008), Wyatt et al., (2000) are in consensus that the concept of SC incorporates a 'cradle-to-grave' approach, starting from the planning and design stages and continuing through to the de-construction stage. In the past decade, this cradle-to-grave approach of SC has undergone a further conceptual shift towards the cradle-to-cradle framework. As opposed to the one-way material flows in cradle-to-grave approach, the cradle-to-cradle framework looks at material flows in 'safe, regenerative, closed-loop cycles' (McDonough et al., 2003). Thus, SC has evolved from focusing on mere reduction of negative impacts (i.e. cradle-to-grave approach) (for example see, Huovila and Richter, 1997; Lanting, 1998; van Bueren and Priemus, 2002) to maximising the positive effects in terms of benefits (i.e. cradle-to-cradle framework) towards the environment, society and economy (Du Plessis, 2005; McDonough and Braungart, 2003).

2.6.2 Elements of SC

The second issue that draws attention in reviewing the available definitions for SC is the different elements of SC that the authors have focused upon. These elements of SC have also been referred to as dimensions of SC. Some authors such as, van Bueren and Priemus (2002), Huovila and Richter (1997) and UNEP (2003), in their definitions, have viewed SC as primarily an environmental issue. This has led several authors to view SC as being synonymous to 'good environmental management'. However, this understanding of SC as primarily an environmental issue has undergone noticeable changes over the years. Initially, the emphasis was on the issue of limited resources (especially energy) and reducing the environmental impacts (see section 2.5). The solutions were sought mainly through technical improvements to building materials, components and energy related design concepts (Sjostrom and Bakens, 1999). However, it is now generally accepted that achieving SC is not possible purely through an environmental perspective.

Since, SC reflects the application of SD principles to the construction sector, it is generally accepted that similar to SD, SC also addresses the three environmental, social and economic elements. However, review of the SC and generic SD literature reveals a number of additional elements that have been considered by different authors in different contexts (refer to Table 2.2).

Table 2.2: Elements of SC

Elements/ Dimensions of SC / Reference	Environmental/ Ecological/ Biophysical	Social	Economic	Institutional	Legal	Political	Cultural	Technical	Managerial	Community	Moral
Sjostrom and Gavle (2000)	•	•	•		•	•		•			
Pawlowski (2008)	•	•	•		•	•		•			•
Valentin and Spangenberg (2000)	•	•	•	•							
Sutheerawatthana and Minato (2009)	•	•	•								
Persson and Olander (2004)	•	•	•				•				
Sjostrom (2001)	•	•	•		•	•	•	•			
Hill and Bowen (1997)	•	•	•					•			
Ofori (1998)	•	•	•						•	•	
Mitlin and Satterthwaite (1996)			•				•			•	
Liu (2006)			•		•						
Ashley et al. (2003)	•	•	•					•			
Nelms et al. (2005)	•	•	•					•			
Du Plessis (2002)	•	•	•				•				
Langford et al. (2000)							•				
IISD (1997)	•	•	•	•							

In addition to the above mentioned, Liu (2006) uses two other elements, socio-economic (which describes the behaviour of project participants' in acquiring built assets) and socio-environmental, in place of the more common three elements. Hill and Bowen (1997) have used the term bio-physical in place of the environmental element and introduced a fourth technical element in addition to the three main elements. The technical element introduced by them, describes the principles that relate to the 'performance and quality of a building or structure'. Although, this could typically be viewed as part of the social element, the introduction of the additional element has been justified due to the fact that it requires application of technology (Hill and Bowen, 1997). Valentin and Spangenberg (2000) have also used a fourth element to differentiate the institutional aspects from the environmental, economic and social elements. Herein, the institutional element is described as referring to the human interaction and the rules by which they are guided, which in other words is viewed as 'institutions of the society'. In contrast, the social element according to Valentin and Spangenberg consists of the aggregate of human capabilities.

According to Gibson (2001), the number of dimensions or elements considered is merely an issue of placing emphasis. For example, he notes that in SD discussions, environmentalists generally favour a two-pillar approach as this places equal importance on the environmental concerns and human development. On the other hand, the international development programmes seem to place emphasis on the three or five pillar versions to stress the importance of the other elements in long-term development. However, a main issue with regard to these various elements put forward by different authors is the lack of reasoning given for selecting a particular set of elements and/or disregarding the rest. For example, Hill and Bowen (1997) who consider SC based upon the four social, economic, bio-physical and technical elements, have not provided any reasons for selecting those particular dimensions.

Selection of what specific elements are to be considered and prioritised would depend upon the context of the study (Ofori, 1998). The type and scale of problems faced, development priorities, capacity of local industry and government, nature of building stock, stage of industrial development, skill levels and cultural values are some of the factors that could play a part in determining the significance of different SC elements in a given context (Sjostrom, 2001; Sourani, 2005). For example, Ofori (1998) states that managerial and community elements are especially relevant for developing countries. This is because in these contexts, managerial sustainability can ensure that 'construction products, especially large and complex ones undertaken by foreign companies, remain in effective and efficient use throughout their lives'. Similarly, community sustainability is important in instances where major developments are carried out without due regard to the community concerns, thereby, causing disruptions to the local livelihoods and social links.

Pawlowski (2008) postulates that there is a hierarchal relationship between the different elements of SD. He views moral issues to hold the highest position in this hierarchy. The ecological (or environmental), social and economic issues comprise the second level, whilst legal, technological and political elements are at the final level. He views full integration of all these three levels as necessary, even though extremely difficult to achieve in reality.

However, there is wide acceptance that SC should incorporate at least the three environmental, social and economic elements. These appear to be the most commonly discussed and used throughout the literature. Furthermore, typically, the issues considered under the legal, political, ecological, cultural, bio-physical, technical, managerial and community elements can also be broadly categorised under the three main elements. Therefore, it could be postulated that attaining SC requires reaching a state of harmony between these three basic elements during the life of a construction. This will in turn contribute to the achievement of long-term SD goals. The following sections go on to discuss the importance of and goals in relation to each of the three main elements.

2.6.2.1 The Environmental Element

Construction sector activities and end products have significant impacts on the environment. The major environmental impacts of construction include, energy consumption, air (e.g. dust and gas) emissions, waste generation, noise pollution, land use, existing site dereliction, habitat destruction, the use of natural resources, the use of water resources, and water discharges (Tam et al., 2006). The environmental costs of construction are not limited to the physical construction phase, but accrue over the entire life cycle of the construction (Circo, 2008).

Worldwide, the construction industry is responsible for more than one third of total energy usage and the associated GHG emissions (Cheng et al., 2008). The United Nations Environment Programme (UNEP) has reported that 30-40 % of all primary energy used worldwide is in buildings (Cheng et al., 2008; Circo, 2008). This value is expected to further increase over the years with the increasing demand for housing and office spaces in developing countries. The Inter-governmental Panel on Climate Change (IPCC) (cited Cheng et al., 2008) reports that the building related CO_2 emissions, including use of electricity, could increase from 8.6 billion tonnes in 2004 to 11.4 billion tonnes in 2030, under a low-growth scenario. On a high-growth scenario this figure is estimated to be 15.6 billion by 2030. Out of this, the amount of Carbon Dioxide (CO_2) emissions that construction can influence is significant, accounting for almost 47% of total CO_2 emissions of the UK (BIS, 2010).

The amount of materials used in the construction industry annually is equivalent to 6 tonnes per head of population in the UK (Shelbourn et al., 2006). The production of these construction materials consume over 90% of non-energy minerals extracted in the UK. The Environmental Agency (2012) reports that in 2010, 20 million tonnes of construction, demolition and excavation waste was sent to landfill. In fact, construction, demolition and excavation waste was found to be the largest contributor to illegal waste sites at the end of 2011 (Environmental Agency, 2012). The construction industry is also responsible for 20% of all industrial and commercial noise complaints (BRE, 2002).

According to Adetunji et al., (2003) environmental sustainability addresses the impact of construction activities on the environment and propagates the prevention of harmful and potentially irreversible damages to the environment. However, few have taken this further and consider the environmental sustainability to be concerned not just with 'preventing' harmful effects on the environment by careful use of natural resources and minimising waste, but also where possible, 'restoring or enhancing' the environment (BRE, 2002). Principles of environmental sustainability of construction found in literature include (Anink et al., 1996; Dair and Williams, 2006; DETR, 2000; Hill and Bowen, 1997; Venters et al., 2005);

i. Minimisation of resource consumption - includes energy (especially carbon based), water, materials and land.
ii. Maximisation of resource re-use/recycling.
iii. Use of renewable resources in preference to non-renewable resources.
iv. Extract fossil fuels and minerals, and produce persistent substances foreign to nature, at rates which are not faster than their slow redeposit into the Earth's crust

v. Protecting and enhancing the earth's vitality and bio-diversity.

vi. Creation of a healthy and non-toxic environment by minimising pollution.

vii. Pursuit of quality in creating the built-environment.

viii. Minimise damage to sensitive landscape.

Environmental sustainability in construction is fairly well researched and is generally considered to be more advanced than the social and economic aspects. This could partly be attributed to the availability of well-established environmental management systems. Furthermore, it is easier to develop quantifiable targets for the environmental principles of SC, compared to the social and economic principles (UK Green Building Council, 2009) report. In addition, the general trend in the industry is that, most that are vested with the responsibility of implementing SC are from environmental management backgrounds (Adetunji et al., 2003). This has also resulted in a high level of emphasis to be placed upon the environmental issues.

2.6.2.2 The Social Element

Pawlowski (2008) views the social element as an environment that could undergo degradation in the same way as the natural environment. According to Pawlowski, this 'environment' comprises of a large number of factors, including customs and traditions, culture, spirituality, interpersonal relations and living conditions. Hence, social dimension of SC could be seen as concerned with addressing the needs (related to the above mentioned factors) of people that are involved in the construction at different stages of its life cycle. This may include stakeholders such as, clients/users, suppliers, employees and local communities. Addressing the social concerns over the construction life cycle is especially difficult because, unlike the other manufactured products, constructed facilities (especially buildings) have significantly longer life spans.

Typically, the construction industry has acquired a negative perception amongst the public. The industry has been perceived as being dirty, disruptive, dangerous, old fashioned and sometimes dishonest (Construction Industry Research and Information Association - CIRIA, 2001; Myers, 2005). The latter is mostly attributed the existence of rogue traders, known as 'cowboy builders' that tarnish the industry reputation (DETR, 2000).

Construction is a key industry that creates a physical stock of facilities and infrastructure that determines our way of living for up to 100 years or more after its establishment (Pollington, 1999). The built environment determines the nature, function and appearance of our towns and country sides (DETR, 2000). Thus, the construction industry plays an important role in determining the quality of life of people. People typically spend around 90% of their lives in buildings (BRE, 2002) and it is expected that 70% of the world's population will be living in urban areas by 2050 (Population Reference Bureau, 2012). Hence, the buildings have the ability to make significant impacts on the health of their occupants. Indoor air in general has been found to contain two to five times more pollutants than outdoor air (occasionally, this value is found to be greater than 100 times even). This poor quality of indoor air can result in various health risks such as, cancers, asthma and Legionnaires' disease (Baum, 2007; Kibert, 2008). Overall, the buildings in the UK have been found to be less healthy, less efficient, generating more waste and pollutants and more costly to run compared to those in most other European countries (Halliday, 2008).

The social element of SC is, therefore, concerned with the legal, moral, and ethical obligations of the construction industry to its stakeholders such as, employees, suppliers, and the community in which it operates (Adetunji et al., 2003). Given below are some of the various principles of social sustainability in construction found in literature (Dair and Williams, 2006; DETR, 2000; Hill and Bowen, 1997; Sjostrom, 2001);

i. Improving the quality of human life, including poverty alleviation.
ii. Making provisions for social self-determination and cultural diversity in development planning.
iii. Uplifting communities.
iv. Protecting and promoting health through a healthy and safe working environment.
v. Adhering to ethical standards (ethical trading standards and fairness-at-work policies).
vi. Developing human resources.
vii. Implementing skills training and capacity enhancement of disadvantaged people.

viii. Fair and equitable distribution of social costs of construction.

ix. Equitable distribution of social benefits of construction.

x. Seeking inter-generational equity.

xi. Providing adequate local services and facilities to serve development.

xii. Integrating development within the locality.

xiii. Providing high quality, liveable developments.

xiv. Conserving the local culture and heritage.

xv. Providing structures that meet the needs of the customers and users (e.g. provide greater satisfaction, well-being and value).

xvi. Respecting and fair treatment of stakeholders.

2.6.2.3 The Economic Element

According to Adetunji et al. (2003), the economic sustainability of construction is, 'the industry's contribution towards maintenance of high and stable levels of economic growth and employment through increased productivity and improved project delivery'. This requires efficient use of resources including labour, materials, water and energy so that profitability may be increased. However, the pursuit of profitability should not be sought at the expense of the environment or public needs (BRE, 2002). Hence, SC in an economic or business sense, seeks to provide better value for clients, whilst reducing the impacts on the environment and better addressing the needs of all stakeholders.

The construction industry is key to a nation's economy. Not only that, the industry is also seen as a critical component for governments to achieve many of their policy aims (Bosher et al., 2007). Construction industry is also the largest economic sector in many countries. In the UK, the construction sector contributes approximately 7.6% to the overall Gross Domestic Product (GDP) (Office for National Statistics, 2012). In 2010, the sector contributed £71 billion to the national Gross Value Added and played a crucial role in sustaining the economic recovery (GVA, 2011). Being mostly labour intensive, the construction industry is a major source of employment for people. It also has strong backward and forward linkages with numerous other industries. For instance, the construction products accounts for 20% of UK's total manufacturing output, which represents 4% of the country's GDP (Construction Products Association, 2007).

Furthermore, the state of the buildings and other constructed facilities can make a major impact on the productivity of the other industries.

The consideration of sustainability issues can also help minimise some of the key risks associated with construction for the clients. This could be through reducing the exposure to Green taxes, minimising costly planning application processing delays, avoiding loss of reputation and resistance by pressure groups and/or making buildings more accessible. In addition, various researchers have shown a positive link between business performance and sustainability in the construction industry (Adetunji et al., 2003).

The principles of economic sustainability of construction found in literature include (Dair and Williams, 2006; DETR, 2000; Hill and Bowen, 1997; Sjostrom, 2001);

i. Ensuring financial affordability for beneficiaries by reducing overemphasis on technical sustainability.
ii. Promoting employment creation and labour intensive construction in order to keep the financial contribution in local hands.
iii. Using full cost accounting and real cost pricing to set prices and tariffs for goods and services fully reflecting social and bio physical costs.
iv. Enhancing efficiency and competitiveness by adopting policies and practices that advance sustainability issues.
v. Selection of environmentally responsible suppliers and contractors.
vi. Investment of some of the proceedings from the use of non-renewable resources in social and human-made capital (this is to ensure that the needs of the future generations could be met).
vii. Acquiring financial benefits/profits.
viii. Supporting local economic/business diversity.

Adetunji et al. (2003), Sjostrom (2001) and Sourani and Sohail (2005) have all observed that compared to the environmental dimension, the social and economic dimensions of SC appear to be far less developed.

2.6.3 Consideration of Non-Technological Solutions

This third feature characterising SC questions the sole reliance on technology to drive forward the SC agenda. There are several problems associated with pursuing SC primarily through the provision of technological solutions. For instance, Murray (2009) argues against the emphasis on technology as the primary means for achieving SC due to the following reasons;

i. ‘there are unintended (as well as intended) outcomes of new technologies’
ii. the necessity to have ‘effective uptake of technologies in order for them to be effective’
iii. it can ‘draw attention away from more urgent needs for systematic change’

It is now increasingly acknowledged that achieving SC is not possible solely through technological means (Pawlowski, 2008; Rodriguez-Melo and Mansouri, 2011). This means that technological innovations and various design-directed solutions to achieve SC should be complimented with more ‘process-oriented measures’ (van Bueren and Priemus, 2002). Thus, the uptake of SC is not just dependent upon the technological solutions, but also the industry structure, communication channels, and the ‘organisation and strategic orientation of its constituent actors’ (Boden cited Rohracher, 2001). One of the more comprehensive definitions for SC, which is provided in ‘The Agenda 21: SC for Developing Countries’ addresses this issue. It refers to ‘ethical, moral, and spiritual connotations’ requiring ‘attitudinal changes’ and ‘value re-orientation’ with regard to the uptake and implementation of SC (Du Plessis, 2005). This is especially important given the nature of the concept of SC, which makes it improbable to avoid the need for the key decision makers to make explicit value judgements (Foxon et al., 2002). This in turn calls for changes to long-held beliefs, practices, traditional value systems and attitudes of the stakeholders (Kurul et al., 2012). The significance of these non-technological aspects has led some authors to state that technical solutions are only a minority solution to the challenge of SC (Huesemann, 2003, Masoso and Grobler, 2010, Rohracher, 2001; van Bueren and Priemus, 2002). The ‘social embedding’ and ‘socially interactive process’ that must be followed throughout the construction life-cycle, is viewed to be a much more crucial element in achieving SC (Rohracher, 2001).

2.6.4 Addressing the Needs of Present and Future Stakeholders

The construction practice relies upon the interactions among many different stakeholders in a 'complex network of relations' (Atkinson et al., 2009; Bosher et al., 2007). The traditional viewpoint within the construction industry is that the constructed facility has to address the needs of their clients and owners. This same view is taken up by Augenbroe et al. (1998) in defining SC as a 'possible strategy to better meet the needs of clients and owners' (refer to Table 2.1). However, SC calls for extending this traditional view to ensuring that the real needs of all present end-users are met, whilst recognising the impacts on future generations as well (Fenner et al., 2006). The latter requires the completed facility to have the flexibility to address the changing needs of the various stakeholders throughout the life cycle of the construction (for example, Raynsford, 2000).

This further highlights the importance of stakeholder participation in the decision-making process (Acreman, 2005; Ashley et al., 2003). The time at which the stakeholders get involved in the decision-making process is important as the opportunity to provide inputs on certain aspects of SC can be limited to specific time periods (Dair and Williams, 2006; van Bueren and Priemus, 2002). Hence, it is important to get the stakeholders potentially affected by the proposed activities involved in a timely manner, giving them equal access within the decision-making process (WCED, 1987).

2.7 SUMMARY

Whilst developments are still being made in relation to providing conceptual precision on SD, the principles of SD continue to be applied at various levels/sectors. The activities of the construction industry result in significant environmental, social and economic impacts. The adoption of sustainability principles within the construction industry is therefore, crucial to attain the overarching goals of SD. Herein, different terminologies (such as, green construction, high performance construction) have been used to describe the application of sustainability principles within the construction industry practices. However, further scrutiny revealed that although they have often been used interchangeably within the literature, there are differences in the meanings and applications of these various terminologies. After reviewing these, SC was chosen as the most suitable term to discuss the focus area of this research, as it includes a more comprehensive view of SD in the construction industry compared to other terminologies. Although, there is no unique, universally agreed upon definition, SC is characterised by a number of features. These include, consideration of whole life cycle issues in relation to the processes as well as products, adopting a three pillar approach considering all three environmental, social and economic elements, consideration of non-technological issues in addition to seeking technological solutions and addressing the needs of stakeholders throughout the construction life cycle. In light of the high level of disagreements and confusions within the area, two questions now arise, particularly in relation to the practice of SC within the UK construction industry. Firstly, given the lack of a uniform understanding, there is a need to explore how SC is interpreted within the UK construction industry. Secondly, there is a need to explore how these interpretations are transformed into practice through project level implementation. The latter is especially important given the call for high levels of process and cultural changes in implementing SC. Accordingly, the next chapter will go on to develop a conceptual framework to address these issues.

CHAPTER 3: THE UPTAKE AND IMPLEMENTATION OF SC AT CONSTRUCTION PROJECT LEVEL – A CONCEPTUAL FRAMEWORK

3.1 INTRODUCTION

This chapter presents the conceptual framework developed to guide the next stages of this research. The developed framework encompasses three key focus areas, which are explained in depth within this chapter. Overall, the conceptual framework addresses the key issues highlighted in section 2.7 relating to the interpretation and practical implementation of SC. These issues are discussed in greater detail within the first part of this chapter. A review of the various models and frameworks addressing the aforementioned issues that are available in literature is then provided. This review has been used to justify the need for a novel, more holistic framework addressing the uptake and implementation of SC within construction project environments. The conceptual framework developed is then presented. The first and second stages of the framework address the issues relating to the interpretation (i.e. uptake) of SC and the third stage addresses the implementation issues. The framework also presents the research questions that will be explored at each stage. Accordingly, this chapter fulfils objective 2 and the first research question (i.e. RQ1) of this research.

3.2 WHAT IS A CONCEPTUAL FRAMEWORK?

Conceptual frameworks act as the under-pinning of a general theory (Dean and Clarke, 2003). When there is an absence of theory, a conceptual framework is useful in organising a particular subject, by identifying the connections between various component parts and recognising areas where further development is required (Sprague, 1980). Frameworks are useful for theory generation as they assist in organising inquiry.

Within the literature, 'framework' has often been used interchangeably with 'model'. However, a 'model' is,

> *'an abstract representation of a real-world system that simplifies and assumes as much as possible about the system, and while retaining the system's essential relationships, omits unnecessary detail' (Druzdzel and Flynn, 2002).*

Building a model of a decision problem therefore, allows for analysing, explaining and arguing about a decision problem. On the other hand, frameworks by themselves do not explain or predict outcomes (Walt et al., 2008). According to McGaghie et al. (2001), developing a conceptual framework can contribute to the research process by identifying research variables and clarifying relationships among variables. Thus, clearly a conceptual framework should be closely linked to the research aim (refer to section 1.2) and 'should set the stage for the presentation of the research questions' that are being investigated within the research (McGaghie et al., 2001). The next section of this chapter discusses the key issues that emerged through the initial literature review that formed the basis of the main focus areas of the conceptual framework. The developed conceptual framework is presented in Figure 3.3.

3.3 THE UPTAKE AND IMPLEMENTATION OF SC – KEY ISSUES

The discussions in chapter 2 made it evident that the construction sector has a key role to play in achieving the goals of SD. Indeed, the construction industry acts as the 'delivery mechanism' for many aspects of government policy that are aimed at providing and modernising the nation's built environment (DETR, 2000).

Pressures on the industry to pay more attention towards the social, environmental and economic issues, have led to the development of a plethora of advisory documents (refer to section 1.1). SC is being driven and enforced by the UK Government through stringent fiscal policies and regulations, various 'naming and shaming' policies and several government initiatives (Adetunji et al., 2003). For instance, the Aggregates and Landfill Taxes and waste management licensing regulations have now turned recycling of construction materials into a 'commercial necessity' (Environmental Agency, 2012). Parkin (2000) states that evidence-based policy and UK policy framework are two of the key contexts and drivers for SD in the UK. Taking this commitment forward, the new Greening Government Commitments, published in February 2011, have set out the coalition government's ambitious goals to reduce greenhouse gases, waste and water usage and to further improve the sustainability of its procurement by 2015 (DEFRA, 2011a).

It has been noted that the sheer number as well as the uncoordinated nature in developing these various documents, have made the uptake and implementation of these, at project level, often confusing and inefficient (GVA, 2011; UK Green Building Council, 2009). Indeed, a review of SC activity within England have found that only a small proportion of buildings can claim to be sustainable in any way, revealing that SC is not happening in any substantial way (Halliday, 2008; Williams and Lindsey 2005; Wyatt et al., 2000). The result is that in the construction industry many opportunities that could help make the sector more efficient, less polluting, more socially responsible and therefore, ultimately more sustainable are missed. One indication of this is given in Figure 3.1 below, which shows the SC performance of the construction and refurbishment projects (measured through BREEAM rating system) undertaken by the government departments and agencies during the 2005-2006 period.

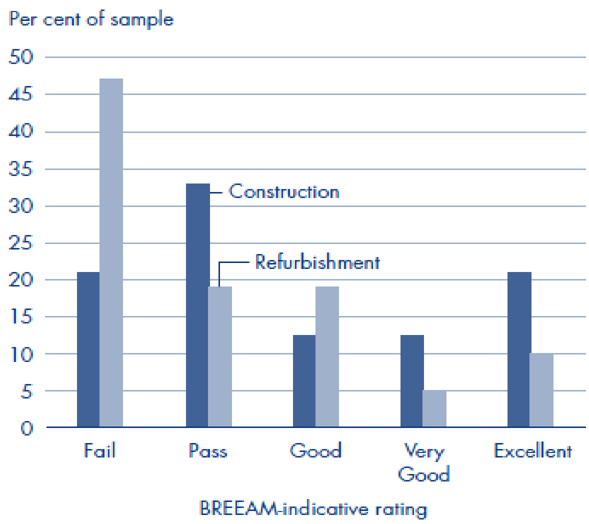


Figure 3.1: Sustainability ratings of construction and refurbishment projects (Source: NAO, 2007)

Furthermore, NAO (2007) has found that even in instances where SC is considered, certain issues were addressed more widely compared to others. Some of the widely addressed SC issues included;

- the use of sustainable timber, ensuring both the health and well-being of occupants by allowing adequate day light penetration and installation of an air intake system;
- energy saving through the incorporation of energy efficient lighting systems and monitoring systems for energy usage;

- improving water efficiency by implementing at least one water-saving measure;
- providing facilities to encourage staff to cycle to work and locating buildings in areas where public transport could be the main mode of staff transport;
- minimising waste by undertaking recycling of metals and aggregates during construction or refurbishment processes;
- conducting bio-diversity impact assessments and using brown field sites as opposed to Greenfield sites to minimise impact on wildlife.

On the contrary, issues such as use of renewable sources for energy generation, monitoring of the environmental impacts during the construction process and social issues such as, local community consultations were given less consideration (National Audit Office - NAO, 2007). The disparity between the levels of consideration given to issues could be attributed to the availability of regulations to guide actions.

There are also indications that the available technological expertise seem to be under-utilised, as evidenced by the gap between the levels of technological ability and the actual performance of the building stock (Rohracher, 2001). This has led to some authors to state that technical solutions are only a minority solution to the challenge of SC (see Rohracher, 2001; van Bueren and Priemus, 2002). Far more important are the 'social embedding' and the 'social interactive process' that must be followed throughout the construction life-cycle to achieve SC (Rohracher, 2001). In this respect, the implementation of SC is not just dependent upon the technological practices, but also the industry structure, communication channels, and the 'organisation and strategic orientation of its constituent actors' (Boden cited Rohracher, 2001).

Thus, the problem appears to be two-fold; i.e. a number of key issues exist both in terms of the uptake of the SC concept and its practical implementation at construction project level. Herein, the term 'uptake' is concerned with the aspects of 'understanding' and 'comprehension', whereas, the term 'implementation' refers to the actual execution and accomplishment (which in other words is described as giving 'practical effect to' and ensuring of 'actual fulfilment by concrete measures') (Merriam-Webster, 2012). Accordingly, implementation involves the active and therefore the most visible phase of achieving a goal. It involves different steps such as making budgets, finding resources, hiring people, establishing and managing organisations, inventing technologies, building, punishing, and rewarding (Meadows, 1994).

The review of literature revealed a number of different frameworks that address some of the above discussed issues. A review of these available frameworks are provided in the following section. Such a review is necessary as a starting point to establish whether a need exists for the development of a new framework within the context of this research.

3.4 A REVIEW OF EXISTING MODELS AND FRAMEWORKS FOR SC

Augenbroe et al. (1998) have put forward a framework, defining SC in a methodological framework with three main axes; i.e. System (boundary), Process (actor) and Aspect (sustainability). The framework is based on the presumption that there are different 'actors' acting within different 'system boundaries', who are responsible for different 'sustainability aspects', during the different phases of the 'life cycle' of a construction. Here the 'system axis' spans from building-internal composition levels (i.e. material, components and building systems level) to building-external macro and meso levels (building, city, ecosystems and world level). Along the 'process axis', the authors emphasise, there is a necessity to measure the 'effectiveness of the process'. This involves scrutinising how well stakeholders are involved in a process phase and working together in order to meet sustainability objectives.

However, Augenbroe et al. (1998) acknowledge that this framework ignores what they state as the 'real problem'. According to them this lies on the transition or boundaries between different system levels, actors and life cycle stages. They further stress the lack of support for integral comparison of different alternatives. When the effectiveness of implementing SC is considered, it is important to see how well the stakeholders involved in a particular process phase, interact to deliver SC requirements at different system boundaries. Augenbroe et al. (1998) advocate transparency across system boundaries at different system levels, as a solution for lack of co-ordination, which has been identified as a root cause for past problems.

A similar framework to the above has been proposed by Matar et al. (2008), called the Operational Context Space (OCS) framework (see Figure 4.2). This framework addresses the issue of lack of an integrated framework for addressing both the SC issues and construction practices at an operational level. It takes the form of a modular integration grid with the three axes; (i) project life cycle phases, (ii) project executing entities and (iii) sustainability performance parameters.

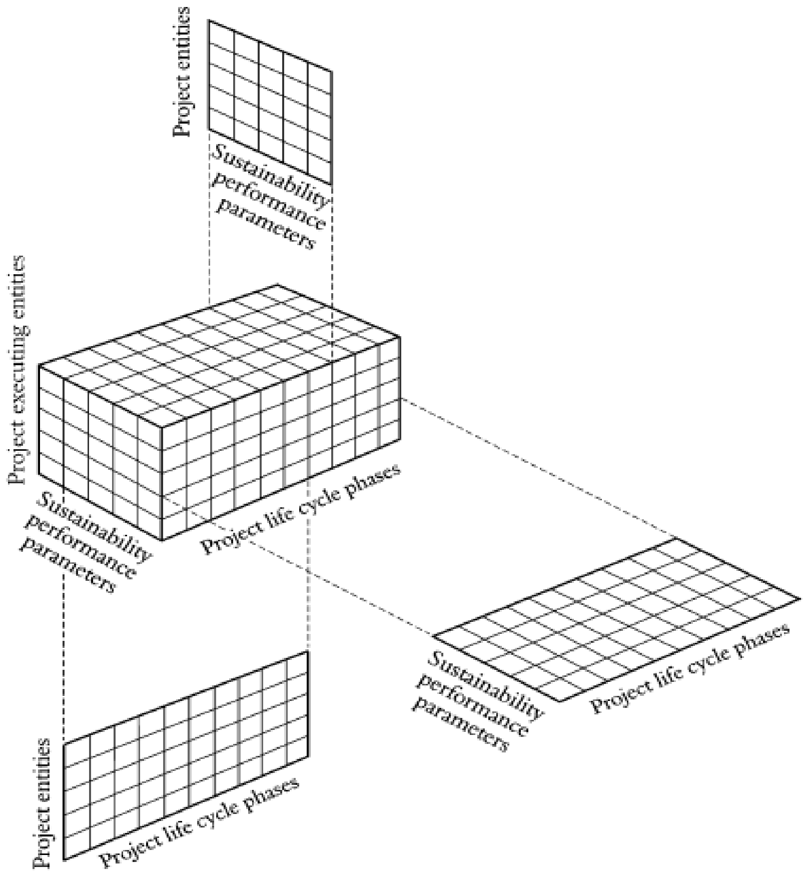


Figure 3.2: Operational Context Space (OPS) Framework (Source: Matar et al., 2008)

Considering the level of prescription within the above mentioned frameworks, neither of these frameworks has been developed to the point of being a useful tool for taking proactive measures in addressing SC. As per the discussions in section 4.3, both these frameworks address issues relating to the 'implementation' of SC. No information has been provided for the project level stakeholders to improve the 'uptake' of SC.

A third framework has been provided by Hill and Bowen (1997), called a 'framework for the attainment of SC'. They present SC principles divided into the four of social, economic, technical and biophysical pillars, which could act as checklists for achieving each of these sustainability 'pillars'. These principles represent 'what' is to be achieved in terms of SC in a particular construction project. In addition to the aforementioned, a set of 'over-arching, process-oriented' principles are also presented. The latter could help to determine both the applicability and the relative importance of each of the above-mentioned four pillars and the different principles coming under each of the said pillars, in a given context. These process-oriented principles include, *inter alia,* prior assessment of proposed activities, timely involvement of stakeholders, promoting inter-disciplinary collaborations and utilisation of life-cycle frameworks. The framework covers ‘how to’ achieve this through the application of ‘Environmental Assessment (EA) during the planning and design stages of projects’ and ‘implementation of Environmental Management Systems (EMS)...during construction, operation and where appropriate...decommissioning’ (Hill and Bowen, 1997).

This framework differs from the previously mentioned two frameworks due to several reasons. Firstly, it provides a set of SC principles that could assist in understanding and comprehending the concept of SC by the project parties. Secondly, Hill and Bowen’s framework targets SC from an organisational point of view, as opposed to one of a physical facility. This prescriptive model is targeted to policy makers and managers in construction organisations. However, a key issue with the principles of SC put forward by Hill and Bowen is that they have been developed at a very high aspirational level. Hence, the practical application of these at project level could be brought into question.

The OGC (2005) framework on SC procurement sets out a way in which the government clients can deliver SC projects. The framework is part of the Achieving Excellence in Procurement guides, which has replaced the Construction Procurement Guidance Notes series. The framework highlights the key decision stages throughout the life-cycle of a construction project and the sustainability issues to be considered at each of these stages. However, Sourani and Sohail (2005) has questioned the evidence base used in establishing the SC aims and issues used in this framework.

The final framework reviewed was called the Sustainability Management Activity Zone (SMAZ) (Khalfan, 2006). This has been developed based upon a previous framework called ‘the process protocol for design and construction’ which was the output of a research project carried out by Salford University. The SMAZ expands this protocol further to incorporate a sustainability management activity zone (Khalfan, 2006). The ambition of the process protocol was to provide an agreed set of processes and procedures in order for the various organisations involved in a construction project to work together seamlessly. One of the key features of the process protocol is that it does not use the professional titles of the project team members. Therefore, instead of using terms such as, Contractor or Designer, the protocol uses terms such as, production management, design management etc. (Lee et al., 2000). The rationale behind this approach is to promote integration within teams by minimising the inherent fragmentation observed within construction team environments based upon different professions and/or organisations. In doing so, it appears the aspiration of the process protocol was to act, in time, as an alternative or replacement for the RIBA plan of work (Lee et al., 2000; Winch and Carr, 2001).

The protocol is presented as a generic process protocol that is applicable to all project delivery contexts. However, it has been brought into question the level to which such a generic approach is applicable to the construction project environment. For instance, given the nature of the construction industry the standardisation of processes (where clients are more proactive than reactive) is viewed as highly elusive (Winch and Carr, 2001). Furthermore, Winch and Carr (2001) draw attention to an earlier study carried out by them in trying to apply this protocol. This revealed the depth of detail and prescription of the protocol, which makes it difficult for single construction clients to apply.

Therefore, in reviewing these available frameworks, it is clear that there is currently a void in literature for a holistic framework addressing both the uptake and the implementation aspects of SC. One significant challenge apparent from the review, is the wide disparity between frameworks in identifying what issues are considered important in defining SC. Whilst it is acknowledged that most of these issues would vary dependent upon the scale and type of projects, as well as local conditions, it is still important to provide a comprehensive view of SC. Another weakness of existing frameworks is their insensitivity to contextual factors. For example, there are lack of provisions within these frameworks for aligning what is achieved in terms of SC at construction project level with the wider scale aims/goals for SC, which are provided in both policy and other advisory documents. This has also been highlighted by the likes of Brandon and Lombardi (2011) who call for a holistic and integrated framework for SC. They state that a new approach, which has the capability to 'integrate and synthesise' all dimensions and different viewpoints in a 'holistic manner' is required for the effective decision-making for SC. The conceptual framework introduced in the next section, therefore, addresses this void.

3.5 AREAS OF FOCUS

The UK government has recognised the importance of the construction industry in achieving the overall goals for SD set for the country. This recognition has led to the development of a vast number of advisory documents. However, at the same time, there is a lack of conceptual precision surrounding the concept of SC. Therefore, the central focus of the conceptual framework developed in this chapter is to address this void.

Several key issues have been identified in relation to the above mentioned, which in turn, form the key areas of focus for the conceptual framework. These issues are;

i. Identifying the different policies and guidance available to guide the construction project stakeholders in the uptake and implementation of SC and understanding how these different documents interpret SC;
ii. Understanding how the construction project stakeholders interpret SC;
iii. Exploring how SC is implemented at project level.

Figure 3.3 below, shows the developed conceptual framework addressing the aforementioned key focus areas. The research questions that need to be investigated under each of these key areas are also presented. Discussions on the main areas of the framework are given in the remaining sections of this chapter.

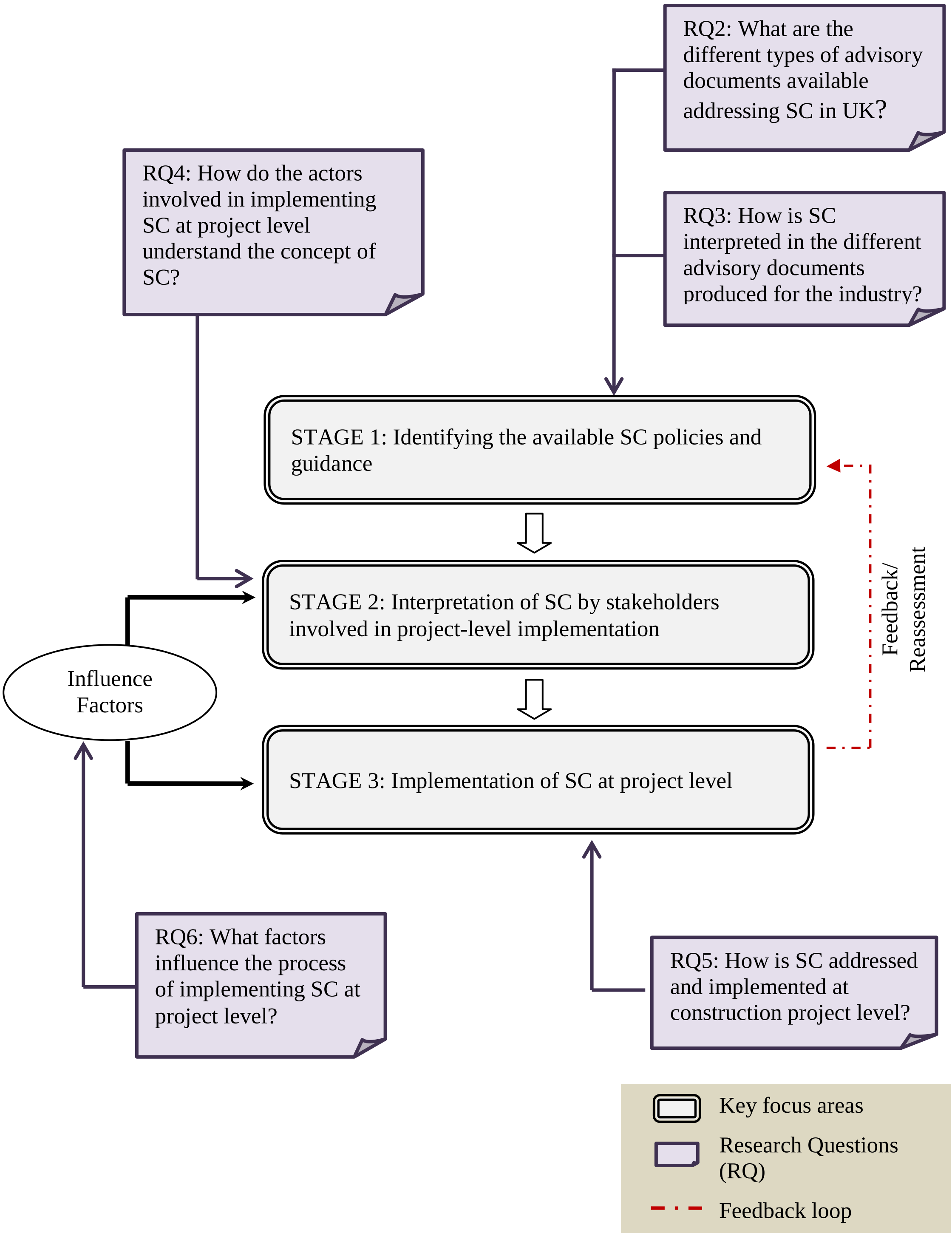


Figure 3.3: The conceptual framework for the uptake and implementation of SC

3.5.1 Stage 1: Advisory Documents' Interpretation of SC

The uptake and implementation of SC in the UK, is guided and stimulated by the use of financial instruments (for example, subsidies and fiscal advantages), product standards, government policies and communicative instruments (e.g. model projects and covenants) (Construction Products Association, 2007; van Bueren and Priemus, 2002).

For several years, SC has been a popular policy issue with policy makers and various government authorities, as well as, other non-governmental institutions directly involved in the construction industry. The last two decades have seen the publication of several government initiated reports on the construction industry (DETR, 2000; Innovation and Growth Team - IGT, 2010; Latham, 1994; Pearce, 2003). All these reports share a common theme in that they call for industry reforms, moving away from the traditional fragmented approaches, highlighting the role of innovation, training, and research (Myers, 2005). 'Rethinking construction', the report of Sir John Egan's Construction task force, called for the Government and industry to work together for radical change and improvement in construction performance (DETR, 2000). As a result, a vast number of policies, guidance and other advisory documents on SC have been produced.

The Innovation and Growth Team in its spring 2010 report state that the number of recent reports and initiatives that have been produced just in relation to carbon reduction by the Government, NGOs or other interest groups to be above 200 (Innovation and Growth Team - IGT, 2010). Referring to the different available government initiatives on SC, GVA (2011), which is a leading UK property advisor, notes that;

> *'at the moment there is a bewildering array of government incentives and initiatives designed to address these issues. But the existing or proposed schemes are generally complex, vary in their market coverage, and are not clearly directed. Despite the significant levels of funding (around £billion per annum) they may not be achieving maximum benefit from their investments' (GVA, 2011).*

Another key issue highlighted by most parties in relation to the development of advisory documents is the fragmented policy responsibility for SC, which is shared by several government bodies in the UK. This fragmented nature of responsibility for developing and implementing different aspects of SC, has sometimes led to 'reinventing the wheel' by different parties (UK Green Building Council, 2009). The NAO in its report 'Building for the future: SC and refurbishment on the government estate' has also addressed this and recommended that clear understanding should be established on the division of responsibilities for SC in the public sector, so that clear accountability for policy could be ensured (National Audit Office - NAO, 2007). The uncoordinated development of various policies, regulations and tools on SC have made the uptake and implementation of these at project level often confusing and inefficient (UK Green Building Council, 2009). In addition the various government departments, several non-governmental institutions such as, the Strategic Forum, Institution of Civil Engineers and Building Research Establishment have also come up with various guidance on SC for the project stakeholders. Cooper (2006) states that there is an 'unresolved bifurcation of SC between the planning system and the construction industry in the UK'. This has resulted in the development of broad policy guidance addressed at urban planners and detailed technical issues addressed at construction industry professionals. However, this divide has not constrained the development of policy initiatives on SC at either level (Cooper, 2006).

In considering the above, at the first instance, there is a need to understand how these various advisory documents interpret SC. This is pertinent to understanding the strategic level interpretation of SC, particularly given the lack of a uniform definition for the concept (refer to section 2.6). Little attention has been given to this issue so far within existing research. Bartlett and Guthrie (2005) have partly addressed this issue by analysing how 17 of the publicly available guides in the UK have defined SD. However, the documents analysed by them, have all been published between 1999 and 2003 and for the most part have now been superseded. In addition, a vast number of key documents have been published since then, including the revised Strategy for SC (HM Government, 2008). This stage of the conceptual framework therefore investigates the following research questions;

RQ2. What are the different advisory documents available addressing SC?

RQ3. How is SC interpreted in these different advisory documents produced for the industry?

3.5.2 Stage 2: Interpretation of SC by Construction Project Stakeholders

The construction industry activities rely upon the interactions among many stakeholders on a 'complex network of relations' (Atkinson et al., 2009; Bosher et al., 2007). Kibert (2008) states that in the USA, SC has provided a platform for bringing together a wide variety of stakeholders such as, builders, manufacturers and others who are generally not considered as 'environmentalists'. Extensive research has been carried out by Dair and Williams (2006) to identify different groups of stakeholders involved in construction. They present six groups of stakeholders, loosely classified according to their involvement in the different phases of the construction life cycle (see Table 3.1).

Table 3.1: Identification of stakeholders (Source: Dair and Williams, 2006)

Stakeholder Groups	Examples of types of stakeholder within each group
Stakeholders involved in land-use planning and regulation	
Group 1: regulators, statutory consultees, service providers and councillors	Environment Agency regulators (e.g.: pollution-control regulators, drainage and flood-defence regulators, biodiversity-protection regulators) Local authority regulators (e.g.: planners, urban designers, environmental health officers, highways and transport regulators, landscape architects) Councillors Health and safety executive regulators Building Control (local authority or approved inspectors) Utility Regulators and service providers (gas, electricity, water and drainage) Central government departments and regional authorities
Group 2: non-statutory consultees, interest groups and individuals	Business interests Pressure groups Community-group interests Individuals
Stakeholders involved in development and construction	
Group 3: property developers and developer interests	***Public sector and private developers*** Investors *(e.g. banks, pension funds)* Landowners Shareholders of investing institutions and developers **[Contractors]** Construction workers Suppliers
Group 4: Professional advisors	Lawyers **Architects**, planning consultants, conservationists, and archaeologists **Civil and environmental engineers** **[Cost consultants]** Surveyors Insurers and valuers Landscaping consultants
Stakeholders involved in end use	
Group 5: End-users	***Clients of developers*** *(e.g.: manufacturer, business entrepreneurs, retailers, home buyers, public-service providers)* Residents of dwellings and residential homes Proprietors of commercial business including offices, shops, and restaurants, and their suppliers, employees, and customers Manufacturers and their suppliers, employees, and customers Managers and proprietors of public or private institutions including schools, hospitals and leisure centres and their employees and visitors [**Facilities managers/Building managers**] Landowners of public or private open space, parks, gardens, woodland, and the public that use them

Note: the stakeholders within [ ] were not included in the original list provided by (Dair and Williams, 2006) and were included for the purposes of this research to make the list comprehensive.

SC decision-making process requires the active participation of the relevant stakeholders in a timely manner (Antunes et al., 2006). Whilst it is important to consider the stakeholders' needs and to incorporate them into the agenda, it is also important to appreciate the extent to which they grasp and put into practical use, the agendas for a sustainable built environment (Bosher et al., 2007). Within the context of a construction project, these numerous stakeholders have complex relationships. This means that perceptions, attitudes and decisions of one stakeholder can affect others.

Stage 2 of the framework therefore, scrutinises what is perceived as SC by those involved in its practical implementation at project level. This is a fundamental issue affecting the uptake and implementation of SC. Dair and Williams (2006) assert that whilst stakeholders generally share a genuine aim to make their developments successful, there is disagreement and confusion in relation to sustainability aspects. Hence, it is important to appreciate the extent to which the various stakeholders grasp and put into practical use the agendas for SC. This knowledge on stakeholders' perceptions on SC is important as a precedent to any discussion on implementing the concept (Kiewiet and Vos, 2007). At this stage there is a further need to investigate whether SC is perceived by the different stakeholders in the same manner that it has been interpreted within the advisory documents (as established in stage 1). Such a comparison is important in order to ensure that what is actually being implemented as SC at construction project level is the same as what is been agreed at the strategic level (Bartlett and Guthrie, 2005; Carter and Fortune, 2008).

Accordingly, this stage of the framework investigates the following research question;

RQ4. How do the actors involved in implementing SC at project level, understand the concept of SC?

3.5.3 Stage 3: Implementation of SC at Project Level

At this third stage, the main focus of the framework is to establish the process of implementing SC at project level. According to Rydin and Vandergert (2006), when it comes to implementing SC, one has to understand the decision-making processes and actors together with the inter-relationships between them. Up to now, this is a key area that has been poorly explored through research (refer to section 1.1). As stated in the previous section, the effective integration, communication and co-operation amongst different stakeholders, become essential when it comes to implementing SC. Moreover, the implementing SC requires the key players to consider 'values', in addition to mere 'facts' when making decisions. This means answering questions such as, what should be honoured, protected, sustained, or developed. Within this context, the use and effectiveness of decision processes that solely rely upon formal assessment techniques with 'analysts', having the full control of decision support, have been questioned (Antunes et al., 2006).

In addition to these, it is also important to investigate the influence factors that act as enablers and barriers to this process. A main challenge now facing the industry is transforming the strategic SD objectives for the nation, which are represented in the industry specific advisory documents, into concrete project level action. In order to achieve this, Augenbroe et al. (1998) call for a 'fundamental paradigm shift' in the way we approach construction itself, stating, that widespread disconnected initiatives alone, are not sufficient to achieve SC.

Stakeholder participation in the decision-making process is becoming more widespread with calls to adopt more transparent and stakeholder-sensitive decision processes (Acreman, 2005; Ashley et al., 2003). The time at which the stakeholders get involved in the decision-making process is important, as the opportunity to introduce and give inputs on certain aspects of SC can be limited to specific time periods (Dair and Williams, 2006; van Bueren and Priemus, 2002). Hence, it is important to get the stakeholders potentially affected by the proposed activities involved in a timely manner, giving them equal access within the decision-making process (WECD, 1987). Given the fragmented structure and project-based nature of the industry, participation and collaboration of a variety of parties is necessary for addressing SC. For example, Dewick and Miozzo (2002) observes that, even though, in the construction industry, the 'upstream product manufacturers and suppliers' are mostly responsible for sustainable innovations, the clients have the responsibility of specifying the use of these innovations taking into account aspects such as, long-term benefits and whole life value. Similarly, the client's advisors have the responsibility of transforming these client's requirements and incorporating them into the project design. The contractors, in turn have the responsibility of incorporating these innovations into the construction by giving due consideration to issues such as, buildability. Within this context, the lack of collaboration and communication between these separate actors can lead to 'vicious circles of blame', where each party seeks to pass the blame to the others for not adopting SC practices (Dewick and Miozzo, 2002). Therefore, it is important to investigate whether all the 'right' stakeholders, whose input is necessary, are involved within the decision process.

Accordingly, this stage of the framework investigates the following research questions;

RQ5. How is SC addressed and implemented at construction project level?

RQ6. What factors influence the decisions made in implementing SC at project level?

3.6 SUMMARY

The aim of this research is to understand the interpretation of SC and to develop a framework that can assist in its effective uptake and implementation within construction project environments. There is wide array of policies and other advisory documents on SC available in the UK. However, despite this abundance of advisory documents and commercially available technologies, the industry shows poor efficiency in engaging in SC and is performing below its full potential. The poor performance of the construction industry in terms of SC appear to be mainly the result of non-technological reasons such as, the lack of understanding or poor interpretation of policies and guidance by stakeholders at project level, lack of integration in decision making systems, poor linkages between policy and on-the ground realities, education and mind-sets of stakeholders, the focus on short-term rather than the long-term and the lack of flexible user-friendly tools for decision support. A gap exists in the present literature for a framework that can address the above mentioned issues. The conceptual framework developed in this chapter aims to fill this void by addressing issues relating to both the uptake and implementation of SC at construction project level. Overall, this chapter addressed the first research question (RQ1) and objective 2 of this research by justifying the need for a holistic and integrated framework addressing the uptake and implementation of SC at construction project level. The conceptual framework also set the stage for the development of further five research questions. The next chapter presents the research design adopted within this study in answering these research questions. The findings in relation to these research questions are discussed within the remaining chapters of this thesis.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter is about the choice of a suitable research methodology to achieve the research aim and objectives of this study. The chapter first lays out the philosophical orientation of the research taking into consideration the epistemological and methodological choices. It then goes on to discuss in detail the chosen strategies of inquiry, including data collection and analysis techniques, for each stage of the research. Overall, the research design consisted of four main stages. The first stage was the literature review. The second stage focused on analysis of advisory documents on SC. The third stage explored the interpretation and implementation of SC at construction project level, using three case studies analysed using the principles of grounded theory. The fourth and final stage of the research focused on the development of a framework that address the uptake and implementation of SC within a construction project environment. The validation and refinement of the developed framework was also addressed during this stage. Methods used to ensure the trustworthiness of research findings are also discussed within this chapter.

4.2 RESEARCH DESIGN

Research involves a 'methodical investigation' seeking answers to a problem or furthering understanding into a particular subject. Good research needs to be systematic; i.e. planned, organised and with a specific goal. Research methodology does not merely refer to the methods adopted in a research study. Research methods are procedures and techniques used for data collection and analysis (Strauss and Corbin, 1998). On the other hand, research methodologies encompass *'the rationale and the philosophical assumptions that underlie a particular study'* (Dainty, 2008). Accordingly, research design provides the 'plan' or 'the procedures' for research, covering decisions made in relation to the aforementioned philosophical, methodological issues as well as, research methods (Creswell, 2009). Accordingly, research designs could be quantitative, qualitative or mixed of both quantitative and qualitative approaches.

It has been widely asserted in literature that research methodology need to be sympathetic to the subject area being investigated. As was mentioned in Chapter 2, this research is multi-disciplinary in nature. It addresses the topic of SD in relation to the construction industry. Hence, the chosen research methodology for this study need to have the ability to address and capture the nature and characteristics of both these fields of research (i.e. SD and construction management).

SD is a value-laden, complex concept that is open to a wide variety of interpretations (refer to chapter 2). It has been used by different people to mean different things in different contexts (Bebbington, 2001). Methodological approaches chosen to study SD should, therefore, ideally have the ability to address the issues of complexity, values and different interpretations. Accordingly, Boulanger and Brechet (2005) highlight five criteria that influence the choice of methodological approaches in SD related research. These are; (i) interdisciplinary approach (ii) uncertainty (iii) long-term perspective (iv) global-local perspective and (v) participation. It is important that the chosen methodological approach for this research successfully addresses these criteria.

The construction industry also represents a complex and multi-faceted environment. Construction management presents a relatively new area for research, which involves a hybrid of natural science and social sciences (Dainty, 2008; Love et al., 2002). However, research in the area appear to be dominated for the most part by natural science related quantitative approaches. This is evidenced, for example, by the work of Dainty (2008), who after reviewing 107 papers published in the Journal of Construction Management and Economics (Vol. 24) highlights the dominance of quantitative research methods in construction management research (see Table 4.1).

Table 4.1: Research methods used in papers published in Vol.24 of Journal of Construction Management and Economics (Source: Dainty, 2008)

	Qualitative	Quantitative	Mixed	Review
Number of Papers	9 (8.4%)	76 (71%)	12 (11.2%)	10 (9.4%)

During the past two decades, there have been rising arguments against the dominance of positivist approaches in construction management research (Dainty, 2008; Seymour and Rooke, 1995; Seymour et al., 1997). Concerns have been raised that the natural science based epistemological and ontological positions within the positivist approach does not give due consideration to the people element, which is an essential aspect in the field of construction management (Seymour and Rooke, 1995; Seymour et al., 1997). Dainty's aforementioned review of the journal volume also highlights that there is a lack of attention given to articulating the methodological position of the researcher in the papers. This makes it difficult to determine whether the dominance of quantitative approaches within the research community is actually the result of positivist philosophical views of the researchers or merely a reflection of the adherence to natural science methodologies within the field (Dainty, 2008). Whichever is the case, Dainty (2008) questions the ability of quantitative approaches in providing 'rich and nuanced understanding of industry practice'.

Existing research addressing SD issues in the construction industry have used a variety of research designs. Chong et al. (2009) for example, have used a quantitative approach to understand and interpret the baseline perceptions of SC amongst civil engineers in the United States. Similarly, Rwelamila et al. (2000) and Manoliadis et al., (2006) have also used quantitative approaches to study sustainability issues in the construction industry. On the other hand, Carter and Fortune (2008) have used a qualitative approach to develop a set of features for sustainable social housing. Williams and Dair (2007) have also used a qualitative approach, using case studies to investigate the SC aspects of using prefabrication. Accordingly, examples could be found of research using both qualitative and quantitative designs within existing research addressing SC issues in the construction industry. What is important here is that whichever the chosen research design is, it has the ability to fully address the research aim and objectives of the study (refer to section 1.2) whilst being sympathetic to the nature and characteristics of the field within which the research is conducted. The remaining sections of this chapter presents the research design of this study, elaborating the decisions made in relation to philosophy (i.e. research paradigms), strategies and methods adopted in order to achieve the aim and objectives of the research.

4.3 RESEARCH PARADIGMS AND PERSPECTIVES

According to Botha (1989), a paradigm is a 'group commitment to a constellation of beliefs, which represents a particular way of viewing the world'. It is a term that has been popularised following the work of T.S. Kuhn. In relation to research, paradigms are defined as 'a cluster of beliefs' (Bryman, 2008; Denzin and Lincoln, 2005). These beliefs influence the researcher's choice of 'what should be studied, how research should be done and how results should be interpreted' (Bryman, 1988). Research paradigms have also been referred to as a 'net' or an 'interpretive framework' that influence the researcher's view of the external world and how he/she operates in it (Denzin and Lincoln, 2005). In addition, others have referred to research paradigms as 'world views' (Creswell, 2007; Fossey et al., 2002); 'schools of thought' (Snape and Spencer, 2003); 'systems of ideas' (Fossey et al., 2002); broadly conceived research methodologies (Neuman, 2006); and knowledge claims (Creswell, 2003).

According to Crotty (1998) research paradigms comprise of theoretical perspectives, epistemology, and methodology. Denzin and Lincoln (2005) further expand this view. They state that research paradigms constitute of assumptions made in relation to the four aspects of, ethics or axiology, epistemology, ontology and methodology. In addition to these four aspects, Creswell (2007) also mentions rhetorical assumptions as forming part of the research paradigm (see Figure 4.1).

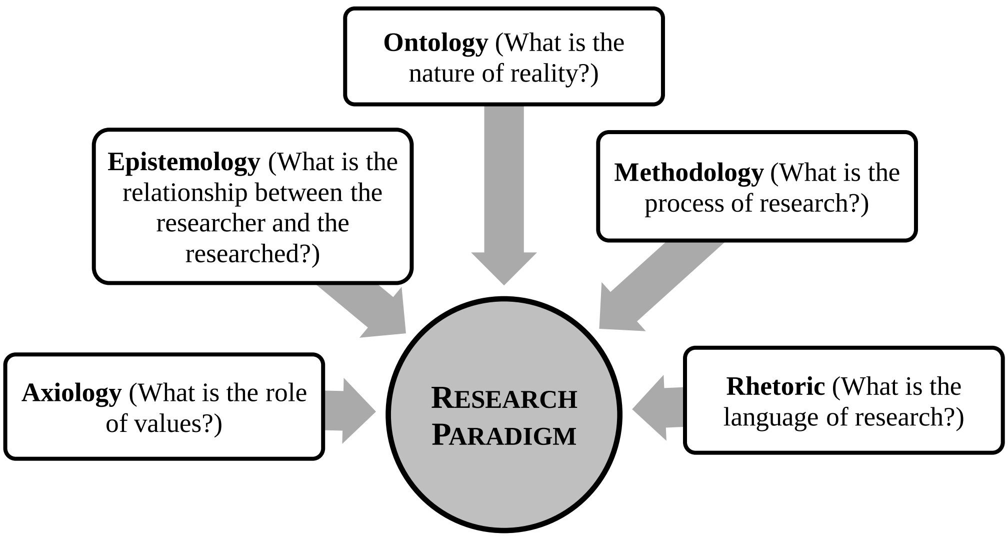


Figure 4.1: Constituents of research paradigm

Herein, epistemology is the technical term given to the 'theory of knowledge' (Benton and Craib, 2001; Crotty, 1998). It addresses the relationship between the researcher and the known (Denzin and Lincoln, 2005). On the other hand, ontology refers to the 'theory of what exists in the world'. Accordingly, the beliefs about ontology determines the answers to questions such as, 'what kinds of things are there in the world?' (Benton and Craib, 2001), 'what kind of being is the human being?' or 'what is the nature of reality?' (Denzin and Lincoln, 2005). A way of thinking about and studying this reality could be presented through the chosen research methodology. The role given to values in the research is addressed within axiological assumptions. Finally, the rhetoric determine the language of the research (Creswell, 2007). The assumptions made in relation to the above within the context of this research, are discussed in the next section.

4.3.1 The Philosophical Positioning of the Research

As Corbin and Strauss (2008) point out 'every methodology rests on the nature of knowledge and of knowing'. The available options of research paradigms are wide and ever expanding. In fact, Creswell (2007) observes that any attempt at discussing available research paradigms would be a partial description of possibilities. According to Fossey et al. (2002) the three principal research paradigms are the empirico-analytical, interpretive and critical research paradigms. Creswell (2007) have described post-positivism, constructivism, advocacy/ participatory (which includes feminist perspectives, racialised discourses, critical theory, queer theory, disability inquiry) and pragmatism as the major paradigms influencing qualitative research. These paradigms continually evolve over time. A good example of evolution of research paradigms could be found in comparing the work of Lincoln and Guba in 1994 and 2000. In their 1994 work Lincoln and Guba have identified the four major research paradigms influencing qualitative research as; positivism, post-positivism, critical theory, and constructionism. However, in Lincoln and Guba (2000), they go on to introduce an additional fifth paradigm called the participatory/co-operative paradigm, after taking into account the developments made by other authors since the publication of their original work.

Likewise, numerous research paradigms exist that the researchers use to guide their work. On one end of the paradigm spectrum are positivism and postpositivism, which respectively asserts that objective or partially objective accounts of the real world are possible (Denzin and Lincoln, 2005). Positivist/ postpositivist research have the characteristics of being reductionist, logical, cause-and-effect oriented and deductive. Values are excluded and their influence on the findings is denied (Creswell, 2007; Guba and Lincoln, 2005).

On the other end of the spectrum is social constructivism or interpretivism. According to Denzin and Lincoln (2008), all research is interpretive by nature. This is because, by nature, research is guided by a set of beliefs held by the researcher in how he/she views, understands and studies the world. Max Weber, who is accredited with leading to the emergence of interpretivism, emphasise the importance of 'Verstehen' (i.e. understanding) required in studying human sciences as opposed to 'Erklaren' (i.e. explaining), which is the focus of the natural sciences (Crotty, 1998). The former could be achieved through qualitative approaches, whereas, the latter is the focus of quantitative approaches. Accordingly, the social constructivist or interpretivist research aim to develop 'culturally derived and historically situated interpretations of the social life-world' (Crotty, 1998) and therefore, allude to relativist ontologies and subjectivist epistemologies. This means that rather than relying upon objective enquiry alone, the focus is on the understanding and interpretation of the human actions and their products (Benton and Craib, 2001; Snape and Spencer, 2003). Such an approach to seeking understanding of the world can in turn lead to the development of 'subjective meanings' on certain objects or phenomena (Creswell, 2007).

In between the above extremes is the pragmatist paradigm. Mead (1956 cited Corbin and Strauss, 2008) notes that pragmatism originated from an interest in the 'act itself' and 'the relationship of thought to the act'. A key feature of pragmatist research is the acknowledgement that research always occurs within a context. Pragmatism also acknowledges that discoveries about reality cannot be separated from the 'operative perspective' of the researcher. However, Corbin and Strauss (2008) highlight that this acknowledgement does not at all lead to radical relativism (i.e. the belief that no certainty about any given reality can be assumed as no version or interpretation can be proven). Rather Corbin and Strauss put forward two main assumptions in relation to 'truth' in pragmatism. Firstly, that truth is equivalent to 'for the time being this is what we know – but eventually it may be judged partly or even wholly wrong' and secondly, despite this that the 'accumulation of knowledge is no mirage'.

This pragmatic viewpoint provides a useful foundation to understand the interpretations of SC held by different stakeholders and also to gain insight into the process of implementing SC grounded upon the complexities and realities at construction project level. Under the umbrella of pragmatist paradigm the following assumptions were made in relation to this research.

Firstly, in relation to ontology, reality is viewed to be complex, fluid and often ambiguous. It undergoes change as well as periods of permanence (Corbin and Strauss, 2008). This is particularly true in relation to the subject area (i.e. SD/SC) of this research, which is rife with complexities and ambiguities, whilst being highly value-laden and context dependent (refer to chapter 2 and section 4.1). Construction projects also involve a wide array of stakeholders (refer to section 3.5.2). It is assumed that these different stakeholders hold a variety of understandings and attitudes towards SC, which in turn lead to different actions, interactions and responses when it comes to implementing SC at project level. Considering that construction projects are delivered by project teams, interactions arise when project parties share perspectives. This in turn means that on occasions where perspectives are not shared, negotiation and compromise becomes necessary. This alludes to an epistemology based upon symbolic interactionism and is therefore, the second assumption underpinning this research (refer to Figure 4.1).

The above ontological and epistemological underpinnings call for a methodology that is capable of capturing as much complexity as possible. The research aim and objectives of this study highlight the need to obtain multiple perspectives on SC, which in turn necessitates the construction of variation and differences in interpretations into the analytic process. These could be facilitated by adopting a more qualitative research approach. This methodological assumption, which is the third assumption underpinning this research, guides the choices made in relation to the strategies of inquiry and data collection/analysis methods discussed within the remaining sections of this chapter.

Fourthly, in relation to axiology, it is acknowledged that the researcher, as well as the respondents/participants of the study, have their own values and biases. Attempts have been made to minimise the biases due to these and increase the trustworthiness of the research findings (refer to sections 0 and 4.8.5). Particular attention was given to ensuring methodological rigour, for instance by adhering to a systematic coding practice. Finally, in relation to the rhetoric of the research, the research findings are presented in a formal language using the third person passive voice considering the audience of this thesis. However, in-verbatim quotes are also used to explicate some of the findings, particularly during the case study stage, so as to bring in the voice of the participants to the research.

4.4 RESEARCH APPROACH

The choice of a research approach is a fundamental part of the research process. The main aim of choosing a research approach is to establish the best possible way of answering the research questions (Blaikie, 2000). Research approaches are also referred to as research strategies. Bryman (2008) notes that the term research strategy simply means ‘a general orientation to the conduct of ...research’. Research approaches or strategies help put the research paradigms into motion in the empirical world through specific methods of data collection (Denzin and Lincoln, 2005). Thus, research approaches act as links between research paradigms and research methods and comprise the ‘skills, assumptions, enactments, and materials practices’ of the researcher (Denzin and Lincoln, 2005).

Research strategies or approaches fall into the two main clusters of quantitative and qualitative research. A quantitative approach is best suited for research that test theories or explanations. Such an approach is also suited for research, where the research problem involves identifying factors that influence outcome or understanding the ‘best predictors’ of outcomes (Creswell, 2003). Accordingly, quantitative research is generally underlined as fixated upon the four aspects of measurement, causality, generalisation, and replication (Bryman, 2008). On the other hand, research that seek in-depth understanding of a phenomena or concept requires a more qualitative approach (Creswell, 2003; Dainty, 2008).

Qualitative research provides an approach to understanding the ‘contexts and settings’ in which the participants address an issue. Whereas, quantitative research aims to provide a ‘general picture of trends, associations and relationships’ focusing on cause and effect relationships, qualitative research aims to explain the mechanisms behind those relationships by exploring ‘why people responded as they did’ (Creswell, 2007). Qualitative research by nature is ‘interdisciplinary, trans-disciplinary, and sometimes counter-disciplinary' and interlinks the natural and social sciences (Nelson et al. 1992 cited Denzin and Lincoln, 2005). A qualitative approach also allows the innovative and flexible working within 'researcher-designed' frameworks (Creswell, 2003). This is a major advantage of qualitative research compared to quantitative research (Charmaz, 2006). This flexibility of qualitative research allows the researcher to explore leads that are generated during the research process.

Table 4.2 provides a comparison of qualitative and quantitative research approaches.

Table 4.2: Quantitative vs. Qualitative research approaches (Sources: Bryman, 2008; Creswell, 2003; Creswell, 2007; Denscombe, 2007; Denzin and Lincoln, 2005)

	Qualitative Approach	Quantitative Approach
Philosophical assumptions	Constructivist/Advocacy/ Participatory	Positivist
Strategies of inquiry	Phenomenology Grounded Theory Ethnography Case study Narrative research	Survey Experiment
Data analysis	Inductive/ Recursive/ Interactive	Deductive
Research design	Emergent design	Predetermined design
Type of data collected	Text or image data	Numeric data
Researcher involvement/detachment	Researcher is a key instrument - brings personal values into the study	Uses unbiased approaches – objective data
Data collection approaches	Observations Interviews (open ended/ semi-structured questions) Documents Audiovisual materials	Closed ended questions
Display of data	Ethnographic prose, Historic narratives, first person accounts, still photographs, biographical and autobiographical materials etc.	Mathematical models, statistical tables and graphs,
Basic unit of analysis	Words/ Images	Numbers
Focus of the study	Holistic account (focus on complex interactions, multiple perspectives, identify many factors)	Specific focus (identifying independent and dependent variables/ cause and effect relationships)
Role of theory in relation to research	Generating theory	Testing theory

In addition to these purely quantitative or purely qualitative strategies, another research approach is to mix both quantitative and qualitative methods. This 'mixed methods approach' emerged during the mid-twentieth century with the premise that inherent biases of one method could be overcome by the use of other methods (Creswell, 2003). Therefore, in mixed method research the quantitative and qualitative research methods can be used in one of three ways; (i) sequentially (to elaborate on the findings of one method with the use of another method), (ii) concurrently (to collect both quantitative and qualitative data at the same time) and (iii) transformatively (using a theoretical lens to provide a framework for the research design, which encompass both qualitative and quantitative data collection).

Creswell (2003) observes that the situation today has moved away from the issue of quantitative *versus* qualitative into determining how the research approach lie on a continuum between the two extremes. Accordingly, the researcher has to decide whether a particular research study is more qualitative than quantitative or vice versa. As Crotty (1998) highlights this determination should be based upon the purpose of the research, as well as the theoretical perspective of the researcher. Similarly, Creswell (2003) notes that the choice of a suitable research approach depends on the research problem. He further emphasises the importance of researcher's personal experiences and the intended audience of the research outputs in determining the research approach.

The research aim of this study (refer to section 1.2) is particularly concerned with 'in-depth' understanding of the concept of SC. In addition, the concept under scrutiny (i.e. SC, which is a sub-set of SD) is context dependent and open to a wide variety of interpretations (see sections 2.3, 2.6, 3.5.2 and 4.3). Investigating the process of implementing SC within a construction project environment requires research to be conducted in a natural setting giving due cognisance to the context and associated realities and complexities (see section 4.3.1). Due to all of these reasons, a more qualitative approach seem better fitting to achieve the aim and objectives of this research.

Having decided upon the qualitative research approach, the next step is to determine a suitable strategy of inquiry for the study. A strategy of inquiry encompasses the 'skills, assumptions, enactments, and materials practices' (Denzin and Lincoln, 2005) of the researcher. There are a large number of strategies of inquiry available for qualitative research (see section 4.8). This research employs a mix of strategies of inquiry to achieve its aim and objectives. These are; (i) document analysis and (ii) case studies together with grounded theory analysis. The rationales for selecting each of these strategies, as well as the methods used for data collection and analysis are discussed in the following sections.

4.5 RESEARCH FRAMEWORK

The research process used in this study can be depicted using a research framework consisting of four key stages as shown in Figure 4.2. In depth discussions on how the research was conducted within each of these stages are provided in the sections below.

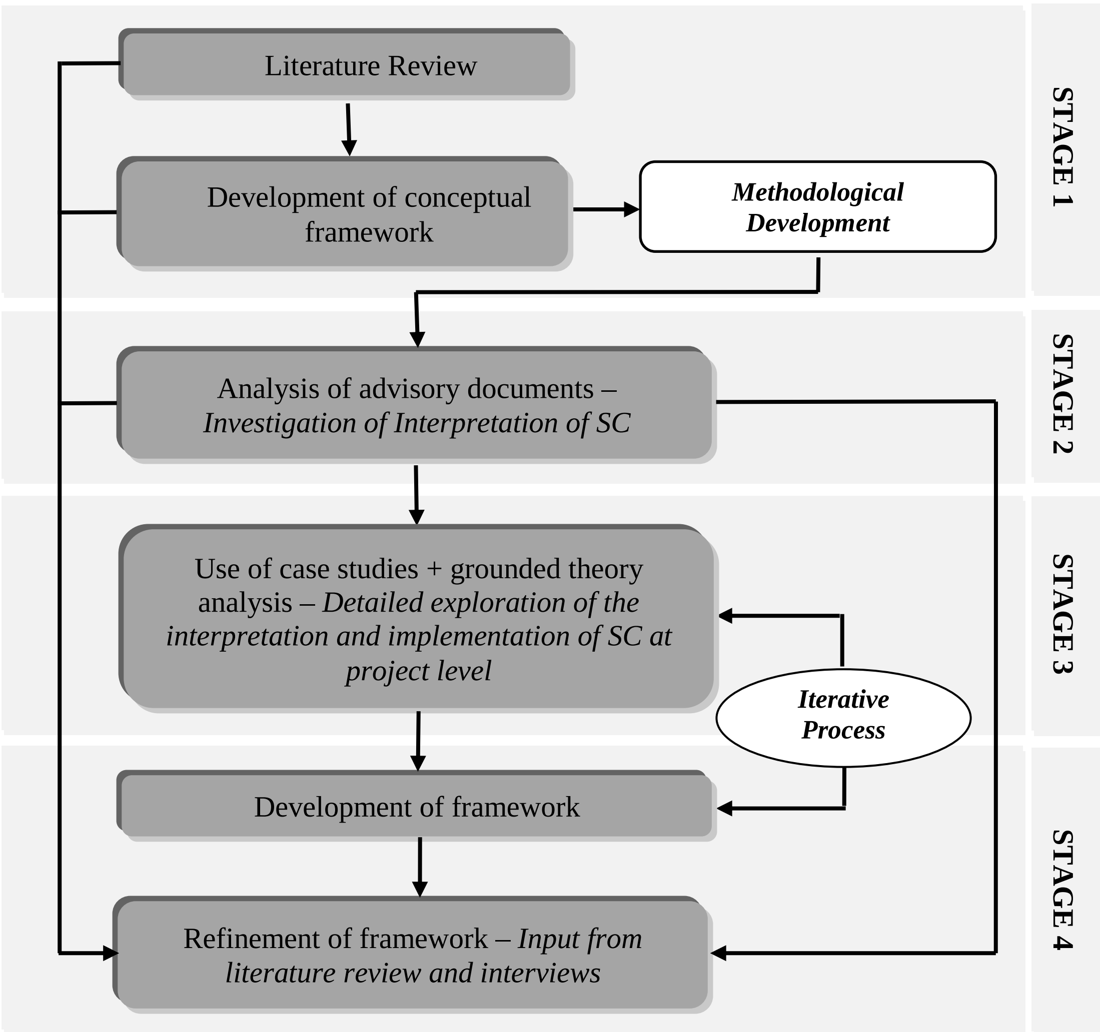


Figure 4.2: The Research Framework

4.6 STAGE 1: LITERATURE REVIEW

The literature review is a crucial phase of any research, as it helps to provide the context for a study and identify the gaps in knowledge. In establishing what is already known in the area, the literature review helps to avoid 'reinventing of the wheel' (Bryman, 2008).

At the very outset of the research process, an initial review of literature was carried out covering the three main focus areas of this study as shown in Figure 2.1. This helped to establish the background of the research and to identify the gaps in knowledge. More in-depth and focused reviews of literature were conducted once findings started to emerge from the latter stages of the research process. Such focused reviews were necessary to strengthen arguments and increase the credibility of the research findings (Charmaz, 2006). The literature survey covered a variety of sources, which included;

- Journal articles
- Conference proceedings
- Books
- Reports (from both governmental and non-governmental sources)
- Web sites
- Electronic research data bases (E.g. Ebscohost / Web of Knowledge)
- Key word searches using internet search engines (E.g. Google scholar)

Bibliographical software (i.e. Reference Manager) was used during the literature review process to keep the references organised. The findings of the initial literature review led to the development of the conceptual framework discussed in Chapter 3. Overall, this first stage of the research framework addressed the first and second objectives of this research (refer to section 1.2).

4.7 STAGE 2: ANALYSIS OF ADVISORY DOCUMENTS

The second stage of the research concentrated on analysing the available advisory documents on SC. These documents had been produced by a variety of parties with the intention of providing guidance on the uptake and implementation of SC to the construction industry stakeholders. The objective of this analysis was to ascertain how these different documents interpret the concept of SC (i.e. objective 3 and research questions RQ2 and RQ3 of this research). The research design for this stage of the study is shown in Figure 4.3.

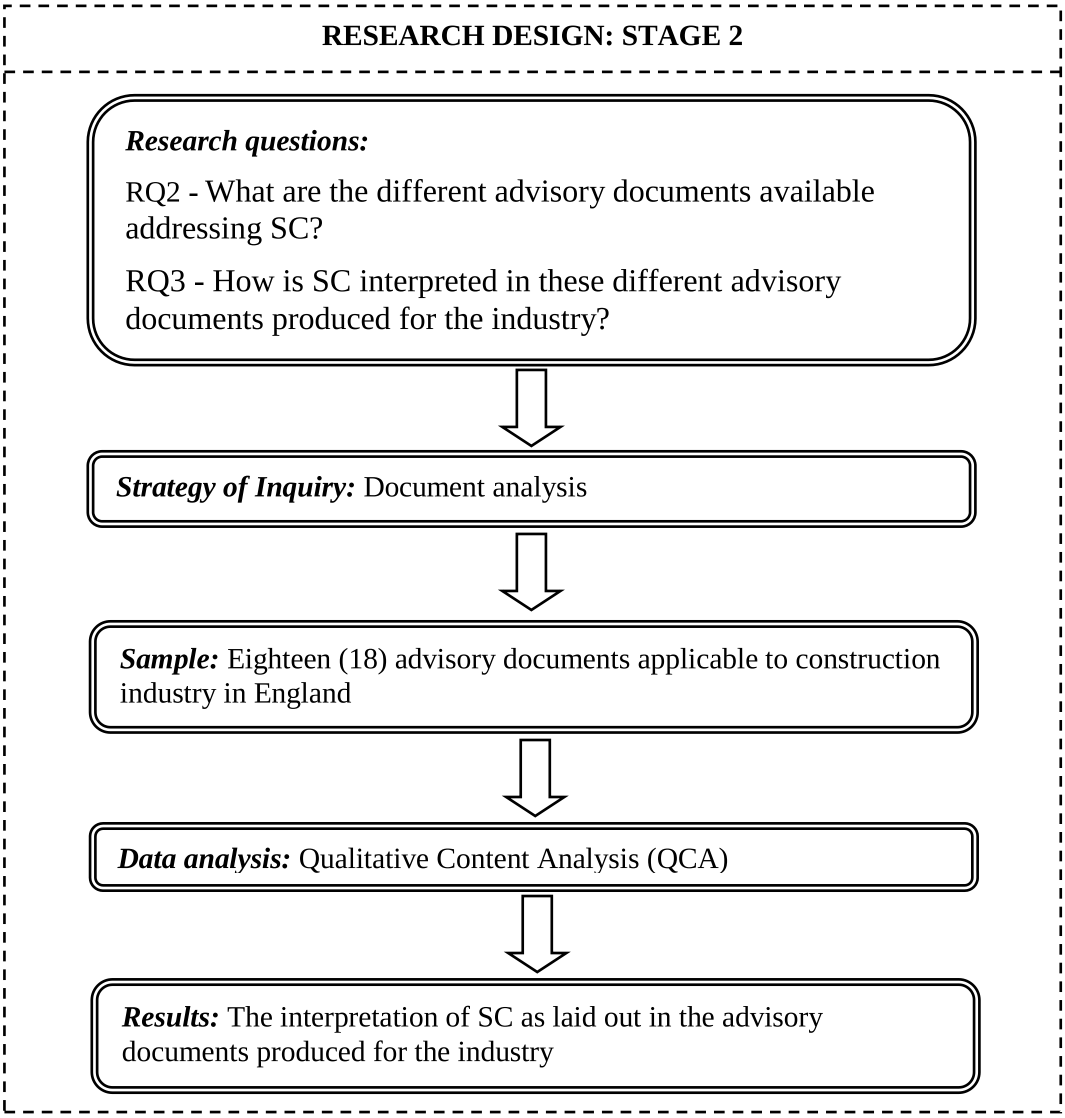


Figure 4.3: Research design for Stage 2

A ‘document’ is often viewed as an artefact, which has as its central feature, inscribed text (Scott, 1990). Herein, the term ‘text’ does not merely refer to the written word. Taking this into consideration, Altheid et al. (2008) define a ‘document’ as ‘any symbolic representation that can be recorded and retrieved for description and analysis’. The focus on documents as containers of information for research is well established, particularly within the social sciences research (Prior, 2008). Documents or texts used in research can fall into two categories based on the researcher’s involvement in producing them. These categories are (Charmaz, 2006);

i. **Elicited texts** (i.e. documents produced in response to a request from the researcher) and,

ii. **Extant texts** (i.e. documents that the researcher had no involvement in producing. In other words, extant texts have been produced for purposes other than the needs of the research).

From the above two categories, the advisory documents with which this research is concerned with, fall into the category of extant texts. This is because the researcher had no input in the development of these documents. The extant texts have the added advantages of being 'non-reactive' and 'stable' (Bowen, 2009) thereby, contributing to the trustworthiness of the research findings (see section 4.7.4). The next section goes onto discuss the process of selecting documents for analysis.

4.7.1 Document Selection – Criterion Sampling

Bryman (2008) notes that the process of searching for documents relevant to a research can be a 'frustrating and highly protracted process'. This was indeed true within the context of this research, as one of the initial difficulties faced was in selecting documents to be analysed. Given the high level of focus on SD as a whole, as well as the significance of the construction sector in achieving it, the number of advisory documents that have been published so far is vast (refer to sections 1.1 and 3.5.1). Due to the large number of documents available as well as, the variety of sources that have produced these documents, it was not possible to analyse all the available documents in a thorough, in-depth manner within the time frame of this research. Therefore, it was necessary to adopt a systematic approach to set 'boundaries' for selecting documents. This could be achieved by using a suitable sampling strategy. Employing such a systematic approach was also important in avoiding limitations due to 'biased selectivity' (Bowen, 2009; Yin, 2003), which could adversely impact on the trustworthiness of the research findings.

There are numerous sampling strategies available that could be used in selecting documents for analysis. The following section discusses the rationale for selecting 'criterion sampling' for document selection.

4.7.1.1 Sampling Strategies

A key difference between quantitative and qualitative research approaches is the different reasoning used to select samples (Patton, 1990). While quantitative research tends to favour larger, randomly selected samples, qualitative research mostly focus upon smaller, purposefully selected samples (Miller and Alvarado, 2005; Patton, 1990). The main focus of random sampling in quantitative research is to achieve generalisation to a larger population. Conversely, the main focus of purposeful sampling is to gain in depth understanding of a fewer number of information rich cases. Patton (1995) has identified sixteen (16) different techniques of carrying out purposeful sampling. These are shown in Table 4.3 below.

Table 4.3: Purposeful sampling strategies (Source: Patton, 1995)

Type of Purposeful Sampling	Purpose/ Advantages/Disadvantages
1. **Extreme or deviant case sampling**	Learning from highly unusual manifestations of the phenomenon of interest (e.g. outstanding successes/ notable failures), can gain in-depth understanding, can supplement statistical data about the normal distributions.
2. **Intensity sampling**	Information-rich cases that manifest the phenomenon intensely, but not extremely (e.g. above average/ below average), involves considerable judgement, requires exploratory work to determine nature of variation.
3. **Maximum variation sampling**	Picking cases with a wide range of variation on dimensions of interest, identifies significant common patterns across cases and derives their significance, can describe variations as well as shared outcomes, cannot attempt to generalise findings.
4. **Homogenous sampling**	Focuses and reduces variation in sample, purpose is to describe a particular subgroup in depth, simplifies analysis.
5. **Typical case sampling**	Illustrates what is typical or average, sample is illustrative and not definitive, does not permit rigorous generalisation.
6. **Stratified purposeful sampling**	Illustrates characteristics of particular sub-groups of interest, facilitates comparison, sample size is generally too small for statistical representativeness or generalisation.
7. **Critical case sampling**	Identifies cases that can make a dramatic point or are particularly important, useful in situations where resources are limited, does not permit broad generalisations to all possible cases.
8. **Snowball or chain sampling**	Identifies cases of interest from people, who know people, who know people, who know information rich cases.

Table 4.3: Purposeful sampling strategies – Contd.

Type of Purposeful Sampling	Purpose/ Advantages/Disadvantages
9. **Criterion sampling**	Picking all cases that meet some criterion, provides quality assurance.
10. **Theory-based or operational construct sampling**	Finding manifestations of a theoretical construct of interest so as to elaborate and examine the construct.
11. **Confirming and disconfirming cases**	Elaborating and deepening initial analysis, seeking exceptions, testing variations, challenge of finding confirming and disconfirming cases.
12. **Opportunistic sampling**	Following new leads during field work, taking advantage of the unexpected, flexibility.
13. **Random purposeful sampling**	Adds credibility to sample when potential purposeful sample is larger than one can handle, reduces judgement, improved credibility.
14. **Sampling politically important cases**	Selecting (or sometimes avoiding) a politically sensitive site or unit of analysis, attracts attention to the study or avoids attracting undesired attention by purposefully eliminating from the sample politically sensitive cases.
15. **Convenience sampling**	Doing what is fast and convenient, saves time, money and effort, lowest credibility, yields information poor cases.
16. **Combination of mixed and purposeful sampling**	Triangulation, flexibility, meets multiple interests/needs.

From the descriptions given in Table 4.3, it is clear that criterion sampling is best suited for the purposes of this stage of the research as it 'picks all cases that meet some criterion', thereby, providing quality assurance. For that reason, from the different sampling techniques described in Table 4.3 above, criterion sampling was chosen as the most suitable sampling technique for selecting documents.

The criteria used to carry out the selection of documents using criterion sampling are presented in the following section.

4.7.1.2 Criteria Considered for Selecting Documents

Various types of documents exist that can be used as sources of data in research. These include; personal documents (e.g. diaries and letters), official documents deriving from the state, official documents deriving from private sources (e.g. organisations), massmedia outputs and virtual outputs (e.g. internet resources) (Bryman, 2008). However, given the focus of this phase of the study, it was important that the analysis be limited to ‘official’ documents. Official documents can originate from either the state or private sources. General web surveys using internet search engines were used as the primary means of identifying documents for analysis. Particular attention was given to the ‘publications’ sections in the web sites of key government departments and non-governmental institutions relevant to sustainability issues in the construction industry. The key words used in the search for documents included ‘sustainability’, ‘sustainable development’ and ‘SC’.

Since, this study is focused on the issue of sustainability in the construction industry, only those documents that are specific to the construction sector were selected for analysis. Therefore, the selected documents did not include documents such as, the UK government’s ‘Strategy for Sustainable Development’ or ‘Sustainable Procurement Action Plan’. Although, these documents had implications for the construction industry, it was assumed that the sector specific strategies/policies reflect more specifically on the area of research. Furthermore, due to the differences in governance structures between England, Scotland, Wales and Northern Ireland, it was decided to limit the study to documents that are relevant to England. All the documents considered for the study had been published in or after the year 2000. This year provided a milestone as in April 2000, the then Department for Environment, Transport and the Regions (DETR) published the first strategy addressing SC in UK, called ‘Building a Better Quality of Life’. Finally, all the selected documents were those that were freely available for the public.

Following the aforementioned criteria, 18 documents were selected for in depth analysis (see Table 4.4). These selected documents were grouped into four categories. These were;

i. **Policies/ strategies -** In basic terms a policy could be viewed as a statement of what must be done. These are written plans or courses of action intended to influence and determine decisions, actions and other matters. According to the International Energy Agency (2011), policies addressing SD in construction need to be both ‘broad’ enough to address specific barriers, as well as ‘deep’ enough to reach all the stakeholders. The latter is especially important given the fragmented nature of the industry.

Strategies lay out broad, long-term plans of action aimed at achieving the goals of SC and ultimately, SD. The Strategy for Sustainable Construction (HM Government, 2008) for instance, aims to provide clarity around and signal the future direction of government policy in relation to SC. The strategy is wide ranging and is aligned with the 'broader aim of modernising construction' (HM Government, 2008).

ii. **Guides -** Guides (also referred to as guidance within this research) are sets of recommendations about things that should be considered when implementing SC. These are not requirements. They are merely suggestions that may have been written up into an informal checklist or similar format. Various such guides have been developed aimed at different groups of stakeholders, to assist them in the uptake and implementation of SC.

iii. **Reports -** Reports include those documents that have been published to describe the present state in relation to various aspects of SC in the construction industry. These reports sometimes also include various recommendations aimed at improving the industry's performance in relation to SC.

iv. **Measurement tools/indicators/codes/standards -** The fourth category includes documents that aid in measuring the extent to which SC has been addressed within a particular construction project. These documents generally include measurable performance standards and a final score or a rating that indicates the level of SC achieved (UK Green Building Council, 2009).

The selected documents include four key policy/strategy documents, three industry reports, seven guides and four measurement tools or codes (refer to Table 4.4).

Each document was assigned an identification code, which constituted of three parts; i.e. (i) a letter indicating the type of document (P – policy/strategy, R – report, G – guide, M – measurement tools), (ii) a document number (between 1 and 18) and (iii) the year of publication. These document codes were useful during the analysis process, as they enabled easy reference and identification of documents.

Table 4.4: Advisory documents selected for analysis

	Title	Publishing Body	Year	Document Type: Policy/ Strategy	Report	Guide	Measurement Tools/ Codes/ Standards	Assigned Code
1	Building Research Establishment Environmental Assessment Tool	Building Research Establishment (BRE)	2011				•	M1-2011
2	CEEQUAL- The Assessment and Awards Scheme for improving sustainability in civil engineering and the public realm	Institution of Civil Engineers (ICE)	2010				•	M2-2010
3	Building a sustainable future together: Guidance note	Joint Contracts Tribunal (JCT)	2009			•		G3-2009
4	Sustainability in the built environment: An introduction to its definition and measurement	Atkinson et al.	2009		•			R4-2009
5	Making the case for a code for sustainable buildings	UK Green Building Council	2009		•			R5-2009
6	Strategy for sustainable construction	HM government/ Strategic Forum for Construction	2008	•				P6-2008
7	Sustainability in building construction: general principles	BSI	2008			•		G7-2008
8	Building for the future: SC and refurbishment of the government estate	National Audit Office (NAO)	2007		•			R8-2007
9	SD strategy and action plan for civil engineering	ICE	2007	•				P9-2007
10	2012 Construction Commitments	Strategic Forum	2006				•	M10-2006
11	Planning policy statement 1: Delivering sustainable development	ODPM	2005	•				P11-2005
12	Procurement guide: Sustainability - Achieving excellence in construction	OGC	2005			•		G12-2005
13	Sustainable and secure buildings Act	HM Government	2004	•				P13-2004
14	Sustainability in construction	CIOB	2004			•		G14-2004
15	Constructing for sustainability	Construction Industry Council (CIC)	2003			•		G15-2003
16	Managing SC (MaSC): profiting from sustainability	BRE	2002			•		G16-2002
17	A sustainability checklist for developments	BRE	2002				•	M17-2002
18	Sustainable construction procurement: A guide to delivering environmentally responsible projects	Construction Industry Research and Information Association (CIRIA)	2001			•		G18-2001

Bowen (2009) notes that when it comes to selecting documents for a document analysis exercise, the main concern should be about the 'quality of the documents and the evidence they contain' and not the number of documents selected. The quality of the results of a document analysis exercise is highly dependent upon the quality of the documents that have been selected for analysis. Scott (1990) has put forward four criteria that could be used to ascertain the quality of selected documents. These are;

- Authenticity (i.e. establishing that the documents are genuine and of unquestionable origin).
- Credibility (i.e. establishing that the documents are free from error and distortion).
- Representativeness (i.e. establishing that the documents are typical of their kind and if not, the extent of their untypicallity is known?).
- Meaning (i.e. establishing that the documents are clear and comprehensible?)

The selected documents shown in Table 4.4 can be considered as authentic as they have all been produced by either a government body or a recognised professional institution. When selecting documents all the documents were checked to verify their authorship. In some instances, the documents have been compiled by a group of individuals under the auspices of a particular government department or an institution (for example, see Atkinson et al., 2009). In such instances, it was assumed that these documents represent the views of the relevant government body or institution, as the documents have been published under the names of these bodies. Further, before publishing, these documents have been subjected to rigorous public consultation processes to ensure that they are free from errors and that their meanings are generally clear and comprehensible. They can also be considered as typical compared to other documents within their representative category. Therefore, it appears that in general, the selected documents can be considered as of high quality.

4.7.2 Data Analysis – Choice of Qualitative Content Analysis (QCA)

The main purpose of this document analysis exercise was to ascertain the interpretation of SC. According to Taylor (1985 cited Langhelle, 1999) interpretation aims to bring to light an 'under-lying coherence or sense' in a text, which is in some ways 'confused, incomplete, cloudy, or seemingly contradictory'. Review of literature on research methods reveals a variety of approaches that can be used to analyse textual data for the above purpose. These include approaches such as, content analysis, semiotics, deconstruction and hermeneutics. The choice of a suitable analysis approach depends on the type of text been analysed, as well as, the purpose of carrying out the analysis. This stage of the research therefore, calls for an approach that could explore how the selected advisory documents interpret the concept of SC. This requires a means of searching for themes from textual data, which could be achieved through content analysis.

Content analysis is a research tool or technique for 'making replicable and valid inferences from data to their context' (Krippendorff, 1980). It is a highly flexible research method that could be used to analyse a wide variety of unstructured information such as, words, meanings, pictures, symbols, ideas, themes or any message that could be communicated through written, visual or spoken form (Bryman, 2008; Neuman, 2006). It is also a very transparent research method as the coding scheme can be set out to enable replication and follow-up studies.

Content analysis could be carried out either as a quantitative or a qualitative study using an inductive or deductive process (Elo and Kyngas, 2008). In quantitative content analysis 'objective and systematic counting and recording procedures' are used to produce 'numerical description[s]' of the content within a text (Neuman, 2006). This process of quantitative content analysis is often regarded as a method for 'quantitative analysis of qualitative data' (Morgan 1993 cited Hsieh and Shannon, 2005). It requires the formulation of a hypothesis from the available theory and is therefore, 'prospective' in nature. In contrast, 'understanding' the concept of SC as per the available advisory documents (which is the focus of this stage of the research) requires a 'retrospective' approach with little to no prior expectations (Strijbos et al., 2006). Further, this requires an emphasis on allowing categories or themes to emerge from the examination of documents that would help develop an understanding on the concept of SC. This calls for an inductive approach to analysing the documents. An induction process involves 'drawing generalisable inferences out of observations' (Bryman, 2008). This could be best achieved using Qualitative Content Analysis (QCA). QCA is sometimes also referred to as ethnographic content analysis (Altheid, 1996 cited Bryman, 2008).

The coding system plays a fundamental part of data analysis in QCA. The 'coding system' refers to 'a set of rules on how to systematically observe and record content from text' (Neuman, 2006). According to David and Sutton (2004), coding is the 'single most significant act' in the process of qualitative analysis of texts. Coding allows the identification of themes within the data being analysed, which could be used to develop concepts. The latter should be achieved through a 'recursive and reflexive' movement between data coding, analysis-interpretation and concept development (Bryman, 2008). Accordingly, Neuman (2006) observes that,

> *'Instead of a clerical data management task, qualitative coding is an integral part of data analysis [which is] guided by the research question.'*

Within this context, coding serves to achieve two objectives (David and Sutton 2004; Neuman, 2006);

- mechanical data reduction and
- analytic categorisation.

In order to achieve the above, coding of documents during this stage of the research was carried out in two main stages; i.e. open coding and axial coding. These stages of coding and how they were carried out are explained in detail in the following sections. This study also made use of NVivo computer software for analysis of qualitative data. The rationale for using Computer-Assisted Qualitative Data Analysis Software (CAQDAS) within the context of this research is given in section 4.9.

4.7.2.1 First Review of Documents - Open Coding

Open coding marked the first attempt of the researcher in condensing the collected data into categories, by locating themes and assigning initial codes. During open coding, the researcher is open to creating new themes and the possibility of changing these initial themes during subsequent analysis. The themes generated from open coding serves three purposes (Neuman, 2006);

- They help the researcher to see the emerging themes at a glance.
- They stimulate the researcher to find themes in future open coding.
- The list of themes can be used to build a universe of all themes in the study, which in turn could be reorganised, discarded, extended, combined during

further analysis.

Some researchers suggest that open coding process should begin with a list of concepts (i.e. deductive approach). This was not suitable within the context of this research, as the inductive process called for within this stage of the study required the researcher to generate themes during the process of reading the documents itself.

The degree of detail in coding (i.e. whether the coding is limited to a few words or whole paragraphs) depends on the research question, the richness of the data and the researcher's purposes. During the analysis of advisory documents, care was taken to retain as much detail as necessary during this initial coding stage in order to derive the most comprehensive view of the concept of SC. The use of 'in-vivo' codes was found to be particularly useful in this respect.

In-vivo codes refer to the coding of certain phrases or terms as they are found in the analysed texts. According to Charmaz (2006), in-vivo codes act as 'symbolic markers' of meanings and could fall into the following three categories;

i. 'General terms' that everyone knows, which provide condensed but significant meanings.
ii. 'Innovative terms' that encapsulate certain meanings or experiences.
iii. 'Insider shorthand terms' that are specific to a certain industry or a group of people.

In-vivo coding was useful in identifying the discourse of terms and language that have been used within the documents. For example, phrases such as *'synergy rather than compromise'* were retained in their original form as a result of the in-vivo coding process. During this study, the above mentioned open codes were created as 'Free Nodes' in NVivo (see Figure 4.4).

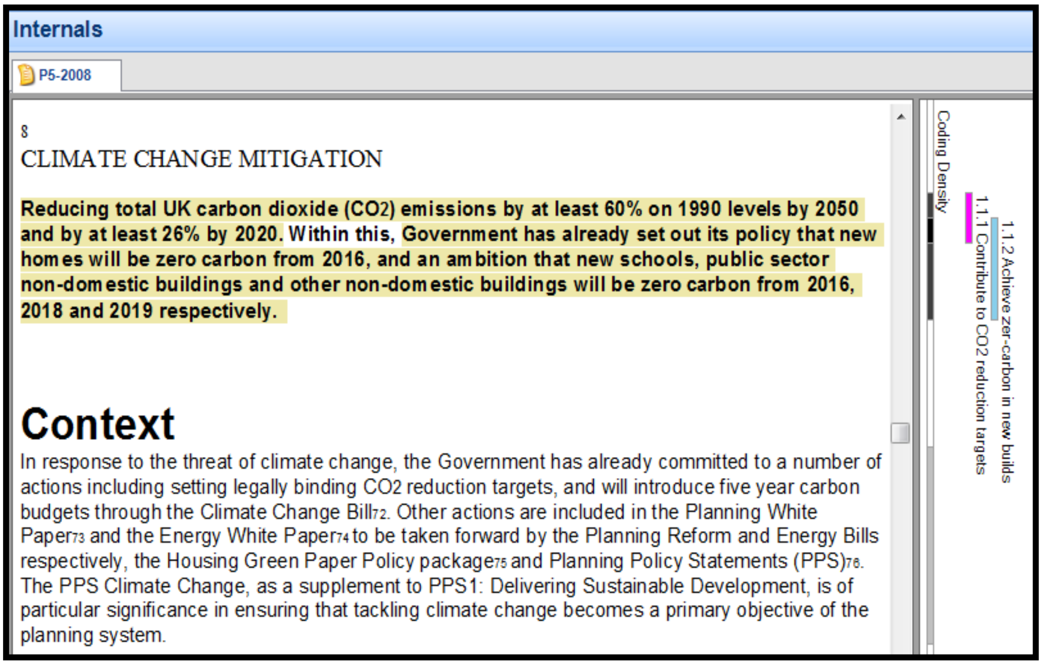


Figure 4.4: An example of open coding of documents using NVivo software

4.7.2.2 Subsequent Review of Documents - Axial Coding

While open coding focused on raw data and assigning code labels to themes, it did not attempt to make connections between themes or to elaborate the concepts that emerged out of those themes. This second stage of coding (referred to as axial coding) focused on these latter two aspects.

In axial coding, the researcher moves towards 'organising ideas or themes and identify[ing] the axis of key concepts in analysis' (Neuman, 2006). Miles and Huberman (1994) also stress the importance of having some 'conceptual or structural order' to the codes. They state that the 'codes should relate to one another in coherent, study important ways' and that 'they should be part of a governing structure'. Although the primary focus during axial coding is to review and examine the initial codes, additional codes or new ideas can still emerge during this process.

In this research, the second review process involving axial coding began with the set of initial codes or preliminary concepts that were generated through the open coding process. During axial coding, the possibility of dividing these existing concepts into subcategories and/or categorising few of the existing concepts together into more general categories was explored.

The ‘tree node’ function in NVivo was particularly useful during this stage to achieve the aforementioned. Tree nodes allowed the ‘free nodes’ created during the previous analysis stage to be organised into hierarchical structures consisting of ‘parent’ and ‘child’ nodes (see Figure 4.5).

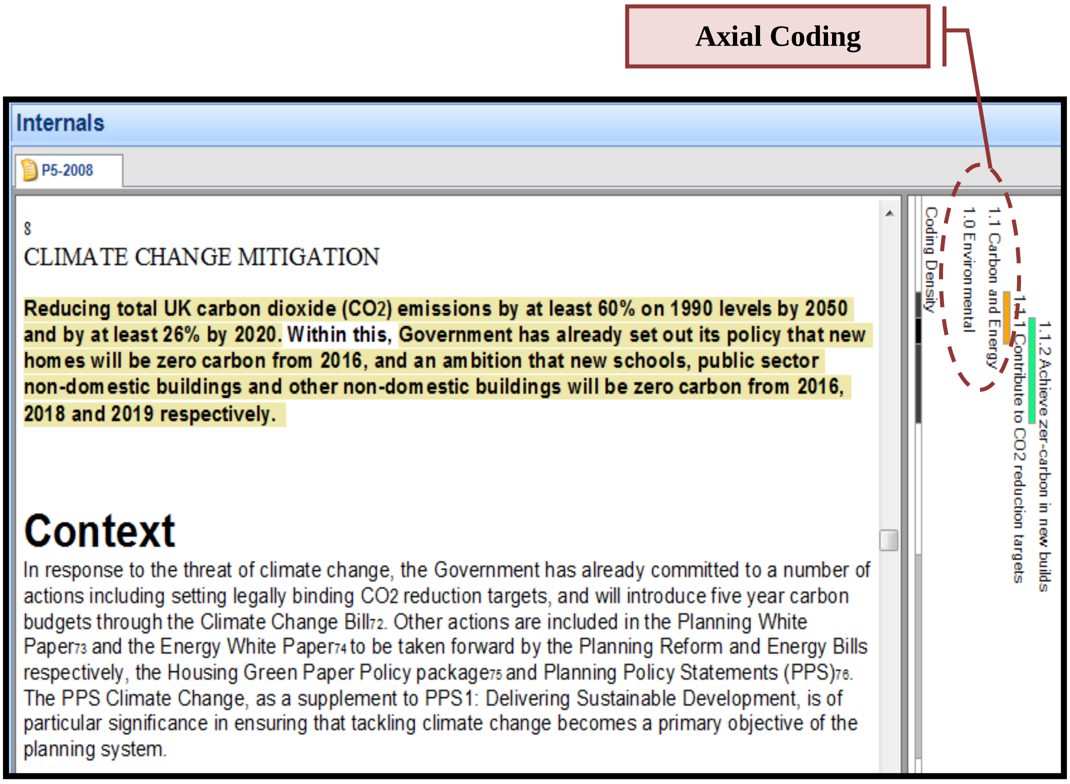


Figure 4.5: Axial coding example 1: Development of objectives, sub-elements and elements of SC using Nvivo software

In the example shown in Figure 4.5, the two codes ‘achieve zero-carbon in new builds’ and ‘contribute to CO_2 reduction targets’, which were initially created as free nodes (as shown in Figure 4.4 above), have been categorised under the ‘parent node’ of ‘carbon and energy’. This ‘carbon and energy’ node in turn has been categorised as a ‘child node’ under ‘environmental’ objectives. This process was followed for the entire set of free nodes that were created during the open coding process. As a result, at the end of the axial coding process two main categories emerged, which provided a picture of how the analysed advisory documents interpreted the concept of SC. These categories were called ‘characteristics of SC’ (see section 5.3.1) and ‘objectives of SC’ (see section 5.3.2). Figure 4.6 shows how NVivo software enabled the axial coding process in developing the elements, sub-elements and objectives of SC.

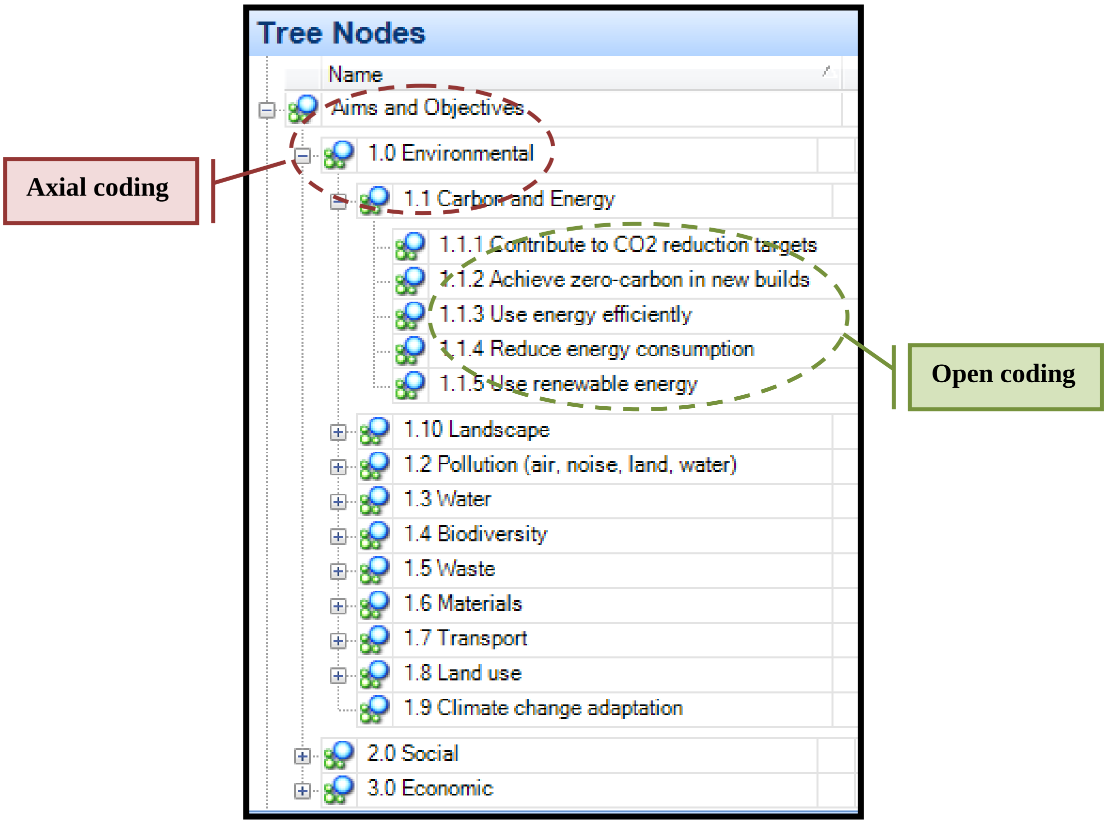


Figure 4.6: Axial coding example 2: Development of objectives, sub-elements and elements of SC using Nvivo software

4.7.3 Presentation of Results

The results of this stage of the research are presented mainly within Chapter 5 of this thesis. Matrices as shown in Table 4.5 below have been used to depict the results of the document analysis exercise. This provided a way of presenting the results, illustrating the relationships between the findings (shown down the left hand side of the Table) and the documents (shown along the top of the Table) using symbols placed at intersections. This way of presenting data, referred to as 'matrix analysis', provided a useful means of summarising the data in one Table and highlighting the 'gaps in knowledge and relationships between items' (Department of Trade and Industry, 2000).

The main purpose of depicting the document analysis findings in matrices, as shown in Table 4.5, was to provide insight into the manner in which the derived characteristics and objectives of SC had been covered across the documents. This is different from an attempt at quantification of qualitative data. Moreover, developing such Tables was also important for maintaining an 'audit trail', which helped in improving the credibility and transferability of the research findings (refer to section 4.7.4).

Table 4.5: Presentation of results – An example

Code assigned to document (refer to Table 4.4)

Characteristics of SC	1 M1-2011	2 M2-2010	3 G3-2009		Total no. (%) of documents mentioning characteristic
1) Three primary elements: economic, environmental and social	√	√	√		18 (100%)
2) complex interrelationships between elements			√		
Total no. of characteristics mentioned	**6**				

Total number of characteristics mentioned in document

Total no. of documents mentioning the characteristic

Total percentage of documents mentioning the characteristic

4.7.4 Limitations and Establishing the Trustworthiness of Research Findings – Stage 2

Document analysis was found to be a useful and cost effective strategy of inquiry to address the objective of this second stage of the research process. Moreover, as data contained within the documents can be considered as ‘stable’, document analysis provided a means of investigating the phenomenon of SC over a long period of time (Berg and Lune, 2012).

One of the major disadvantages of the method was that the coding process, described within section 4.7.2, was extremely time consuming. Since the QCA process followed in this research was inductive in nature, there were no pre-set codes used. The codes were generated while going through the documents. It was necessary to constantly revise and change the codes during the analysis process to ensure that the codes were ‘internally homogeneous’ and ‘externally heterogeneous’ (Patton, 1987 cited Graneheim and Lundman, 2004). In other words, the categories generated through coding needed to be exhaustive and mutually exclusive (Krippendorf, 1980). To ensure these conditions, the open codes initially generated were often revisited and revised during the axial coding process. The use of Nvivo software helped to make the coding process more efficient and manageable through easy data retrieval and arrangement functions.

During the early stages of coding, there was a tendency on the part of the researcher to over code the documents. Over coding during the open coding stage made further analysis through category development, a tedious and an overwhelming process. Hence, it was necessary on two occasions to completely scrap the coding and start the process from the beginning. The tendency to over code could be seen as partly the result of the use of CAQDAS as opposed to manual coding (see section 4.9).

In addition, the QCA process discussed here required the researcher to exercise judgement in interpreting data and developing categories. Waltz et al. (2010) observe that this could result in losing or modifying of the original meaning of text due to lack of information and/or subjectivity of the researcher. Furthermore, this reliance on interpretive skills of the researcher in QCA (especially when using inductive processes as was the case in this research), minimises the ability to standardise the research. Given these drawbacks of QCA approach, there is a need to establish the trustworthiness of the research findings by evaluating the research process adopted in generating those findings.

Trustworthiness of a qualitative document analysis exercise could be established by addressing the issues of credibility, dependability, transferability and conformability of the research process (Lincoln and Guba, 1985). Keeping audit trails and providing thick descriptions of phenomena were useful for establishing the aforementioned trustworthiness criteria.

Establishing the ‘credibility’ of the document analysis process ensures the ‘truth-value’ of the research findings. Credibility establishes the extent to which the research findings are reflective of reality (Shenton, 2004). This is equivalent to the positivist research criteria of ‘internal validity’. Yin (2009) has emphasised the importance of adopting ‘correct operational measures’ throughout the research process to enhance the credibility of the research findings. Within this research, credibility of the research process was ensured by clearly stating and justifying how advisory documents were selected for analysis and how the coding process was conducted. Establishing the quality of the documents selected for analysis through the four criteria mentioned in section 4.7.1.2, was also important in establishing the credibility of the document analysis findings. Furthermore, these selected documents had come from different sources (including several government departments and non-governmental institutions) and fall into different categories. This also improves the credibility of the research by enabling the research question to be addressed in a richer manner (Graneheim and Lundman, 2004). Furthermore, peer scrutiny of the research project (Shenton, 2004) during the coding process also helped to verify the robustness of the document analysis by bringing in fresh perspectives of individuals other than the researcher. This was useful for challenging the assumptions made by the researcher (for example, in relation to developing categories), requiring the researcher to provide clear justifications for the decisions made during the coding process and strengthen the arguments made.

The criterion of ‘dependability’ establishes the precision of a document analysis exercise. This is equivalent to the positivist research criteria of ‘reliability’. The issue of dependability arises out of concerns for changes to data over time and variations that can occur in the researcher’s decisions during the analysis process (Graneheim and Lundman, 2004). Since this document analysis exercise dealt with printed data, there was no possibility of data changing over time. In order to minimise variations during analysis, data was constantly revisited throughout the coding process and the generated coding categories were continuously checked for their consistency (i.e. in terms of internal homogeneity and external heterogeneity). According to Lincoln and Guba (1985), demonstrating the credibility of research as mentioned above, also helps to establish the dependability criteria as well. Hence, thick descriptions of the research design, data collection and analysis techniques have been used to provide the readers with a thorough understanding of the research process and its appropriateness and effectiveness within the context of this research. This allows the readers to replicate the research process if needed.

‘Transferability’ establishes the extent to which the results of a qualitative research can be generalised or transferred to other contexts. As this stage of the research used publicly available documents as sources of data, the collected data was clearly visible and traceable (Prior, 2003). This helped to improve the transferability of the research findings by providing the readers with access to data sources. Moreover, providing clear and distinct descriptions of background data to establish the context of the study (Shenton, 2004) and providing thick descriptions on how the documents were selected and their characteristics also helped to further improve the transferability of the research.

'Conformability' co-relates to the quantitative research criteria of 'objectivity'. Within the context of qualitative research, establishing the conformability of research findings requires the researcher to ensure that the findings are reflective of the ideas of the informants (in this case, documents) rather than the views and experiences of the researcher (Shenton, 2004). Compared to other qualitative data collection approaches such as, interviews, a main advantage of the document analysis approach is that it is 'non-reactive' or 'unobtrusive' (Berg and Lune, 2012; Bowen, 2009; Bryman, 2008). In other words, the documents analysed for this study did not contain the effects of the researcher's presence in the field. This is mainly due to the fact that the documents chosen for analysis (as is the case in this research) have not been created specifically for the purposes of research (i.e. extant texts). In addition, acknowledging the predispositions of the researcher has been identified as a key criterion for demonstrating conformability by Miles and Huberman (1994). Accordingly, the preceding sections of this chapter has detailed the researcher's reasoning underpinning the decisions made in relation to chosen research methods and data analysis techniques. As observed by Shenton (2004), such detailed methodological descriptions help the reader to 'determine how far the data and constructs emerging from it may be accepted'. In addition, during the discussion of the findings from the document analysis (presented in chapter 5), occasions where researcher's judgement was used to derive the findings, have been clearly acknowledged (for instance, see section 5.4).

4.8 STAGE 3: CASE STUDY METHODOLOGY WITH GROUNDED THEORY ANALYSIS

This stage of the research was undertaken to answer the research questions RQ4, RQ5 and RQ6 given in section 1.2. These questions are mainly exploratory in nature and are aimed at scrutinising the interpretation and implementation of SC at project level in an in-depth manner.

A number of strategies of inquiry are available that fulfils the criteria of qualitative research, which could be used to obtain in-depth understanding on an issue. The most commonly used strategies amongst these include; Phenomenology, Grounded Theory, Ethnography, Case Study and Narrative Research (see Table 4.6). Creswell (2007) notes that these strategies can be singled out, as they all have well established systematic procedures for inquiry with rigorous methods for data collection and analysis.

Table 4.6: Comparison of strategies of inquiry for qualitative research (Source: Creswell, 2007)

	Narrative	**Phenomenology**	**Ethnography**	**Grounded Theory**	**Case study**
Focus	Exploring the life of an individual	Understanding the essence of the experience	Describing a culture sharing group	Developing theory grounded in data	In depth description and analysis of one or more cases
Unit of analysis	One or more individuals	Several individuals sharing an experience	Group sharing a culture	A process, action or interaction involving many individuals	A event, program or activity
Discipline background	Anthropology, literature, history, psychology, sociology	Philosophy, psychology and education	Anthropology, sociology	Sociology	Psychology, law, political science, medicine
Type of problem best suited to be addressed	To tell stories of individual's life experiences	To describe the interpretation of a shared experience	To describe/ interpret the shared patterns of a culture	To develop theory grounded in the views of the participants	To provide an in-depth understanding of a case or cases

From the above mentioned, **'narrative'** research focuses on stories of individuals and include approaches such as, biographical studies, autobiographies and life histories (Creswell, 2007). As Pinnegar and Daynes (2006 cited Creswell, 2007) note narrative can refer to the 'method', as well as the 'phenomenon' of study. It is generally used in studies focused on one or two individuals to report their stories and life experiences in chronological order (Creswell, 2007).

'Phenomenology' on the other hand, focuses on the lived experiences of several participants with respect to a particular phenomenon and describes the commonalities observed in their experiences (Creswell, 2007). It deals with how 'people interpret events and make sense of their personal experiences' (Denscombe, 2007). Therefore, while narrative research focuses on providing a narrative on an individual's life arranged in chronological order, phenomenology focuses on describing the 'essence of the experience of the phenomenon' (Creswell, 2007). Denscombe (2007) observes that phenomenology is sometimes presented as an alternative to positivism, representing strategies of inquiry that do not rely upon measurement, statistics or other aspects associated with the natural sciences model.

'Ethnography' focuses on an entire cultural group and studies the life styles, understandings and beliefs of those within that culture or group (Denscombe, 2007). The term ethnography refers to both a process and a product (Creswell, 2007; Tedlock, 2000). It represents an 'on-going attempt to place specific encounters, events and understandings into a fuller, more meaningful content' (Tedlock, 2000). The purposes of ethnographic research have been observed to fall within a spectrum, which ranges from providing rich descriptions of real life situations to acting as a 'test-bed' for development of theories (Denscombe, 2007). Similar to narrative and phenomenological research, ethnography also draws upon people's experiences and autobiographies (Denzin and Lincoln, 2005). However, unlike narrative or phenomenology, ethnography aims to provide a holistic view of an entire culture sharing group (Creswell, 2007). Denzin and Lincoln (2005) also observe that ethnography is perhaps the most contested amongst qualitative research strategies today.

'Case study' is a common strategy of qualitative inquiry. It is a widely used, broad approach in social research that is used to study a particular experience in-depth, providing greater insight. Case studies focus upon one or few instances of a phenomenon under scrutiny in order to provide 'an in-depth account of events, relationships, experiences, or processes occurring in that particular instance' (Denscombe, 2007). However, Stake (2000) is of the view that rather than being a methodological choice, case studies are a choice of what is to be studied. Nevertheless, others have viewed it to be a strategy of inquiry (Creswell, 2007; Denzin and Lincoln, 2005).

'Grounded theory' has been designed to 'develop a well-integrated set of concepts that provide a thorough theoretical explanation of a social phenomenon under study' (Corbin and Strauss, 1990). It provides systematic inductive guidelines for collecting and analysing data. The aim of grounded theory is not just to describe the phenomenon or concept under study, but also to explain it. This is achieved by generating 'theory', which refers to a general explanation or 'an abstract analytical schema of a process' (Creswell, 2007). Such schemas are often presented in the form of figures or diagrams (Strauss and Corbin, 1998). 'Grounded theory' can complement both qualitative and quantitative research approaches (Charmaz, 2006).

The focus of this stage of the research is to understand the concept of SC and its project level implementation, based upon the views of construction project level stakeholders. Therefore, from the above discussions, narrative research (which is suitable for exploring the life an individual) and phenomenology (which is suited for obtaining understanding of the meaning of experiencing a phenomenon) can be excluded from consideration as suitable strategies of inquiry for this research.

Out of the remaining strategies, case studies have the characteristic of being specific (with boundaries) rather than general. Stake (2000) for example, views a 'case' to be an 'integrated system' with an identity, purpose and working parts. This can be compared to studying a culture-sharing group (i.e. the focus of ethnography), which could also be considered as a case. However, the difference is, while using ethnography could help to understand the workings of the culture, case study research could be used to understand a specific issue within that culture (Creswell, 2007). Yin (2003) states that case studies are suitable for occasions where the phenomenon being studied cannot be clearly separated from its context. Furthermore, Eisenhardt (1989) have also highlighted how case studies are useful in 'understanding the dynamics' within a particular setting. Barrett and Sutrisna (2009) observe that case studies are particularly useful in investigating complex situations, such as, construction projects. This is because the case study approach has the ability to capture reliable and rich information whilst retaining the 'holistic and meaningful characteristics of real-life events' (Barrett and Sutrisna, 2009).

The purpose of this third stage of the research was two-fold. Firstly, the focus was on gaining understanding on the concept of SC 'grounded' in the views of the construction project level stakeholders. Secondly, it was necessary to attain in-depth understanding on the process of implementing SC within a construction project environment. Accordingly, this third stage of the research was undertaken, not just to provide a general description, but also to provide an explanation on the issues of uptake and implementation of SC. This can be achieved by using case study methodology together with grounded theory analysis (Eisenhardt, 1989). Research outputs from case studies combined with grounded theory analysis can have important strengths such as, novelty, testability, and empirical validity due to intimate linkage with empirical evidence (Eisenhardt, 1989). Therefore, combining case studies together with grounded theory analysis provides a fitting way of addressing the aforementioned purpose of this research stage, whilst staying true to the philosophical positioning discussed in section 4.3.1.

The research design adopted for this stage of the research is shown in Figure 4.7.

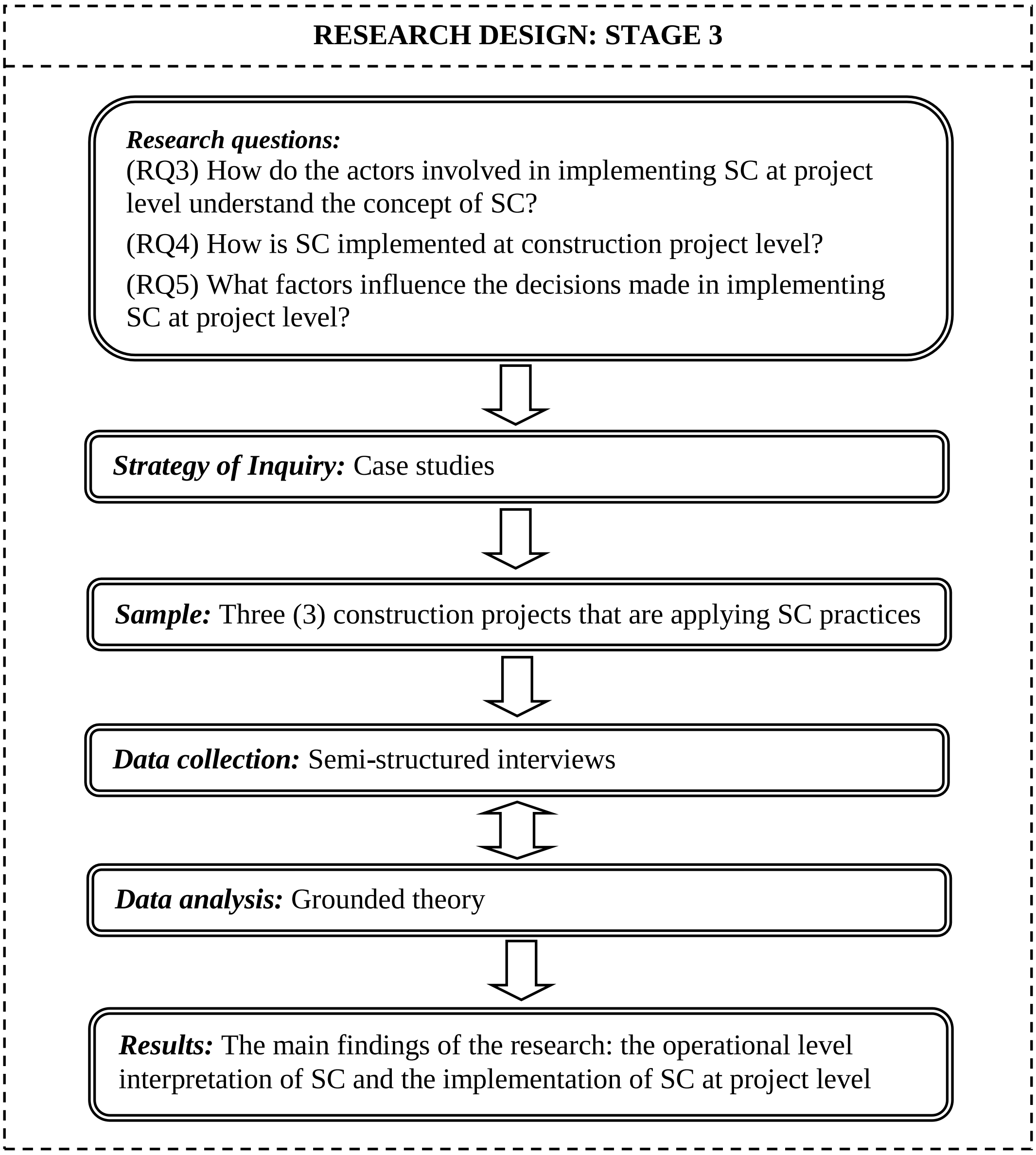


Figure 4.7: Research design for Stage 3

4.8.1 Grounded Theory Analysis

Grounded theory as a generic term is used to denote theoretical constructs generated from data (Corbin and Strauss, 2008). Data in this instance has been systematically gathered and analysed through the research process (Strauss and Corbin, 1998). Hence, in grounded theory there are close interrelationships between the data collection, analysis and theory development activities. The main focus of grounded theory is on generating theory from data. This is an opposite approach to the usual practice of deducing hypothesis from existing theories to be tested on the ground (i.e. the deductive approach). Clark (2003) describes 'grounded' theory as a 'substantive theory' that is formed by integrating the analytic codes and categories generated during the analysis. Such theory should address the substantive area that is the focus of the research study. It has been argued that theory generated through grounded theory fits better for its intended users (Glaser and Strauss, 1967; Strauss and Corbin, 1998). Furthermore, such theory is presumed to last longer than logically deduced theories, since they are intimately linked to data (Glaser and Strauss, 1967). According to Strauss and Corbin (1998), these theories consist of a number of components; i.e. (i) causal conditions (ii) phenomenon (iii) strategies (iv) context (v) intervening conditions and (vi) consequences.

The development of grounded theory was an answer to the criticisms during the mid-twentieth century that qualitative research was 'impressionistic, anecdotal, unsystematic, and biased'. The rigour and usefulness of grounded theory has led quantitative researchers using mixed method research approaches to also accept it (Charmaz, 2006).

Grounded theory was first discovered by Barney G. Glaser and Anselm L. Strauss and was articulated in their book titled 'The discovery of grounded theory' (Glaser and Strauss, 1967). Since their collaboration in the development of grounded theory, Glaser and Strauss have moved the method in different directions. Corbin and Strauss (1990) prescribed a detailed set of procedures that must be followed when using grounded theory. This approach of Corbin and Strauss' was heavily criticised by Glaser (1992) as being too prescribed and structured. According to Glaser, this high level of prescription reduces the level of flexibility allowed for the qualitative researcher in using grounded theory. The process advocated by Glaser, as noted by

Thomson (2006) is more emergent and fluid in nature, resulting in a number of problems to many users of this approach. In fact, Corbin and Strauss argue that prescribed procedures prevent researchers from claiming they have used grounded theory, when they have either only adopted a few grounded theory procedures or have adopted the procedures incorrectly (Corbin and Strauss, 1990). Such a prescribed approach can also be particularly useful to researchers who are new to grounded theory research, as it provides an improved level of understanding on the process of data collection and analysis, as well as presentation of final outputs.

Although the use of grounded theory is quite common in social sciences related disciplines (particularly research in the area of health), it is not as widely used within construction management research. Examples of researchers in construction management using grounded theory can be found in the works of Carter and Fortune (2008) and Thomson (2006). Carter and Fortune have used a similar approach to the Strauss and Corbin's version of grounded theory to explore the perceptions of sustainable procurement within the social housing sector. Thomson has also opted to adopt the Strauss and Corbin's version in his study aimed at gaining understanding on the innovation process within a construction project environment. However, Thomson has introduced certain modifications to the process presented by Strauss and Corbin, in order to address some of the criticisms put forward by Glaser. This modified process of grounded theory is shown in Figure 4.8.

Thomson's modified grounded theory process consists of four main phases. This process avoids the criticisms raised by Glaser through the use of principles of saturation within each phase of the analysis (see Figure 4.8). The need to reach the point of saturation is highlighted within each phase. This requires, the activities within each phase to be continually revisited and repeated (Thomson, 2006). Each phase of the process is made up of a series of activities that are interrelated and therefore, carried out in an iterative, 'fluid' manner. The recognition of this fluid, iterative nature of the activities helps to avoid the main criticism of Strauss and Corbin's approach, which is the use of a too formally structured and prescribed process.

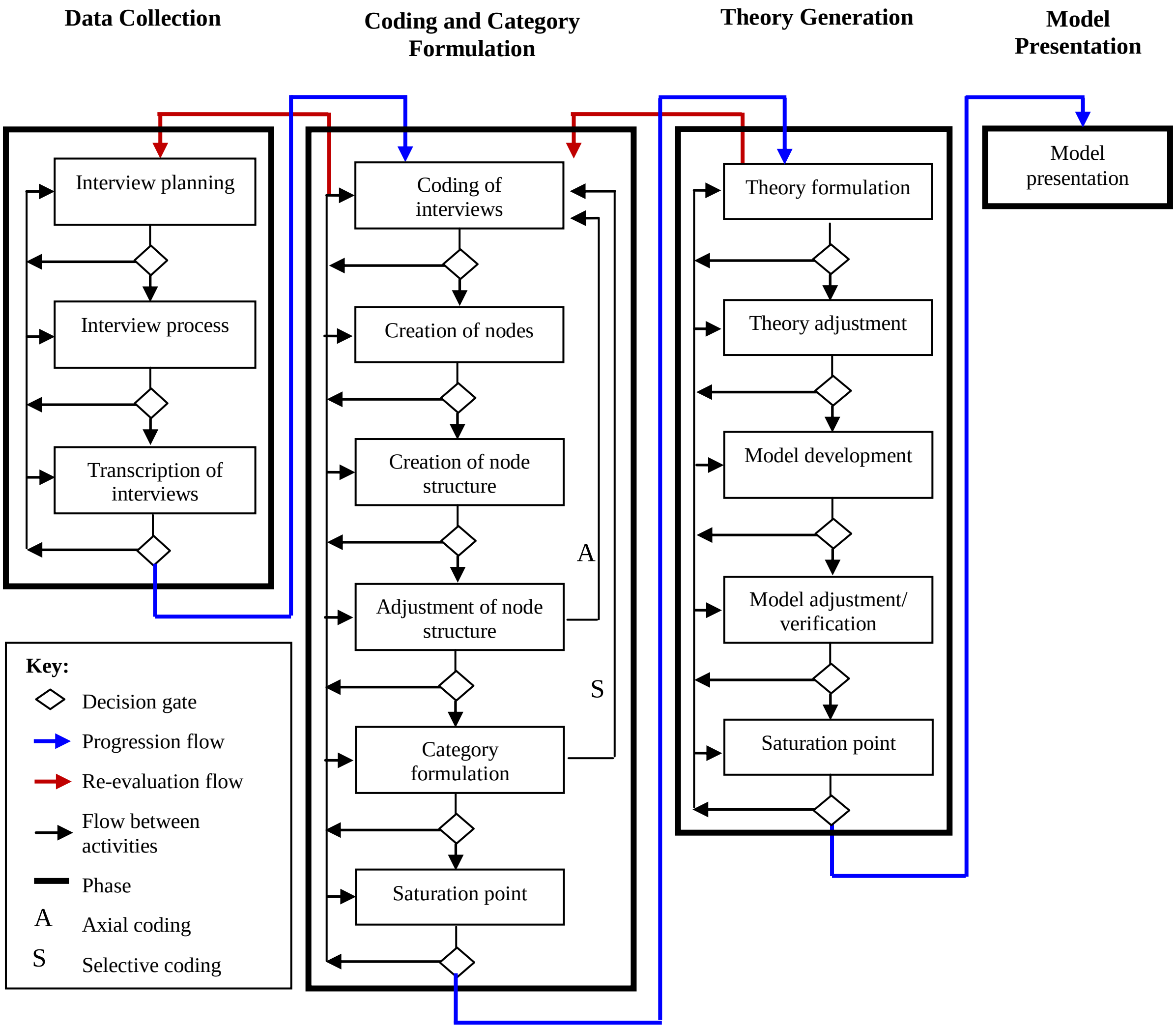


Figure 4.8: Grounded theory process used in this research (Source: Thomson, 2006)

The application of grounded theory approach adopted in this research differed from that described by Glaser. According to Glaser, the phenomenon or issue to be studied has to be identified once the researcher has entered the field based upon the collected data. However in this study, the phenomenon for study, which is the issue of 'uptake and implementation of SC', was identified prior to commencing data collection. This is supported by Strauss and Corbin's approach to grounded theory, where they permit the researcher to determine a subject of inquiry before data collection (Parker and Roffey, 1997). However, in order to accommodate for the criticisms of the Strauss and Corbin's approach, Thomson (2006)'s modified grounded theory process was used within this research.

4.8.2 Selection of Cases – Theoretical Sampling

Having decided upon the case study approach, the next step is to select the appropriate 'cases' for the study. A 'case' is a 'naturally occurring' phenomenon that exists independent of the research been undertaken (Yin, 2009). It is not something that the researcher has a hand in creating for the specific purposes of a study. The study of a particular 'case' involves carrying out an in-depth scrutiny of the complexity and particularity of that 'case', typically using multiple perspectives (Stake, 2000). Case studies could be designed as either single or multiple case study designs. Similarly, they could be either holistic or embedded. These different case study designs and their suitability for this stage of the research are discussed in the following two sections.

4.8.2.1 Holistic vs. Embedded Case Studies

One point of ambiguity in relation to case study approach is in defining the 'unit of analysis'. 'Unit of analysis' help determine the scope of data collection in case study research, ensuring that the case study stays within feasible limits (Yin, 2009). The term 'unit of analysis' has sometimes being used synonymously with the term 'case' (Grunbaum, 2007). For example, Gerring (2004) defines a 'unit' as a 'spatially bounded phenomenon, observed at either a single point in time or over a demarcated period of time'. However, 'unit of analysis' differs from the 'case'. As Yin (2009) explains, the purpose of the 'unit of analysis' is to differentiate between data about the subject of the case study (i.e. 'phenomenon' or 'case') from data external to the case (i.e. 'context'). The boundaries of a unit need not always be explicit and can be implicit. A unit of analysis can vary from an individual person or an organisation to an event (for example, a decision, a programme, an implementation process, etc.). Data collection in case studies is determined by the chosen unit of analysis and any sub-units therein (Grunbaum, 2007; Yin, 2009).

Depending upon the number of units of analysis selected, the case study design can be considered as either holistic or embedded. Case study design is considered holistic when the research involves a single unit of analysis. On the contrary, embedded case studies have multiple units of analysis (Yin, 2009). In embedded case study methodology, the identification of sub-units allows for a more detailed level of inquiry to be carried out on the features, context, and process of a phenomenon (Yin, 2009). Based upon the objectives of this stage of the research, adopting an embedded case design was considered to be more advantageous compared to a single case design. This was because the former design enabled the investigation of both the stakeholder interpretation of SC and the SC implementation process within each case study. In order to address the above, within each case study, the process of implementing SC was selected as the main unit of analysis and the individual project team members involved in the said process was selected as the sub unit of analysis.

4.8.2.2 Single vs. Multiple Case Study Designs

Deciding whether to collect data from a single case or multiple cases is a primary decision to be made in relation to case study design (Yin, 2003). A single case design, which is similar to a single experiment, can be justified under the following conditions (Yin, 2003);

- *Critical case:* where a single case meets all the necessary conditions to test a well-formulated theory.

- *Extreme or unique case:* where a single case represents a rare occurrence/phenomena, which is worth documenting and analysing.

- *Representative or typical case:* the opposite of the above mentioned extreme or unique case, where a single case is used to capture a common everyday situation.

- *Revelatory case:* where an investigator is given the opportunity to study a previously inaccessible phenomenon.

- *Longitudinal case:* where a single case is studied at two or more different points in time.

Likewise, it has been noted that single case designs can make significant knowledge contributions by studying scenarios that cannot be satisfied using multiple case designs. However, the main drawback of the single case design is its vulnerability to failure as the researcher is required to ‘put all her/his eggs in one basket’ (Yin, 2009). On the other hand, a multiple case design, although more demanding than a single case design, ‘permits the induction of more reliable models’ (Bourgeois and Eisenhardt, 1988). Multiple case designs therefore, provide a better chance of doing a ‘good’ case study (Yin, 2003). Hence, it was decided that a multiple case design is most suitable for this study.

From the different sampling techniques described in section 4.7.1.2, it is recommended that studies relying upon cases to generate theory should use theoretical sampling to select cases (Clark, 2003, Strauss and Corbin, 1998, Glaser and Strauss, 1967; Patton, 1990; Eisenhardt, 1989). The use of random sampling to select cases in such instances is considered not necessary and is indeed not recommended. The goal of theoretical sampling in selecting cases is to 'choose cases that are likely to replicate or extend emergent theory' (Eisenhardt, 1989). The focus is upon selecting 'new data sources' that can explicitly address the theoretically interesting facets (Clark, 2003). Accordingly, Eisenhardt (1989) highlights that the selection of cases in theoretical sampling may serve one or more of four purposes; i.e. (i) replicating previous cases, (ii) extending emergent theory, (iii) fill theoretical categories, and/or (iv) provide examples of polar types.

As this stage of the study employs grounded theory approach, the selection of case studies is mainly governed by the need to select theoretically useful cases, following the principles of saturation (Corbin and Strauss, 2008). Theoretically useful cases in this instance are those that would help to replicate or extend theory by filling the conceptual categories (Eisenhardt, 1989). Thus, within the context of this research, the main focus was on selecting cases that have been recognised as being 'sustainable' or implementing sustainable practices. This was achieved by selecting projects that have been rated as 'Excellent' or 'Very good' by BREEAM, which is the most commonly used rating system in the UK to assess SC performance. In order to obtain a rich, in-depth understanding of the process of implementing SC, it was important to minimise the variances between cases due to other project attributes such as, procurement type and/or project type. Accordingly, the selection of cases was limited to PFI projects in the healthcare sector. The rationales for selecting these attributes are discussed in the next two sections.

4.8.2.3 Rationale for Selecting PPP/PFI Projects

Execution of a construction project requires the formation of 'temporal virtual organisations' involving a variety of people from different professional backgrounds with different priorities (Brown et al., 1999; Brown et al., 2001; Hughes, 1990). The type of procurement system adopted has a significant impact on how these people are organised systematically and determining their roles, responsibilities, and interrelationships. For example, Love et al. (1998) define a procurement system as 'an organisational system' that 'assigns specific responsibilities' to the project parties and 'defines the relationships' between them. Hence, it is clear that different procurement approaches will have different impacts on the process of implementing SC at project level. It was decided to limit the selection of cases to PFI procurement projects, so as to avoid variances in findings between cases due to differences in procurement methods. The selection of PFI was due to a number of reasons as discussed below.

Private Finance Initiatives (PFI) are a form of Public Private Partnership (PPP) that was first launched in UK in 1992. However, PPPs remain poorly defined and evaluated, and there is dispute and low level of understanding surrounding their meaning (Hodge, 2006; Hodge and Greve, 2007). The differences of opinions on PPPs range from some viewing it as a new governance tool replacing the traditional method of procuring public services (Hodge and Greve, 2007) to others viewing it to be a mere 'language game' (Hodge, 2006). In general, PPPs can be described as long-term development and service contracts used by governments to obtain capital-intensive infrastructure with long life spans using a combination of government and private finance. These projects are then operated by private entities under long-term franchises, contracts or lease agreements (Maskin and Tirole, 2008; Savas, 2000).

The initial drivers for the UK government to take up PPP/PFI schemes mainly rose out of concerns regarding the availability of public finance. These schemes provided a means for the government to keep the infrastructure costs off the public balance sheets, thereby cutting public spending, whilst maintaining high levels of investment and avoiding public sector borrowing limits (Bing et al., 2005). However, Bing et al. (2005) note that the above interests have now significantly shifted. They postulate that nowadays, PPP/PFI schemes are being pursued more and more for their capacity to accommodate novel methods of risk allocation.

In the European PPP market, UK remains the most active user of PPP/PFI procurement in terms of the number of deals (European PPP Expertise Centre - EPEC, 2010). These contracts as mentioned earlier are typically long term (in general, 25-30 year periods) and are high valued (see Table 4.7). Consequently, this has led to a general increase in commitment towards good procurement practices within PPP/PFI projects, which in turn has been broadened to incorporate SC/sustainable procurement. There is higher emphasis upon establishing business cases and rigorous review processes, leading to clear focus on project objectives (The Chartered Institute of Purchasing and Supply - CIPS, 2008). PFI contracts generally incorporate the design, construction, maintenance and operation of procured facilities. Given that capital costs are on average only 5.5% the lifetime value of a built asset, this gives contractors, in theory, an incentive to design using operational efficiencies at every stage (Green Alliance, 2004). In other words, there is higher incentive within PFI schemes for taking whole life costs into consideration in decision making. As the contractors have control over aspects of service provision (for example, energy strategies, water provision, etc.) there is a higher possibility of inducing them to invest in front end solutions that will result in lower operational costs (The Chartered Institute of Purchasing and Supply - CIPS, 2008). In addition, PFIs have a greater focus on identification, assessment and allocation of risk, which provides an avenue for various risks related to SC options to be accurately identified and allocated to parties most suited to managing them (Bing et al., 2005; The Chartered Institute of Purchasing and Supply - CIPS, 2008).

PFI procurement also provides room for ‘programme effect’ in procurement (Green Alliance, 2004). This means that as contractors may be bidding for several projects, there is potential for developing increasingly sophisticated bids. Similarly, sponsoring departments and local authorities can indicate their expectations on sustainability across a whole programme, thereby increasing the incentive for contractors to invest in appropriate supply-chain management and research and development to address those requirements (Green Alliance, 2004). Moreover, since there are relatively few key players in terms of contractors and funders, there is more opportunity for penetration of guidance and spread of successful ideas.

Accordingly, it could be argued that PFI procurement presents a number of opportunities to address sustainability issues over other forms of construction procurement. Therefore, they present an opportunity to obtain rich data on the issues of uptake and implementation of SC, which is the focus of this stage of the research.

4.8.2.4 Focus on the Healthcare Sector

PFI procurement in the UK is mainly used in the procurement of the following types of facilities; i.e. transport, healthcare, fire and police stations, waste treatment plants and schools (HM Treasury, 2012). From amongst these, the selection of cases for this study was limited to the healthcare sector. This was due to several reasons, including the high capital value of healthcare sector PFI projects, the increased level of attention given to PPP/PFI procurement in the health sector and the domination of a single public sector provider within the sector. Chris Naylor, who is a Fellow in health policy at the King's fund, argues that;

> *'It [i.e. healthcare] is a sector dedicated to improving human lives, and dominated in the UK by a single provider – the NHS – which is under public control. It might be hoped that these characteristics would provide fertile conditions for developing sustainable practices.' (Naylor, 2012)*

During the past decade, PFI has been the main mode of modernising hospitals. As of March 2011, there were a total of 698 current PFI projects (out of which 632 were operational) with a total capital cost of £52.9 billion in the UK (HM Treasury, 2012). Out of these the most number of projects (i.e. 166) was in the education sector and the second highest number of projects (i.e. 118) was in the healthcare sector. However, the total capital cost of the healthcare sector projects (i.e. £11,614.3 million) far exceeded the total capital cost of education sector projects (i.e. £7,731.1 million). It had been further estimated that healthcare projects with an aggregate capital cost of £90 million will reach preferred bidder stage during the 2012-13 period (HM Treasury, 2012). An overview of characteristics of the PFI population within the healthcare sector in the UK is shown in Table 4.7.

Table 4.7: Characteristics of PFI population of NHS hospital projects (Source: National Audit Office - NAO, 2010)

	Minimum	Maximum	Average (Mean)	Average (Median)	Total
Capital value (£m)	3.7	512	82	46	6000
Current unitary charge (£m)	0.6	63.1	11.8	6.5	890
Contract length (years)	24	60*	32	30	

Note:

***Contracts of 60 years have break clauses which can be exercised at an earlier point.**

According to Barlow and Koberle-Gaiser (2008), the government was driven by three main factors to consider the PFI schemes for the healthcare sector. Firstly, PFIs provided an opportunity to bring in private sector finance to renew the healthcare infrastructure. This was a faster mode of obtaining finance for revamping the sector than waiting for public funds. Secondly, PFI schemes provided provisions for the maintenance of facilities over the life time of the contract, which would in turn minimise the burden on the public sector for maintenance of these facilities. Thirdly, PFIs were viewed as a means of bringing in the skills and expertise of the private sector to provide innovative design and construction solutions for the healthcare infrastructure provision.

In general, the UK government requires public procurement to be carried out in a way that supports the achievement of the nation's SD goals. Moreover, according to Green Alliance (2004), there is evidence within the healthcare sector that a number of SC design features (such as, increasing the use of natural ventilation and light in hospitals, maintaining biodiversity around the site and providing access to green areas) are also important drivers of patient recovery. Accordingly, the selection of cases for this study was limited to PFIs in the healthcare sector. The narrowing down of the focus to one particular sector helped to further reduce the variations between projects due to differences in sector priorities/requirements and thereby, increase the homogeneousness of the selected cases.

Healthcare in the UK is mainly provided by the National Health Service (NHS). The NHS, which was launched in 1948, is the world's largest publicly funded health service today (National Health Service - NHS, 2011). NHS mainly comprises of two sections; i.e.

- Primary care (controlled by Primary Care Trusts or PCTs - forms the first point of contact for most people) and,

- Secondary care, also known as, acute healthcare (controlled by Acute Care Trusts - includes planned specialist medical care or surgery and emergency care).

From these the selection of case studies was limited to acute care hospitals, as they involve the larger scale PFI projects. There are differences in the PFI procurement process depending on the capital value of contracts. Hence, selecting large scale projects (i.e. over £35 million in capital value) helped to avoid discrepancies in findings due to such procedural variations.

Following the above criteria, three PFI acute care hospitals were selected for analysis. All three of the hospitals had been accredited as either 'Excellent' or 'Very Good' by BREEAM. Each case was assigned a code as shown in Table 4.8 for ease of reference.

Table 4.8: Codes assigned to case studies

Case Study	Code Assigned
Case study 1	CS1
Case study 2	CS2
Case study 3	CS3

The next section provides the background details of each of the three cases selected for this phase of the research.

4.8.2.5 Profile of Selected Cases

A brief description of background details of each case is given in Table 4.9. The details of selected cases are given in greater detail within the remaining parts of this section.

Table 4.9: Profile of selected cases

	CS1	CS2	CS3
Capital value (£)	320 mn	350 mn	125 mn
Financial closure	2007	2004	1999
Contract length	37 years	32 years	30 years
Current stage	Construction/ Operation	Construction/ Operation	Operation
Location	England	England	England

<u>**Case study 1 - CS1:**</u> The inception of CS1 was as early as 1999. The hospital, which is estimated to treat an estimated 700,000 patients a year, has a capital value of £320 million. During the early 2000s, when the outline business case for the project was being prepared, PFI in the UK healthcare sector was still a relatively new venture. The Trust had expressed interest from three potential bidders at this stage, out of which one bidder dropped out soon after. There was a long gestation period for the project with the preferred bidder being selected in 2004 to finally reaching financial closure in 2007. This was mainly due to a need to re-scope the project after the contractor had

been selected to accommodate changes to policy and national targets for affordability. The re-scoping of the project presented several challenges to the Trust as well as the PFI consortium. For the Trust, it meant that some of the original project objectives had to be scrapped with concentrating the focus upon the priority objectives. The long gestation period since preferred bidder selection was also creating pressures for the consortium, which were magnified by delays to the financial close of the project. However, even with these added pressures the project has succeeded in achieving a BREEAM rating of ‘Very Good’. Despite the difficulties, the re-scoping process is now viewed in a positive light by the project parties for allowing the project to be re-energised with a strong focus on delivery.

Case study 2 - CS2: CS2, which is part of a £350 million PFI, is located in the East Midlands region and provides healthcare for approximately 300,000 people per year. The PFI contract incorporated the design, construction, finance and operation of the hospital until year 2035. The project involves the refurbishment of a small portion of retained facilities. However, the majority of the work (approximately 70%) is new built. The redeveloped hospital has a total area of 140,000 m^2 and a total capacity of 920 beds (i.e. 100 additional beds than before). The construction was scheduled to be completed in March 2011, however, 60% of the new facilities were available for use from 2009 onwards. The hospital remained fully operational throughout the development. As a result of the new build, the hospital has been converted from what was originally an old, tired estate (known to be the second worst polluter in the region after the motorway) to a modern purpose built facility.

The project has been rated Excellent by the NHS Environmental Assessment Tool or NEAT and has also won a gold award from the Royal Society for the Prevention of Accidents. One of the key considerations for the Trust was the need to improve adjacencies and co-location of services within the site. These requirements were laid out in the output specifications by the Trust. A partnership approach was adopted during the design development between the Trust and the consortium. As a result, the Trust strongly believes that the PFI design solution for the hospital achieved the project’s objectives of high quality design and being fit for purpose. In addition, the PFI has also been recognised at international level for its consideration of various aspects of SC such as, innovative energy efficient/saving technologies.

Case study 3 - CS3: CS3 involved the modernisation of one of the largest and busiest hospitals located in the south of England. The PFI was the most significant modernisation carried out at this hospital since 1913. One of the main challenges in CS3 was to incorporate the design and construction of the new build into a very tight urban site, whilst adhering to the hospitals Victorian heritage. The project company was led by a contractor who was new to the PFI market in UK. As a result, the contractor was determined to deliver a high quality, sustainable facility as a means of breaking into the UK healthcare PFI market. The project achieved the highest possible score in one of the pilot studies carried out in developing the NHS Environmental Assessment Tool (NEAT).

4.8.3 Data Collection – Use of Semi-Structured Interviews

The case study approach does not prescribe specific methods to be used in data collection. On the contrary, one of the strengths of the case study approach is that it allows the researcher to use a variety of methods to collect a range of data from different sources (Denscombe, 2007). It can often be found that several data collection methods such as, interviews, questionnaires, observations and archives are used together to collect data in case studies. The nature of data thus collected may be purely quantitative, purely qualitative or a mixture of both (Denscombe, 2007; Eisenhardt, 1989). However, the case study approach is often associated with qualitative techniques (Yin, 2009). This research used semi-structured interviews and project documents as the main methods of collecting data from the selected case studies.

Interviews can take various forms. In structured interviewing, the interviewer asks the same set of questions with a limited set of responses from all the respondents. Little to no flexibility is allowed in the way the questions are asked or answered. Thus, structured interviews require the interviewer to play a neutral role restraining from improvising or displaying independent judgement (Fontana and Frey, 2000). This type of interviewing does not take into consideration the differences in social context or individuals that can influence the responses. Furthermore, the rigid format of structured interviews is not suitable for obtaining in depth answers to questions from the respondents. An opposite approach to the above is to use unstructured interviews. Unstructured interviews are generally carried out in the style of everyday conversations (Fossey et al., 2002) and are advocated for their ability to provide greater breadth of data. In unstructured interviews, the agenda is generally set by the interviewees and the interviewer acts as the facilitator of the discussion (Fossey et al., 2002; Thomas, 2011). The main disadvantage of this type of interviews is that they can go in unexpected directions. This can result in the interviewer losing control of the data collected.

Semi-structured interviews therefore, provide a useful alternative to the above, avoiding the drawbacks of both extremes to achieve the 'best of both worlds'. In semi-structured interviews, the interview guide provides a list of issues, potential questions and follow-up questions (or probes) that are to be covered during the interview (Thomas, 2011). The use of interview guides gives semi-structured interviews a level of focus that is lacking in unstructured interviews. While the use of interview guides in grounded theory related research has been criticised by Glaser (1998) for imposing received codes on data, Charmaz (2006) argues that the use of an open ended interview guide is far from being similar to imposing received codes on data. Therefore, semi-structured interviews can be viewed as presenting the best option to obtain the required information within this stage of the research, while providing the interviewees with a level of flexibility to provide their own insight.

Thus, the interview format used in this research was semi-structured interviews with open ended questions. The interview guide used is given in Appendix 2. The interview questions addressed the following four main areas;

i. Background of interviewees
ii. Interviewees perception of SC
iii. Process of implementing SC
iv. Influence factors in implementing SC at project level

Follow up questions were asked on occasions where further clarity was required on the responses given.

In developing interview guides, the use of reference groups or pilot studies is useful to ensure 'sensitivity to participants' language' and 'privilege [from] their knowledge' (Fossey et al., 2002). Therefore, before commencing the case study interviews two pilot interviews were conducted; one with a member of the academic community with expertise on SD and the other with a construction industry professional with expertise in PPP/PFI projects. These pilot interviews were useful in establishing any issues relating to clarity of the questions asked. As a result of the feedback received, the initial interview guide was refined by changing the phrasing of two questions, so as to make them more understandable for the interviewees. Furthermore, notes were made on the interview guide where further guidance may need to be provided during the interviews in order to obtain all the necessary information from the respondents.

Within each case study, respondents belonging to the following four main stakeholder groups were selected to be interviewed;

- Client organisation (i.e. NHS Trust),
- Contractor organisation (i.e. main PFI partner),
- FM organisation and
- Design team (contracted by the PFI project company).

Figure 4.9 shows the generic contract structure of the selected case studies, with the organisations represented by interview respondents highlighted.

All respondents interviewed held positions of responsibility for their respective organisations within the project. For example, the representatives from the NHS Trusts that were interviewed all held the position of 'project director' within the project team. It was assumed that selecting respondents with high levels of authority and responsibility would facilitate the collection of richer and more insightful information on the issues being investigated (particularly in relation to the process of SC implementation). In order to further improve the quality of data gathered in relation to above, particular attention was given to selecting respondents who have been involved in the projects from an early stage.

Altogether, twelve people were interviewed from the three case studies. All but two of the interviews were carried out as face-to-face interviews, which facilitated maximum interaction with the interviewees. Two interviews were conducted as telephone interviews due to difficulties in arranging face-to-face interviews.

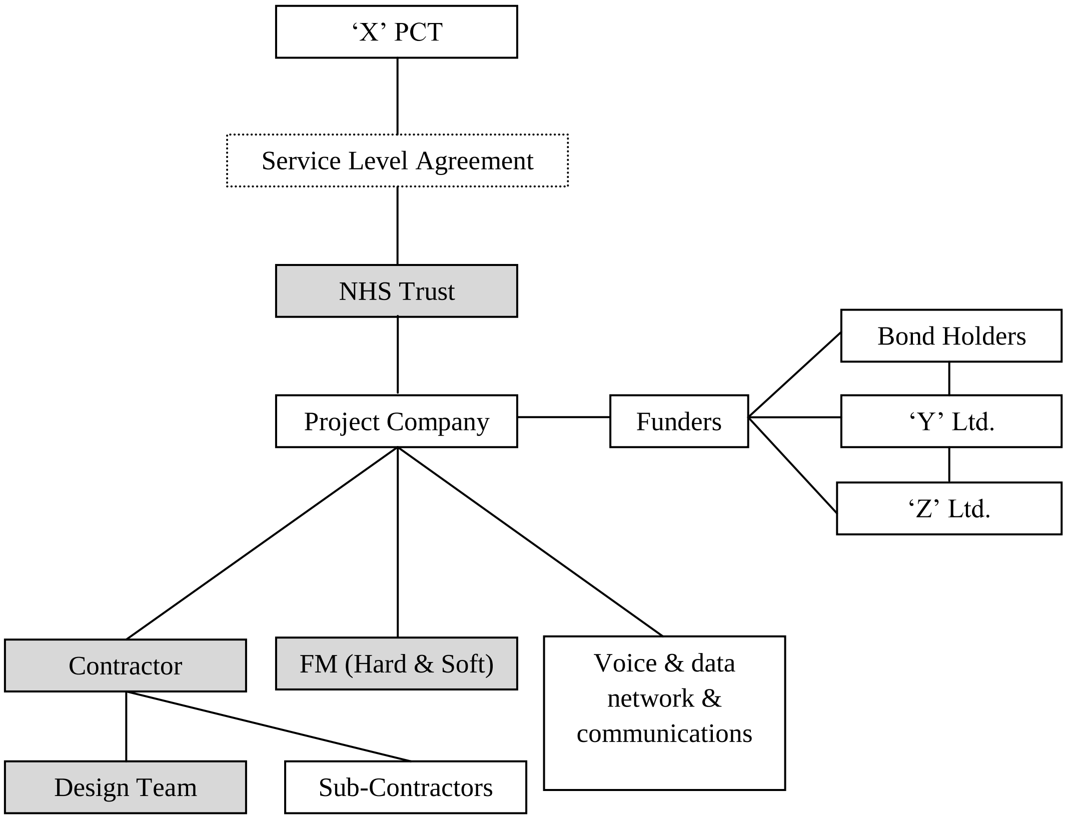


Figure 4.9: Generic contract structure of case study projects

Each interview lasted between one to two hours. All the interviews were recorded using a digital voice recorder. These recorded files were then transferred and stored as computer files in Waveform Audio File or WAV format. This format was easy to record and could be played back using many of the commonly available tools. Furthermore, it also presented a 'lossless' format (i.e. no audio information was lost during the creation of the file) and was therefore, useful for retaining first generation archived files in high quality over longer periods (Dunning, 2005).

4.8.4 Data Analysis – Coding

According to Turner (1983 cited Denscombe, 2007) the 'novelty of grounded theory lies not in the mode of investigation associated with it, but in the manner in which the collected information is analysed'. The data analysis in grounded theory comprise of qualitative coding. Coding refers to 'naming segments of data with a label that simultaneously categorises, summarises and accounts for each piece of data' (Charmaz, 2006). It represents an analytic process through which whole-text data are fractured, conceptualised and integrated to form theory. Data collection and analysis processes in this stage of the research were conducted interactively (see Figure 4.8)

The recorded interviews were transcribed word for word, manually in MSWord documents to facilitate coding. The transcribed files were then imported to NVivo to begin analysis. The transcribed interviews were then analysed using the processes of open coding, axial coding and selective coding developed by Strauss and Corbin (1998) and shown in Figure 4.8.

Open coding was carried out during the first pass through the data. At this first instance, no attempts were made to establish criteria or discover patterns within the data. The saturation point (refer to Figure 4.8) was reached for this activity when no further codes were emerging from the data. Once the saturation point was reached, the open codes were reviewed to establish patterns and relationships. This was done by creating Nodes as mentioned in section 4.7.2. Establishing patterns and relationships between coded data led to the emergence of a hierarchical structure for the Nodes (i.e. Tree Nodes). Axial coding is the activity of reconsidering and reviewing these Nodes further and developing sub-nodes around the axis of the central node. The component parts of theory put forward by Strauss and Corbin (refer to section 4.8) were useful in order to achieve this. Accordingly, axial coding was useful for developing the shape of the research findings through its display as categories. Once saturation was reached for this activity, selective coding was employed to develop the depth of each of the categories and assess for codes previously missed. Each of the aforementioned activities was continually revisited until saturation was reached, both individually and as a phase as a whole (refer to Figure 4.8). In addition, the revisiting of the first phase of the process occurred at numerous occasions, as patterns emerged during this phase required further investigation during the interview process. This emphasised the need for an iterative process between data collection and analysis that constantly revisited previous activities (Thomson, 2006).

4.8.4.1 Use of Conditional Matrix

Conditional matrixes are useful tools in grounded theory that helps in fully understanding a particular phenomenon. The use of conditional matrixes in grounded theory studies have been proposed by Strauss and Corbin (1998). According to them a conditional matrix can be defined as;

> *'An analytic device to stimulate analysts thinking about the relationships between macro and micro conditions/consequences both to each other and the process'*

Therefore, a conditional matrix is useful in establishing how the macro and micro conditions and activities often intersect and interact with each other. The Figure 4.10 below shows the conditional matrix that has been used in this research.

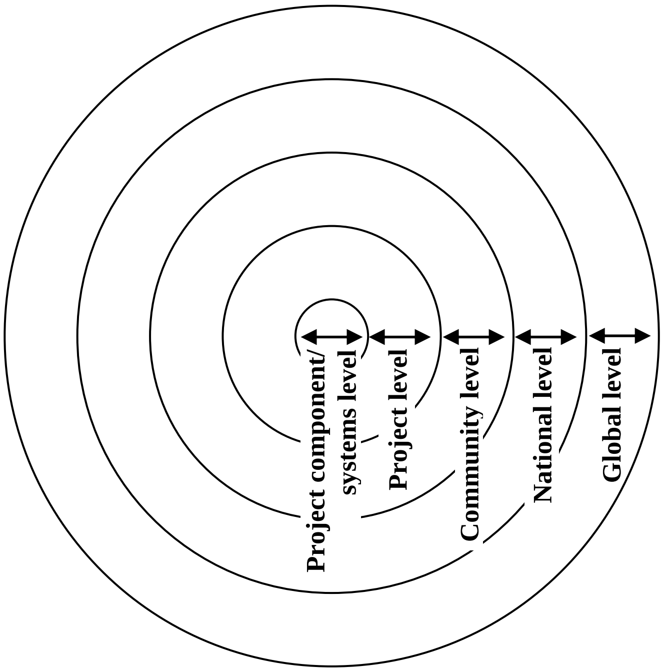


Figure 4.10: Conditional matrix (Adapted from Strauss and Corbin, 1998)

In order to properly address the issues within the context of this research in developing the matrix presented in Figure 4.10, Strauss and Corbin's depiction of conditional matrix has been integrated with the frameworks for systematic nesting of different scales for SD in the built environment presented by the likes of Sexton (2000) (see Figure 4.11 below).

Figure 4.11 depicts the relationships between the different components of the built environment (refer to section 2.4) and illustrates the broad areas that need to be considered in addressing SD within the built environment context (Brandon and Lombardi, 2011).

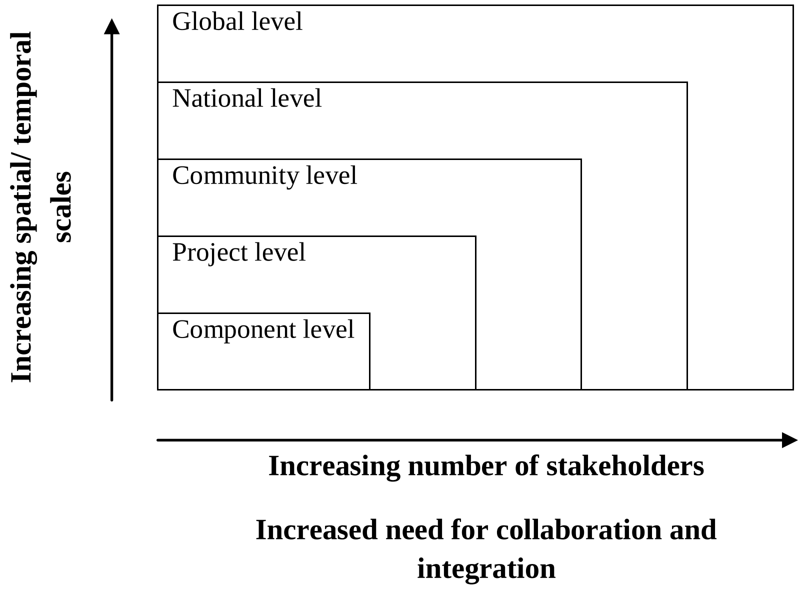


Figure 4.11: Nesting of scales in the built environment (Source: Sexton, 2000)

The use of a conditional matrix poses several advantages for this research. First, the uptake and implementation of SC at construction project level cannot be understood in isolation, ignoring the contextual situation at global, national and community levels. From the discussion in chapters 1, 2 and 3 it could be postulated that the activities and developments being made at these macro levels have impacts on how the concept of SC is understood and implemented at the project level. The advisory document analysis carried during the stage 2 of this research for instance, looked to establish the national level context in terms of SC. On the other hand, the actions taken and the experiences gained from the activities at project level could in turn influence the developments being made at macro levels.

The above is useful in this research as it allows the central phenomenon of SC to be situated within its context allowing for a richer and more holistic view to emerge.

4.8.4.2 Presentation of Results

For ease of reference during data analysis, each interviewee was assigned a code as shown in Table 4.10.

Table 4.10: Codes assigned for interview respondents

Respondent's organisation	Generic code for the respondent	Case study code		
		CS1	**CS2**	**CS3**
Trust/Client organisation	CL	CL1	CL2	CL3
Contractor organisation	CT	CT1	CT2	CT3
Design team	DT	DT1	DT2	DT3
Facilities management	FM	FM1	FM2	FM3

Similar to stage 3 of this research, Tables were produced as shown in Table 4.11 to present a summary of results from the case study phase. These Tables were used to depict the SC issues identified by each respondent in the three case studies. Therefore, producing these Tables was especially helpful in the cross-case analysis of research findings. The findings of this stage are presented in chapters 6, 7 and 8 of this thesis.

Table 4.11: Presentation of results - case study findings

Code assigned to the interview respondent (refer to Table 4.10)

Code assigned to the case study (refer to Table 4.8)

What is SC?	CS1				CS2	Total
	CL1	**CT1**	**DT1**	**FM1**		
▪ By product of achieving mandatory targets	√					3
▪ Reducing energy consumption	√			√		

Total number of respondents mentioning the issue

Quotations from interview transcripts have been used throughout the discussions in the aforementioned chapters to support the inferences made and improve the trustworthiness of findings. Where parts of the quotation has been omitted for brevity, a '...' has been used to represent a break in the actual quotation. On certain occasions, it was necessary to insert words into a quotation to enable clear understanding for the reader. On such instances, square brackets '[ ]' have been used to indicate the inserted words.

4.8.5 Limitations and Ensuring the Quality of Findings – Stage 3

Section 4.7.4 discussed how thick descriptions and audit trails can be used to improve the trustworthiness of research findings. These were applicable to this third stage of the research as well. Accordingly, within section 4.8, thick descriptions have been provided on the research process, along with justifications for the decisions and choices made. In addition, the chapters 6, 7 and 8 discuss the research findings in depth, making co-relations to the data sources through the use of quotations and matrices (see section 4.8.4.2). Use of CAQDAS was particularly helpful for maintaining an audit trail of the data analysis process discussed in section 4.8.4.

In addition to the above, discussions within section 4.8 asserted the need to maintain objectivity within the grounded theory analysis process. It is important at this point to note that the notion of objectivity differs within the quantitative and qualitative research domains. In quantitative research objectivity deals with controlling variables; in qualitative research it refers to 'openness', 'a willingness to listen' and 'give voice to respondents' (Strauss and Corbin, 1998). When carrying out data analysis in grounded theory, it is prescribed that the researchers set aside any preconceived concepts that may be the result of knowledge and/or experience, thereby bringing in complete objectivity to the analysis process. However, over the years it has been acknowledged that such complete objectivity is not realistic (Charmaz, 2006; Strauss and Corbin, 1998). Charmaz (2006), as well as Strauss and Corbin (1998) acknowledge that researchers have ideas and skills and that they bring into the research, which in turn brings in a level of subjectivity to the research. The issue here is minimising the effects of this subjectivity on the analysis process. However, the openness in data analysis is highlighted as key to developing grounded theory by all proponents. The structured process for grounded theory analysis used within this research as shown in Figure 4.8 was useful in minimising the effects of subjectivity through the emphasis on techniques such as constant comparison and saturation.

In addition, several techniques that have been suggested by Strauss and Corbin (1998) were used to ensure the objectivity during data analysis;

- Thinking comparatively
- Gaining multiple viewpoints.

- Gathering data from multiple sources

Employing constant comparison technique helped in developing comparative thinking during the analytic process. This included comparing data to each other, as well as to the available literature. The data gathered from interviews were compared to other interviews within the same case study (i.e. within case analysis), and the findings from each case study was compared and contrasted to the findings from the other case studies (i.e. cross-case analysis). Furthermore, where possible the findings were compared to the available literature. However, Strauss and Corbin (1998) are clear that the latter does not mean using the literature as data. Rather the literature is used to gain insight and stimulate thinking on properties and dimensional level. Furthermore, within each case study of this research, data was gathered from multiple viewpoints (i.e. client, contractor, design team and facilities management). In addition to the interviews other sources of data, such as annual reviews, company policies, and business cases were also reviewed.

4.9 THE USE OF COMPUTER-ASSISTED QUALITATIVE DATA ANALYSIS SOFTWARE (CAQDAS)

The qualitative data analysis entails activities such as, coding of data into sub-categories, categories, concepts, themes etc. The use of Computer-Assisted Qualitative Data Analysis Software or CAQDAS is becoming increasingly popular amongst qualitative researchers. These packages are especially helpful in managing large amounts of data available for qualitative researchers providing a methodological framework (Blismas and Dainty, 2003). Dainty et al. (2000) have observed three ways in which the use of computer software in qualitative data analysis can improve the research process by;

i. Assisting in data management
ii. Providing the facility code and retrieve all data on a particular topic
iii. Bringing the researcher closer to simultaneously studying phenomena both extensively and intensively by using large sets of data

However, Richards (1996 cited Blismas and Dainty, 2003) have criticised research offering no reflections on the use of CAQDAS in terms of how they have assisted or hindered the data analysis process. Therefore, this section provides a critical discussion on using CAQDAS within this research.

NVivo8 qualitative computer software was used within this research to assist in analysing data. NVivo provides advanced data handling and manipulation features over the other CAQDAS packages (Blismas and Dainty, 2003).

The stage 2 of the research included the analysis of 18 advisory documents. Most of these documents had in excess of 50 pages. In addition, during the case study stages 12 interviews with open ended questions were carried out. This generated in over 20 hours of recorded interview data which was then transcribed word for word. Using NVivo software was useful in managing and analysing of this data in a timely and efficient manner. Furthermore, CAQDAS has facilities to code and retrieve data on a particular topic or category which is not possible when using manual techniques (Blismas and Dainty, 2003). This was useful in making the coding process much more organised and less time consuming.

However, there are also several criticisms of using CAQDAS for qualitative analysis, particularly when using grounded theory. For example, Glaser is opposed to the use of CAQDAS for grounded theory analysis claiming that it undermines the creativity of the researcher (Glaser, 2003). Hesse-Biber (cited Bryant and Charmaz, 2007) also acknowledges that there is a possibility of losing the intimacy between the researcher and the data through the use of CAQDAS. However, he maintains that 'software supports structure' and 'enriches the learning process' (Bryant and Charmaz, 2007). Therefore, care was taken to ensure that the use of CAQDAS within this research did not change the process of coding and data handling and only served as a tool to reduce the time and labour spent on this process.

Overall, using NVivo enabled to reduce the time spent on clerical tasks associated with data handling, allowing more time to be spent on the actual analysis process. The rigid time frames of the PhD programme also necessitated the speeding up of data analysis phase which provided motivation for using CAQDAS.

4.10 STAGE 4: DEVELOPMENT AND REFINEMENT OF THE FRAMEWORK FOR UPTAKE AND IMPLEMENTATION OF SC

The findings from the previous stages of the research established the need for a framework to address the issues of uptake and implementation of SC within a construction project environment. Figure 4.2 how these findings from research stages 1 to 3 were used to develop and refine this framework for uptake and implementation of SC. This allowed for using triangulation in the development of the final framework, thereby giving the contents of the framework more depth and richness.

Triangulation is a term that is used to describe the use of multiple methods in a single study. Triangulation in qualitative research assists in developing an in-depth understanding of the studied phenomena. Flick (1998 cited Denzin and Lincoln, 2005) has highlighted that triangulation is not a tool for validation. Rather it is an exercise that helps in providing rigor, breadth, richness, and complexity to the study. In this study, the triangulation process used the findings from the literature review, advisory document analysis, and the case study interviews to establish a broader understanding of the concept of SC. These multiple data sources were useful in substantiating the constructs and hypotheses (Eisenhardt, 1989). The in-depth understanding of these findings and analyses was used to develop the proposed framework presented in Chapter 9.

This developed framework was then refined and validated further using qualitative interviews. Interviews were conducted with two members of the academic community and two industry practitioners. The members of the academia were those with specialised expertise in the subject area of SD/SC. Accordingly, their input was useful in establishing the theoretical soundness of the developed framework. The industry practitioners were those with experience in working within construction project environments addressing SC issues. Their inputs were useful to ensure the practical applicability of the developed framework.

The final framework was sent out to all four of the interviewees prior to the interviews. The interviews consisted of open ended questions addressing the following aspects (refer to Appendix 3);

i Level of coverage in terms of the main sections constituting the framework.

ii Level of coverage in terms of the contents within each of the constituent sections of the framework

iii The flow/ logic/ clarity within the framework

iv Overall usefulness of the framework.

The discussions in relation to the development and refinement of the framework in presented in Chapter 9 of this thesis.

4.11 SUMMARY

This chapter presented the overall research design of the study. It was decided that the research aim and objectives of this research could be best achieved through the use of a more qualitative approach. This allows for more in depth investigation and understanding of the research questions stated in section 1.2, whilst taking into consideration the contextual factors and inherent complexities identified within the subject areas of this research. Overall, the research process consisted of four key stages; i.e. literature review, document analysis, case studies, and development of the final framework. The strategies of inquiry employed during each of these stages, along with techniques used for data collection and analysis, were also presented within this chapter. Within each stage of the research, the justifications for selecting the aforementioned strategies of inquiry and data collection and analysis techniques have also been provided. The remaining chapters of this thesis go on to present the findings of the research derived using the research approach and methods discussed within this chapter.

CHAPTER 5: THE ADVISORY DOCUMENTS' INTERPRETATION OF SC

5.1 INTRODUCTION

The aim of this research is to understand the interpretation of SC and to develop a framework that can assist in its effective uptake and implementation within a construction project environment. This chapter addresses the first part of this aim from a strategic level perspective, by analysing how SC has been interpreted in the advisory documents produced for the industry. This addresses the first stage of the conceptual framework presented in Figure 3.3. In order to set the context for the discussions in relation to the aforementioned, the first part of this chapter provides a review of different purposes or aims of the analysed advisory documents. The chapter then goes on to discuss the advisory documents' interpretation of SC under the two main headings of characteristics and objectives of SC. A discussion and synthesis of the overall findings is provided at the end of the chapter. Overall, this chapter fulfils objective 3 and answers research question RQ3 of this research.

5.2 THE PURPOSES OF ANALYSED ADVISORY DOCUMENTS

The complete list of documents analysed during this review (along with the rationale for selecting them) has been provided in section 4.7.1.2. Before embarking on in-depth analysis of these documents to ascertain how SC is interpreted in them, the stated purposes for developing the documents were reviewed. This helped in contextualising the findings from the subsequent analysis on the interpretation of SC.

Out of the 18 documents reviewed, four did not explicitly state the purposes for producing the documents. All the other documents contained either a single purpose or multiple purposes. Upon analysis using QCA (see section 4.7.2), it emerged that these stated purposes of the documents could be categorised under eight broad themes. These were; (i) increasing awareness and understanding, (ii) providing guidance, (iii) encouraging consideration, (iv) examining current practice, (v) promoting good practice and improved performance, (vi) providing a tool, framework or method, (vii) making commitments, and (viii) supporting government policy. Table 5.1 presents the analysed documents categorised according to these main theme areas and the purposes under each of the main themes.

Table 5.1: The purposes of the analysed documents

Themes	Purposes	Number of documents (Document codes)
To increase awareness and understanding of SC	- Bring together current thinking - Create / raise awareness - Provide an overview - Highlight the importance - Shared understanding - Set out a vision - Summarise tasks needed - Provide accurate information - Help understand the role - Broader perspective	**3** (R4-2009, G7-2008, G15-2003) **3** (M1-2011, M2-2010, M17-2002) **2** (G12-2005, G18-2001) **1** (G12-2005) **1** (P9-2007) **1** (P9-2007) **1** (G18-2001) **1** (G18-2001) **1** (G18-2001) **1** (G18-2001)
To provide guidance on SC	- Identify standards and further guidance - Set out aims and objectives - To deal with sustainability issues - Illustrate ways to deliver SC - To help specify requirements	**3** (G12-2005, M17-2002, G18-2001) **3** (G7-2008, P9-2007, G15-2003) **1** (G3-2009) **1** (G12-2005) **1** (M17-2002)
To provide a tool or framework or method for SC	- For assessment purposes - To further improve performance - To demonstrate achievements made - To make provisions for consideration	**3** (M1-2011, M2-2010, M17-2002) **1** (P9-2007) **1** (M17-2002) **1** (P13-2004)
To promote good practice and improved performance on SC	- Recognise good practice - Set higher standards - Continuous improvement	**2** (M1-2011, M2-2010) **2** (M1-2011, P7-2008) **1** (M2-2010)
To support government policies on SC	- Support government strategy/ policies - Provide clarity about the range of government commitments/ targets	**2** (M2-2010, P11-2005) **1** (P6-2008)
To examine current practices of SC	- Extent to which SC targets are met - Summarise experience of organisations	**1** (R8-2007) **1** (G18-2001)
To make commitments for SC	- To achieve sustainability in specific areas - To take collective action	**1** (P6-2008) **1** (P9-2007)
To stimulate demand	- Encourage consideration of SC	**2 (**M1-2011, G12-2005)

According to Table 5.1, the highest level of emphasis was on the theme of 'increasing awareness/understanding on SC' (addressed by eight, i.e. 50% of the documents). This was followed by 'providing guidance on SC' (addressed by seven, i.e. 39% of the documents). Together, ten separate documents (i.e. 56%) emphasised the aforementioned two key themes. The next highest level of focus was on the theme of 'providing a framework, tool or method' for assessing SC performance. This was addressed by five documents (i.e. 28%). In addition, the themes of 'promoting good practices and improved performance on SC' and 'supporting government policies on SC' were covered by three documents (i.e. 17%) each.

The above analysis highlights the high levels of emphasis placed within the documents on providing guidance and understanding on SC issues to their intended users. This poses an interesting issue, as the discussions in chapter 2 highlighted the lack of a common understanding and numerous disagreements surrounding the concept. This further underpins the need for further analysis of these documents to ascertain how they interpret the concept of SC. It could be assumed that having such an interpretation, whether explicit or implicit, is essential for achieving the aforementioned purposes of providing guidance and understanding on SC. The remaining sections of this chapter go on to discuss the findings from the document analysis exercise in relation to the above.

5.3 THE ADVISORY DOCUMENTS' INTERPRETATION OF SC

The QCA process used to analyse the documents was discussed in section 4.7.2. The analysis made it apparent that the advisory documents described SC, by either discussing the features or attributes of the concept (i.e. characteristics of SC) or its end goals (i.e. objectives of SC). Findings relating to the former are presented within the following section and findings relating to the latter are given in the subsequent section.

5.3.1 The Characteristics of SC

The term 'characteristic' could be defined as a 'feature or quality' belonging particularly to a person or a thing that serves to identify it (The Oxford English Dictionary, 2012). 'Characteristics' of a person (or a thing) provide certain distinguishing traits, features or properties that are typical or revealing of that person (or thing) (Merriam-Webster, 2012). The term 'characteristic' could be seen as being synonymous to other terms such as, 'feature', 'attribute', 'criterion', 'property' or 'quality'. Accordingly, the characteristics of SC describe the nature and features of the concept of SC around which the advisory documents' interpretation of SC is based upon. These characteristics or features determine how the objectives of SC (discussed in section 5.3.2) should be considered. Table 5.2 presents the characteristics of SC identified through the advisory document analysis.

Altogether, 15 characteristics of SC were identified through the analysis. For the most part, characteristics were explicitly stated in the documents. However, on a few instances certain characteristics were found to be only implied in some documents. One example is the first characteristic presented in Table 5.2. While the documents R5-2009, G14-2004, G16-2002 and M17-2002 did not explicitly state that SC comprised of the three main environmental, social and economic elements, they went on to discuss objectives of SC that fell under these three elements (see Table 5.3). Therefore, it was postulated that these documents also recognise that SC should incorporate all three of these elements (i.e. characteristic 1 given in Table 5.2).

The remainder of this section goes on to provide detailed discussions the characteristics of SC presented in Table 5.2.

It is generally accepted that similar to SD, SC also consist of the three principal environment, social and economic elements (refer to section 2.6.2). This was mentioned in all of the analysed documents. Although the Table 5.2 uses the term 'elements', different terminologies have been used in the documents in referring to the environmental, social and economic aspects of SC. These include, 'triple bottom line' (R5-2009), 'the three pillars of sustainability' (G12-2005) and 'dimensions' of SC (P9-2007). These terms are in direct reference to the SD literature.

Table 5.2: Characteristics of SC

Characteristics of SC	1 M1-2011	2 M2-2010	3 G3-2009	4 R4-2009	5 R5-2009	6 P6-2008	7 G7-2008	8 R8-2007	9 P9-2007	10 M10-2006	11 P11-2005	12 G12-2005	13 P13-2004	14 G14-2004	15 G15-2003	16 G16-2002	17 M17-2002	18 G18-2001	Total no. (%) of documents describing the characteristic
1) Three primary elements: economic, environmental and social	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	**18 (100%)**
2) Consider whole life cycle	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√		√	**16 (89%)**
3) Holistic approach aimed at synergy not compromise		√			√		√	√	√		√	√		√	√	√	√	√	**12 (67%)**
4) Context dependent	√	√	√		√		√			√	√	√					√		**9 (50%)**
5) Makes business sense					√	√				√		√		√	√	√		√	**8 (44%)**
6) Contribute to the maintenance of ecosystem components and functions for future generations/ defining feature is reduction of environmental impacts	√						√	√	√	√			√	√					**7 (39%)**
7) Complex interrelationships between elements		√		√		√	√							√			√		**6 (33%)**
8) Global challenge/ global impacts					√		√		√		√						√	√	**6 (33%)**
9) SC is a sub set of SD		√			√		√		√									√	**5 (28%)**
10) Requires judgment and individual interpretation / flexible approach	√		√				√					√							**4 (22%)**
11) Requires an approach based on evidence	√	√		√	√														**4 (22%)**
12) Optimises performance / meets requirements for technical and functional performance			√				√												**2 (11%)**
13) Broad/ highly complex issue							√								√				**2 (11%)**
14) No single right answer			√	√															**2 (11%)**
15) Concept under constant study/rapid change				√			√												**2 (11%)**
Total no. of characteristics mentioned	6	7	6	5	8	4	12	4	6	5	5	6	3	6	5	4	5	6	

A further 16 (i.e. 89%) documents highlight the need for considering the whole life cycle, advocating long term thinking in SC decision making. Such thinking is necessary to consider the impacts handed down over time as a result of the development (i.e. intergenerational consequences). This was the second most mentioned characteristic across the analysed documents. Seven out of these 16 documents specifically mention the use of whole life costing or life cycle costing as a tool in decision making. Adopting a long term approach to decision making within construction project environments, also raises the need for project level decision makers to reconcile between the seemingly contrasting requirements of short-term and long-term planning.

There is also a high level of emphasis placed on the need to adopt a 'holistic' approach when considering SC. This is the third most mentioned characteristic in the documents (mentioned in 67% of the documents). However, some disparities were found in relation to the interpretation of the term 'holistic' between different documents. G18-2001 and M17-2002 merely acknowledge that the term 'holistic' in relation to SC refers to 'embracing of all the issues'. According to R5-2009, this can be summarised as addressing the 'triple bottom line' of social, economic and environmental considerations. On the other hand, G7-2008 describes the term 'holistic' as bringing together the global concerns/goals of SD and the project level SC demands and/or requirements (for example, in relation to aspects such as functionality, efficiency and economy).

Six out of the 18 documents (i.e. 33%) have specifically highlighted that the environmental, social and economic elements of SC are not mutually exclusive. Rather they form a 'complex web of systems' (R4-2009) with each dimension 'overlap[ing] and relat[ing] with the others' (G14-2004). This means that decisions taken with regards to one element have implications on the others. Herein, the aim should be to achieve 'synergy' between the different elements (as mentioned in characteristic 3 above). For instance, the decision-makers need to view SC with a 'joined up attitude' (G14-2004 and P9-2007) resisting the need to make any trade-offs.

In contrast to the aforementioned call for adopting a joined-up or holistic approach to all three elements of SC, a higher emphasis on the environmental element is evident from characteristic 6 given in Table 5.2, which was mentioned in seven (i.e. 39%) documents. This characteristic, which was mentioned for example in R8-2007, states that 'significant reduction in environment impacts' is a defining feature of the concept of SC, thereby, justifying placing greater emphasis on the environmental issues in practice. G14-2004 also observe that the environmental element of SC is particularly important to the construction industry due to the industry's high consumption of materials, energy and land resources. Discussions in section 5.3.2 on objectives of SC further highlight this greater level of emphasis on the environmental element.

The fourth most widely mentioned characteristic (stated in nine, i.e. 50%, of the documents) acknowledges the 'context dependent' nature of SC. This means that the implementation of SC needs to reflect the local circumstances, needs and priorities and therefore, will vary from project to project. As stated in M2-2010, the definition of 'local' in this context is 'dependent on the location and, occasionally, on the nature of the project'. This in turn highlights the importance of 'judgement and individual interpretation' on the part of the decision-makers (M1-2011, G3-2009 and G12-2005) in identifying and prioritising the issues to be addressed in relation to each specific project (i.e. characteristic 10 – mentioned in 22% of the documents). Moreover, this means that there is no 'right answer' to be reached when it comes to implementing SC (i.e. characteristic 14 – mentioned in 11% of the documents).

The analysis also revealed that relatively less focus was given in the documents to expand the aforementioned holistic view of SC and long term thinking beyond the life cycle of the construction to consider the intergenerational, interregional or global consequences of decisions made. Five (i.e. 28%) documents highlight that SC is to be viewed as a sub-set of SD. This encourages the project parties to take into consideration the larger scale impacts of decisions made at project level. For instance, G7-2008 states that discussing how and to which extent the built environment can support and contribute to SD is more important than referring to SC or sustainable buildings in terms of 'absolute attributes'. Similarly, six (i.e. 33%) documents have mentioned the need to consider the global consequences of local actions in SC decision making. G7-2008 for instance, specifies aiming for 'equity' in terms of 'balanced and objective consideration of intergenerational, interregional and inter-societal' issues. These aspects appear to be considered as being mainly the responsibility of the planning system, as they are primarily mentioned in P11-2005, which is the Planning Policy Statement for delivering SD and M17-2002, which is the 'Sustainability Checklist for Developments'. Thus, the planning system can be viewed to act as the link between SC at project level and how it results in achieving sustainable communities at a larger scale (see Figure 5.1).

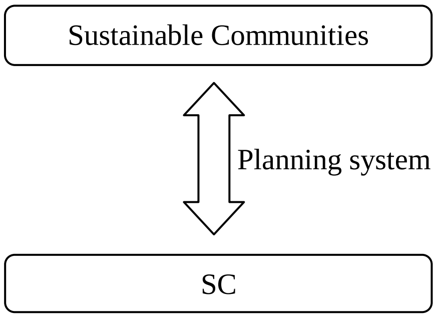


Figure 5.1: SC to achieve sustainable communities

Considering all of the above, as per the advisory documents' interpretation, SC could be characterised as follows;

'SC is a sub-set of SD, which is a broad and complex concept under constant study. It poses a global challenge. SC addresses the three primary environmental, social and economic elements, which have complex interrelationships. The issues to be considered under each element are context dependent and vary from project to project. The identified context specific issues of SC should be addressed in a balanced way, aiming to achieve synergy rather than compromise. This requires decisions to be made in a balanced manner, taking into consideration the whole life cycle of constructed facilities using techniques such as, whole life costing and life cycle assessments. Decisions made should also take into consideration the global consequences of local actions and should make business sense. This in turn calls for judgement and individual interpretation to be used on the part of the decision-makers when addressing SC'.

5.3.2 Objectives of SC

Objectives of SC lay out the desired end points or ultimate expected outcomes of SC. These objectives of SC have sometimes been referred to as 'principles' of SC (for example, see M17-2002). These objectives or principles are useful as they provide 'precise guidance for action' (Gagnon et al., 2009) when implementing SC. Therefore, the objectives of SC stated in the analysed documents can provide insight into how the characteristics of SC discussed in section 5.3.1 translate into targets or goals for construction project level action.

Overall, 80 objectives of SC were identified through the analysis. During the coding process, the identified objectives were categorised under various issue headings or sub-elements (also referred to as 'indicators' within this thesis). Altogether, 27 sub-elements emerged from axial coding under which the objectives of SC were categorised. These 27 sub-elements, in turn could be grouped under the three main categories of environmental, social and economic elements (Figure 5.2). Detailed discussions on the coding process adopted to achieve the aforementioned, have been given in section 4.7.2. The Table 5.3 below shows the coverage of the aforementioned sub-elements across the analysed documents.

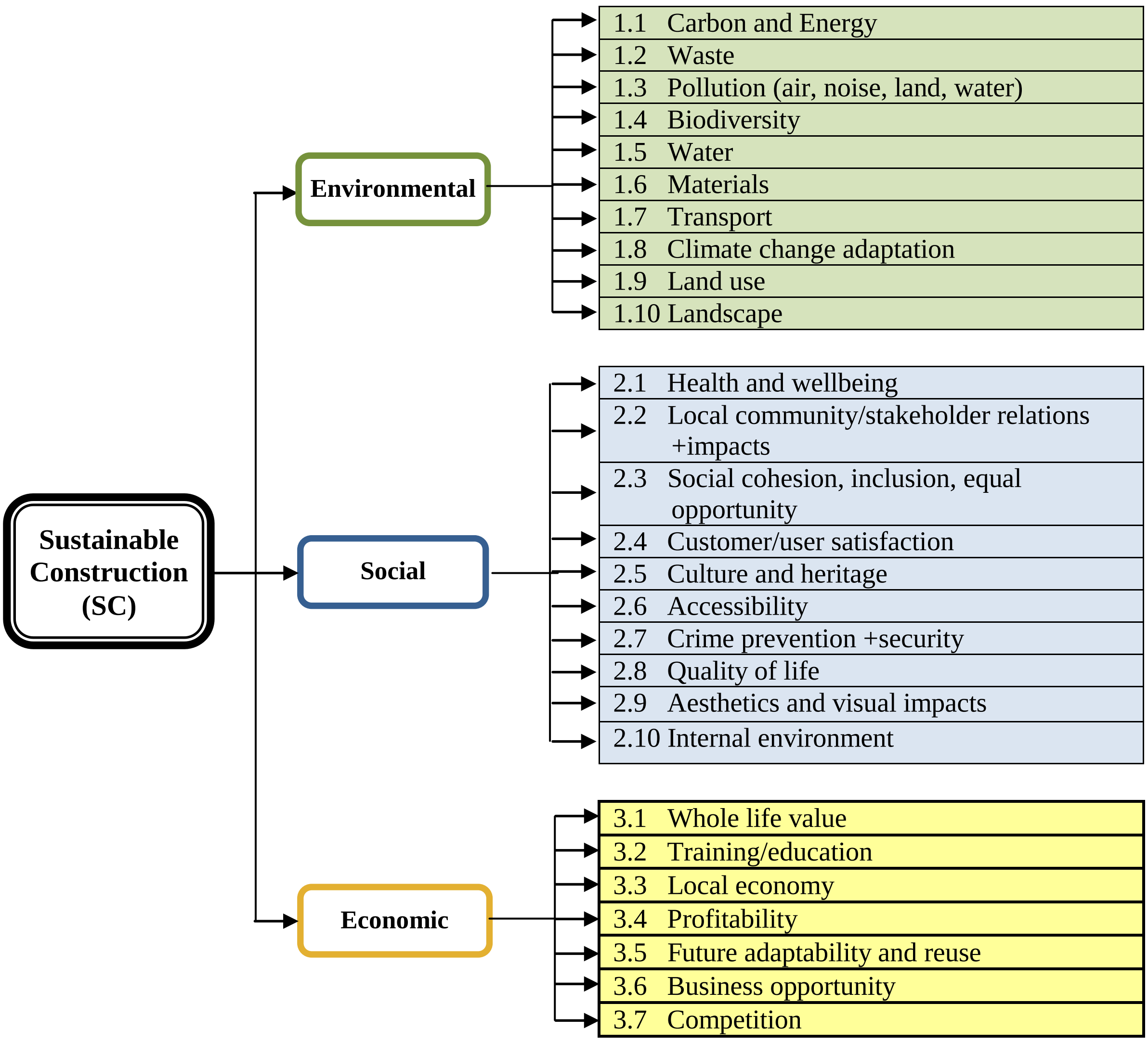


Figure 5.2: Issues addressed under environmental, social and economic elements of SC

Table 5.3: Coverage of environmental, social and economic sub-elements across the analysed documents

Element	Indicators/ sub-elements	Document Code																		Total
		M1-2011	M2-2010	G3-2009	R4-2009	R5-2009	P6-2008	G7-2008	R8-2007	P9-2007	M10-2006	P11-2005	G12-2005	P13-2004	G14-2004	G15-2003	G16-2002	M17-2002	G18-2001	
Environmental	1. Carbon and Energy	√	√	√	√	√	√		√	√	√	√	√	√	√	√		√	√	16 (89%)
	2. Waste	√	√	√		√	√		√	√	√	√	√	√	√	√	√	√	√	16 (89%)
	3. Pollution (air, noise, land, water)	√	√		√	√			√	√		√	√	√	√	√	√	√	√	14 (78%)
	4. Biodiversity	√	√	√	√	√	√	√	√		√	√	√			√		√	√	14 (78%)
	5. Water	√	√	√	√	√	√		√	√	√	√	√	√				√	√	14 (78%)
	6. Materials	√	√	√		√	√		√	√	√		√	√	√	√		√	√	14 (78%)
	7. Transport	√	√	√			√		√			√	√		√			√	√	10 (56%)
	8. Climate change adaptation	√	√		√	√	√			√		√	√							8 (44%)
	9. Land use	√	√		√							√	√			√		√	√	8 (44%)
	10. Landscape		√				√					√						√		4 (22%)
	TOTAL (Env-SE)	**9**	**10**	**6**	**6**	**7**	**8**	**1**	**7**	**6**	**5**	**9**	**9**	**5**	**5**	**6**	**2**	**9**	**8**	
Social	1. Health and wellbeing			√	√	√	√	√	√	√	√	√	√			√			√	12 (67%)
	2. Local community/ stakeholder relations +impacts	√	√			√	√		√		√	√	√		√	√		√	√	12 (67%)
	3. Social cohesion, inclusion, equal opportunity	√						√		√	√	√	√					√	√	8 (44%)
	4. Customer/user satisfaction	√	√						√			√	√				√		√	7 (39%)
	5. Culture and heritage		√					√				√	√	√		√			√	7 (39%)
	6. Accessibility	√							√			√	√			√		√	√	7 (39%)
	7. Crime prevention +security	√										√	√	√		√		√	√	7 (39%)
	8. Quality of life							√		√		√	√				√	√		6 (33%)
	9. Aesthetics and visual impacts		√				√					√						√	√	5 (28%)
	10. Internal environment	√							√				√					√	√	5 (28%)
	TOTAL (Soc-SE)	**6**	**4**	**1**	**1**	**2**	**3**	**4**	**5**	**3**	**3**	**9**	**9**	**2**	**1**	**5**	**2**	**7**	**9**	

Table 5.3: Coverage of environmental, social and economic sub-elements across the analysed documents - Contd.

Element	Indicators/ sub-elements	Document Code																		Total
		M1-2011	M2-2010	G3-2009	R4-2009	R5-2009	P6-2008	G7-2008	R8-2007	P9-2007	M10-2006	P11-2005	G12-2005	P13-2004	G14-2004	G15-2003	G16-2002	M17-2002	G18-2001	
Economic	1. Whole life value	√	√	√		√	√	√	√	√			√		√	√	√		√	13 (72%)
	2. Training/ education	√	√	√			√		√	√	√		√		√	√		√	√	12 (67%)
	3. Local economy		√								√	√	√					√	√	6 (33%)
	4. Profitability						√								√	√	√		√	5 (28%)
	5. Future adaptability and reuse					√						√	√			√				4 (22%)
	6. Business Opportunity												√		√			√		3 (17%)
	7. Competition											√	√						√	3 (17%)
	TOTAL (Ecn-SE)	**2**	**3**	**2**	**0**	**2**	**3**	**1**	**2**	**2**	**2**	**3**	**6**	**0**	**4**	**4**	**2**	**3**	**5**	
	TOTAL (SE)	**17**	**17**	**9**	**7**	**11**	**14**	**6**	**14**	**11**	**10**	**21**	**24**	**7**	**10**	**15**	**6**	**19**	**22**	

In looking at the coverage of sub-elements within the analysed documents, it is interesting to note that only 89% of the documents have covered sub-elements relating to all three elements of SC. This is in contrast to the earlier statements made in all of the documents that SC should address all three environmental, social and economic elements (refer to section 5.3.1). All of the analysed documents have addressed environmental and social sub-elements, while 16 documents (i.e. 89%) have addressed the economic sub-elements. The coverage of sub elements in the documents shows a higher focus on the environmental element. All of the environmental sub-elements, except 'landscape', have been mentioned by eight (i.e. 44%) or more documents. This calls into question the view in section 5.3.1 that SC should incorporate an integrated holistic view with respect to the environmental, social and economic elements.

The most number of sub-elements were mentioned in G12-2005, which referred to 24 out of the 27 sub-elements. G18-2001 and P11-2005 had mentioned 22 and 21 sub-elements respectively. G7-2008 and G16-2002 mentioned the least number of sub-elements, referring to only six out of the 27 sub-elements. Out of these, the main aim of G7-2008 appears to be on characterising SC only, as it had mentioned the most number of characteristics (refer to section 5.3.1).

The following sections go on to discuss in detail the SC objectives identified under each environmental, social and economic sub-element shown in Table 5.3.

5.3.2.1 Environmental objectives of SC

Table 5.4 presents the objectives derived under each environmental sub-element.

Table 5.4: Environmental objectives of SC – Document analysis findings

Sub-element	Objectives
1.1 Carbon & Energy	1.1.1 Achieve zero-carbon in new builds 1.1.2 Reduce carbon emissions 1.1.3 Use energy efficiently 1.1.4 Monitor/ reduce energy consumption 1.1.5 Use renewable energy 1.1.6 Generate energy on-site
1.2 Waste	1.2.1 Reduce impact of waste 1.2.2 Prevent / produce less waste 1.2.3 Recycle / reuse materials 1.2.4 Reduce amount of waste sent to landfill

1.3	**Pollution (air, noise, land, water)**	1.3.1 Minimise risk of water pollution 1.3.2 Improve air quality 1.3.3 Reduce nuisance 1.3.4 Prevent / reduce impact of emissions 1.3.5 Minimise spatial pollution 1.3.6 Reduce air pollution 1.3.7 Minimise light pollution at night
1.4	**Biodiversity**	1.4.1 Protect and enhance biodiversity 1.4.2 Practice habitat creation and restoration 1.4.3 Avoid threats to local environmentally sensitive sites, sites of special scientific interest and protected species 1.4.4 Consider long term impacts of construction on bio-diversity
1.5	**Water**	1.5.1 Encourage efficient use 1.5.2 Monitor consumption 1.5.3 Use environmentally friendly water supply systems 1.5.4 Encourage water recycling
1.6	**Materials**	1.6.1 Minimise use 1.6.2 Maximise utilisation 1.6.3 Local sourcing 1.6.4 Reuse and recycle 1.6.5 Use of secondary or recycled materials 1.6.6 Use of sustainably sourced materials 1.6.7 Use low energy materials 1.6.8 Use of renewable materials 1.6.9 Use of low maintenance materials 1.6.10 Avoid materials harmful to environment and humans
1.7	**Transport**	1.7.1 Reduce amount of congestion / transport 1.7.2 Promote use of public transportation 1.7.3 Limit land required for roads and car parks 1.7.4 Reduce car use 1.7.5 Promote sustainable travel choices
1.8	**Climate change Adaptation**	1.8.1 Adoption of flood and coastal erosion risk management approaches 1.8.2 Ensure resilience and adaptability to climate change
1.9	**Land use**	1.9.1 Encourage the use of most appropriate sites for development 1.9.2 Protect areas of natural beauty 1.9.3 Encourage a mix of land uses
1.10	**Landscape**	1.10.1 Provide quality landscaping to improve ecological value

The environmental element had the most cited number of sub-elements across the documents (refer to Table 5.3). The highest emphasis in the documents was on 'Carbon and energy' and 'waste'. Objectives addressing these sub-elements were cited in 16 (i.e. 89%) of the documents. In addition to these, 14 (i.e. 78%) of the documents addressed objectives in relation to 'pollution', 'biodiversity', 'water' and 'materials'.

The objectives identified under 'carbon and energy' are reflective of two complimentary policy trends set by the UK Government in order to mitigate the effects of climate change. These trends are reflected in the objectives set out in the Energy White Paper (Department of Trade and Industry, 2007) for;

- tackling climate change by reducing CO_2 emissions; and
- ensuring secure, clean and affordable energy as the dependency on imported fuel increases.

The UK government has shown its commitment to achieving the set targets for GHG emission reduction through the development of the Climate Change Act (2008). Indeed, the UK government claims to be the first country in the world to adopt a long-term legal framework for emission reduction through a system of five-year Carbon budgets (DEFRA, 2012). The Intergovernmental Panel on Climate Change (IPCC) in its fourth assessment report stated that the building sector has the largest potential for significantly reducing the GHG emissions. The report further claimed that this potential is relatively independent of the cost per ton of CO_2 equivalent achieved (Cheng et al., 2008). Specific schemes have been set up to reduce emissions and improve the energy efficiency of buildings. These include key programmes such as, the Carbon Emissions Reduction Target (CERT), the introduction of Energy Performance Certificates, the Energy Saving Trust's Act on CO_2 advice line, Warm Front and Decent Homes schemes (P5-2008). In addition, there has been increased attention on promoting renewable energy sources as well. The Feed in Tariff, which came into effect in 2010 for example, offers financial support for small scale renewable, low-carbon energy generation installations (Department for Communities and Local Government, 2011). At present, public authorities and institutions providing services to a large number of persons and occupying over $1000m^2$ of total useful floor area are required to display a valid 'Display Energy Certificate (DEC)' at all times (Department for Communities and Local Government, 2008). In addition, other tools such as the 'Carbon Calculator' developed by the Environmental Agency are available to determine the total carbon footprint of construction and highlight areas where possible carbon savings can be made (Environmental Agency, 2012). Likewise, there has been a high level of activity in developing legislations, tools and guidance on carbon and energy related issues of construction. All of these have put pressure upon the actors at construction project level to give these issues a high level of attention.

'Waste' was the other highest cited environmental sub-element in the documents. The Waste Strategy for England (2007) have identified construction waste as a main sector for action, given the high volumes of construction, demolition and excavation waste generated by the construction industry. The main objectives in relation to waste are to produce less waste or reduction of waste. This could be achieved through activities such as, reducing construction packaging waste (HM Government, 2008), designing to minimise waste creation, considering the long term impacts of design decisions (The Chartered Institute of Building, 2004), use of prefabricated components to reduce waste (Addis and Talbot, 2001; The Chartered Institute of Building, 2004) and increasing the efficiency of construction processes. Techniques such as, 'Just in Time' and 'lean construction' have been highlighted as useful practices to achieve the aforementioned.

When waste is generated the objectives are to recycle as much as possible, reduce the impact of waste that cannot be recycled and divert the construction and demolition waste away from land fill sites. Introduction of monetary measures such as, the Aggregate Levy and Landfill Tax has helped to minimise creation of waste by associating high costs with disposal. The fiscal impacts these taxes and levies have on businesses increase each year, pressuring them to take positive action. For example, the Landfill Tax for non-inert waste is expected to go up from £40/tonne in 2009/10 to an estimated £72/tonne in 2013 (Waste and Resources Action Programme - WRAP, 2010).

The sub-element of 'pollution' was mentioned in 14 (i.e. 78%) of the documents. Objectives under this sub-element addressed the issues in relation to air, water, land (also referred to as, spatial pollution), noise and light pollution. Section 2.6.2.1 discussed some of the impacts and statistics pertaining to pollution caused by the activities of the construction industry. In the past the situation was that the relaxed regulations and low fines meant the construction industry found it cheaper to pollute rather than to prevent it. However, this situation has now changed. The Environmental Agency has put forward a set of documents known as Pollution Prevention Guidance (PPG) Notes setting out the current legal obligations as well as good practice to reduce environmental pollution.

The sub-element of 'bio-diversity' (also cited in 78% of the documents) addresses the principle of 'equity' amongst species (refer to section 2.3). There is a requirement for all construction projects over £1 million to carry out bio-diversity surveys and to undertake necessary actions to mitigate any impacts (P6-2008). The objectives under this sub-element focus not just upon 'protecting' or 'conserving' existing bio-diversity, but also on 'enhancing' it. The Business and Bio-diversity Resource Centre postulate that the planning authorities, clients/developers and designers should work together to address the following aspects in relation to bio-diversity (The Business and Biodiversity Resource Centre, 2001):

- **Enhance** the overall quality by creating new habitats, buffer areas and landscape features,
- **Avoid** developing in sites or areas within sites that could have key adverse impacts on species,
- **Compensate** for features lost by carrying out the development.

The UK government signed up to the Convention on Biological Diversity at the UNCED held in Rio de Janeiro in 1992 (refer to section 2.2.1 and Appendix 1) pledging support to the conservation of biodiversity at all scales. The UK government became the first country to transform this commitment into action through the publication of the 'UK Biodiversity Action Plan' in 1994. In July 2012, this action plan was succeeded by the 'UK Post-2010 Biodiversity Framework', which identifies the activities required to complement the country biodiversity strategies in achieving the targets.

Most of the objectives derived in relation to 'water' (which was also cited in 78% of the documents) related to the operational phase. As recommended in the Strategy for SC (i.e. P6-2008), revisions to Building Regulations in relation to addressing the issues of water efficiency (particularly in relation to dwellings) came into effect in April 2010. The main target in relation to water efficiency is to reduce the average consumption of 'wholesome' water from the existing average of 150 litres per person per day to 125 litres. This is to be achieved through the installation of more efficient water fittings and appliances (Department for Communities and Local Government, 2011).

In addition, 'materials' was also mentioned in 78% of the documents. The most number of objectives were identified under this sub-element. Attention has been given to issues such as reducing the embodied carbon/energy impacts of construction materials, responsible sourcing, maximising utilisation and contributing to the reduction of waste through the use of recycled content. The 'Green Guide to Specification' series, which was first developed in 1996, provide a simple, easy-to-use guide to the environmental impacts of building materials based on numerical data. In relation to the responsible sourcing of materials, two standards have been produced (i.e. BES 6001 - Framework Standard for the Responsible Sourcing of Construction Products and BS 8902 - Responsible Sourcing Sector Certification Schemes for Construction Products: Specification) following the inclusion of this sub-element within the 2008 SC strategy.

Whilst greater attention is being paid to ensuring the sustainability credentials of the construction materials, at present, there are no mandatory regulatory requirements to address these. However, from 1 July 2013, under the Construction Products Regulation 2011, it will become mandatory for materials manufacturers to apply CE markings to any products that are covered by harmonised European standards or European Technical Assessments (CPA, 2012). CE marking represents a manufacturer's declaration that the product complies with the essential European health, safety and environmental protection legislative requirements.

Overall, the advisory document analysis revealed that the environmental element of SC appear to be well developed with clear sub-elements and objectives stipulated.

5.3.2.2 Social Objectives of SC

The objectives derived under each of the social sub-elements identified are presented in Table 5.5. The most number of social objectives were mentioned in P11-2005, G12-2005 and G18-2001, with each document mentioning nine objectives. On the other hand, three documents (i.e. G3-2009, R4-2009 and G14-2004) only mentioned one social objective each.

Table 5.5: Social objectives of SC - Document analysis findings

Sub-elements	Objectives
2.1 Health and wellbeing	2.1.1 Reduce the incidence rate of fatal and major injury accidents 2.1.2 Improve working conditions 2.1.3 Reduce cases of work related ill health 2.1.4 Provide Occupational Health Support on projects

2.2	**Local community/ stakeholder relations + impacts**	2.2.1 2.2.2	Consider the needs of local communities Fully engage the local community in the development process
2.3	**Social cohesion, inclusion and equal opportunities**	2.3.1 2.3.2 2.3.3	Providing equal opportunities in employing ethnic minorities, women and disabled people Foster better social relations Respecting and treating stakeholders equitably
2.4	**Customer/user satisfaction**	2.4.1 2.4.2	Ensure customer/end user requirements are met Ensure usability of systems
2.5	**Culture and heritage**	2.5.1 2.5.2 2.5.3	Enhance or preserve existing culture and heritage Sympathetic to local styles of architecture New developments to reflect the cultural/historic context of area
2.6	**Accessibility**	2.6.1 2.6.2	Ensure equity by enabling all in society to have access Access to green space
2.7	**Crime prevention and security**	2.7.1	Minimise opportunities for crime/provide safe environment for residents
2.8	**Quality of life**	2.8.1	Improve quality of life now and for future generations
2.9	**Aesthetics and visual impacts**	2.9.1	Attractive high quality developments (attractive building detailing, choice of materials)
2.10	**Internal environment**	2.10.1 2.10.2 2.10.3 2.10.4	Ensure indoor air quality Provide visual comfort Provide thermal comfort Ensure acoustic performance

The most widely cited social sub-elements were 'health and wellbeing' and 'local community/stakeholder relations and impacts'. These sub-elements were mentioned in 12 (i.e. 67%) documents each.

The objectives identified under 'health and wellbeing' in G3-2009, P9-2007, M10-2006 and G12-2005 specifically addressed activities during the physical construction phase. Health and safety on construction sites is a key issue that has received a lot of attention during the past two decades. The national government, the Construction Industry Advisory Committee (CONIAC), Health and Safety Executive (HSE), various trade associations and trade unions, as well as pressure groups, have all being pushing for change in the health and safety performance of the industry. Back in 2002, the Health and Safety Executive in its discussion document on 'Revitalising Health and Safety in Construction' has noted that despite advancements made, the industry still remained 'dangerous'. A large proportion of accidents occurring, including fatalities were noted to be preventable. The report attributed the industry's poor performance in health and safety issues to a number of reasons. These are (HSE, 2002);

- deep-rooted, cultural issues,
- tendency to confuse lowest cost tenders with best value, which in turn leads to 'corner-cutting',
- shortage of skilled workers due to losses during the recession and a lack of investment in training,
- shortcomings in leadership, planning and management and
- an often confrontational culture.

Consequently, the re-drafted Construction (Design and Management) regulations were published in 2007 to address the above issues (The Construction Industry Training Board, 2012). Improved health and safety standards could also lead to economic benefits such as, increase in profitability, increase in productivity, improved recruitment and retention and improved quality (HSE, 2002).

In addition to 'health and wellbeing', 'local community/stakeholder relations and impacts' was the other highest cited social sub-element. The construction outputs and processes have significant impacts on the end users, as well as the wider community in general. A list of positive and negative impacts during the construction and post-construction phases has been provided in BRE (2002). Good communication and consultation is necessary to keep the local community informed. Indeed, a majority of the local community members were found to compromise on most of the problems or disturbances occurring during major construction projects if there was better communication and consultation (BRE, 2002). In addition, it is also important to put in place mechanisms for obtaining input/ suggestions/ ideas from local community groups on their needs and providing feedback on developments that affect their communities (Office of the Deputy Prime Minister - ODPM, 2005). Community consultations, community relation programmes and engagements with relevant local groups are useful to achieve the aforementioned.

'Social cohesion, inclusion and equal opportunity' was the third highest cited social sub-element. Eight (i.e. 44%) documents highlighted that SC should offer equality of opportunity and promote social inclusion. During the construction phase this includes promoting equality and diversity in the workplace (G12-2005). During commissioning and operation phases the clients should take into consideration the management implications of inclusion and equality (M1-2011). The Equality Act implemented from October 2010, replaced the previous anti-discrimination laws with one single Act and legally protects people from discrimination in the workplace and wider society.

The first UK strategy for SD published in 1999 defined SD to be about achieving 'a better quality of life, now and for generations to come'. This was based upon the widely quoted Brundtland definition for SD (refer to section 2.3). Accordingly, it was not surprising that 'quality of life' emerged as a social sub-element during the analysis of advisory documents for the construction sector as well. However, interestingly this was only the eighth most cited social sub-element being mentioned in only six out of the 18 documents (i.e. 33%) as an objective. Furthermore, there was lack of clarity provided on the meaning of the term or how it could be translated into practice, particularly given the aforementioned elusive nature of the concept.

From the above discussions, it is interesting to note that five out of the ten social sub-elements requires project level decision makers to take into consideration issues that are beyond the boundaries of a construction project.

5.3.2.3 Economic Objectives of SC

Table 5.6 below presents the document analysis findings in relation to the objectives derived under the economic sub-elements of SC.

Table 5.6: Economic objectives of SC – Document analysis findings

Sub-Element	Objectives
3.1 Whole life value	3.1.1 Consider whole life value of constructed facility
3.2 Training/ education	3.2.1 Provide training/education on SC issues to project stakeholders 3.2.2 Disseminate knowledge and best practice
3.3 Local economy	3.3.1 Ensure viability of local business 3.3.2 Promote economic regeneration 3.3.3 Support local trades and businesses during construction activity 3.3.4 Generate employment/ training prospects
3.4 Profitability	3.4.1 Improve profitability of project

3.5 Future adaptability and reuse	3.5.1 Reduce risk of obsolescence
3.6 Business opportunity	3.6.1 Improve business opportunities
3.7 Competition	3.7.1 Improve competition

'Whole life value' and 'Training/education' were the highest cited sub-elements from the economic perspective. These sub-elements were referred to in 13 (i.e. 72%) and 12 (i.e. 67%) of the documents respectively. 'Business opportunity' and 'competition' were the least cited sub-elements from the economic perspective.

In relation to 'whole life value', the documents referred to terminology such as, 'whole life costing', 'life cycle costing', 'life cycle analysis', 'whole life environmental assessment' and 'full life costing'. The main feature of all of these is the need to account for impacts at all life cycle phases including the indirect effects such as those associated with the manufacture of components (M2-2010). Another key principle highlighted in relation to this was 'Value-for-money (VFM)'. According to the Treasury department, VFM is defined as, *'the optimum combination of whole life cost and quality (or fitness for purpose) to meet the user's requirements' (HM Government, 2004).* It incorporates the principle of whole life costing in procurement of construction projects. Such an approach requires the calculation of costs over the life time of the construction, rather than the project, thereby taking into consideration the *operational*, as well as, the *building costs* (Parkin et al., 2003). The various economic benefits of SC, such as, reduced operating costs and improved productivity (due to better and healthier working environments) (National Audit Office - NAO, 2007), can justify the uptake of SC approaches in terms of VFM.

The second most cited economic sub-element was 'training/education'. This was mentioned in 12 (i.e. 67%) of the documents. Although, 'training' and 'education' has often times been used interchangeably, 'education' differs from training in that it refers to a more formal, longer term process (Liyanage, 2006). At a generic level, enhancement of the human capital through education and training has been identified as essential for improving productivity and economic growth (BIS, 2010). In relation to SC, project-specific training can be provided to inform the project parties on the environmental and social issues/impacts of the construction and to provide them with instruction on how to address those issues (M2-2010). The documents suggest formal courses for project team members, training sessions within project team meetings, site inductions, and toolbox talks (M2-2010) for providing project-specific training and adopting business support tools such as, Continuous Professional Development (CPD) and training plans for providing non-project specific training (P6-2008). In relation to education programmes, organisational level education on SC issues (for example, health and safety) have been suggested (P6-2008), as well as contributing to the education of the local community by providing site visits and materials for curricula (M2-2010). In addition to these, training and education also need to be provided for building users and operators on how to operate the facility optimally (R8-2007).

The objectives identified under the 'local economy' sub-element (cited in six, i.e. 33% of the documents) aim at ensuring the viability and/or sustainability of local economy by providing economic benefits to local communities. The most number of economic objectives were identified under this sub-element. Construction projects can contribute to the local economy by providing employment opportunities for the local workforce and supporting local trades (M10-2006, M17-2002). Carefully planned large scale developments can also contribute to local economic regeneration by improving access to services and encouraging new businesses to the area (G12-2005).

Overall, the economic element was found to be given the least amount of attention in the advisory documents. This was both in terms of the number of sub-elements and objectives identified, as well as the percentage of citations of these sub-elements across the documents. This could be attributed to the fact economic objectives are viewed as an obvious consideration in carrying out construction projects.

5.3.2.4 Inter-relationships between the Environmental, Social and Economic Elements of SC

Whilst the environmental, social and economic elements of SC were discussed separately in this section, it is acknowledged that these elements are inter-related. In other words, it could be postulated that SC is not possible just through the actions, taken on their own, to address the objectives within the three elements. Rather it requires holistic thinking to consider the complex inter-relationships between these three separate elements (Atkinson et al., 2009; Du Plessis, 2007; Kiewiet and Vos, 2007). For instance, as mentioned in section 5.3.2.2, addressing issues of health and wellbeing could also bring about economic benefits, such as increased profitability. Similarly, local sourcing of materials minimises the need for transport and thereby, minimises pollution as well as the use of non-renewable energy sources (i.e. fossil fuel). On the other hand, the most appropriate material to maintain the historic value of a structure may not fulfil the environmental objectives under the 'materials' sub-element. For example, the material may need to be transported over a long distance even though a less historically appropriate material could be locally sourced, requiring the decision makers to strike a balance between the environmental and social objectives (M2-2010). The how this balance will be reached will depend upon the emphasis attributed to each SC objective by the project parties. Acknowledging these relationships enhances the complexity of SC and helps in further understanding of the concept.

5.4 ADVISORY DOCUMENTS' INTERPRETATION OF SC: DISCUSSION AND SYNTHESIS OF FINDINGS

By looking at the spread of the characteristics and objectives of SC across the 18 documents (refer to sections 5.3.1 and 5.3.2), may be with the exception of G12-2005, no single document has endeavoured to set up a clear basis for their intended users by providing a comprehensive description of the concept of SC. Whilst G7-2008 mentioned 12 out of 15 characteristics, it only cited SC objectives under six out of the 27 sub-elements. In terms of the characteristics of SC, there was a high level of emphasis within the advisory documents that SC constituted of the three main environmental, social and economic elements (100%), that it considers the whole life cycle of a construction (89%) and it incorporates a holistic approach (61%). These findings were compatible with the main features of SC discovered through the review of literature (refer to section 2.6).

In reviewing the findings in relation to the characteristics and objectives of SC, there is evidence of frequent usage of certain language or terminology that could be commonly found within SD literature. These terminologies, which included 'holistic approach', 'quality of life,' etc, were often used in a vague manner within the documents without providing any descriptions on their meanings or usage. The term 'quality of life' has been often described as an 'elusive concept' (Felce and Perry, 2001), which could be applied at different levels from social or community wellbeing to situations pertaining to individuals or small societal groups. Different perspectives of quality of life can be found in literature. Three such perspectives put forward by Borhtwick-Duffy (1992) (1992 cited Felce and Perry, 2001). They define 'quality of life' as;

i. The quality of one's life conditions
ii. One's satisfaction with the life conditions
iii. A combination of both life conditions and satisfaction

A fourth perspective has been put forward by Felce and Perry (2001), which views quality of life as 'a combination of life conditions and satisfaction but emphasises the need to take account of personal values, aspirations, and expectations'.

The document analysis exercise also revealed that different documents interpreted the term holistic or joined-up approach in different ways. The interpretations differed with some documents describing this to mean addressing the environmental, social and economic elements of SC to others describing it as bringing together the global and project level concerns. The report of the Bellagio project, which was undertaken by the International Institute of Sustainable Development or IISD reveals a combination of the above viewpoints. The report postulates that the holistic perspective of SD should incorporate the following three key aspects (Hardi and Zdan, 1997);

- The whole system as well as its parts
- Consider the well-being of social, environmental and economic sub-systems and their component parts and the interaction between parts.
- Consider the positive and negative consequences of human activities in monetary as well as non-monetary terms, reflecting the costs/benefits to humans and environment.

Similar to SD, SC, although originated from environmental concerns, incorporates broader concerns regarding, the three basic dimensions of social, economic and environmental aspects. However, the findings showed that there is a high level of emphasis on the environmental element of SC compared to the social and economic elements. The objectives under the environmental sub-elements were far more widely cited within the documents in comparison to the objectives under social and economic sub-elements. The least level of focus was given to the economic element. The current supporting legislative environment, as well as the fiscal tools (i.e. taxes and levies) that are in place, covers a wider, more comprehensive range of environmental objectives compared to social or economic objectives.

It has been noted that while most environmental objectives, such as reduction of energy and water consumption result in measurable financial savings, the performance and benefits in relation to other objectives, particularly those in relation to social sustainability, are hard to measure. R8-2007 calls for a better framework which allows the latter to be assessed and justified, which in turn could bring these objectives to the same level of prominence as the environmental concerns. R5-2009 particularly states the lack of quantitative measures as a reason for exclusion of social sustainability issues in their draft code for SC, thereby compromising the holistic nature of SC. DEFRA (2010) also notes the pressures to report quantitative and more focussed information in relation to sustainability issues.

Giddings et al. (2002) have observed how in England and the USA, environmental concerns have focused on the issues of country-sides, wild animals, and wilderness with the 'aim of preservation from people'. They highlight how this has resulted in little attention been paid to the urban environments, which is addressed under the social sub-elements. This correlates to the views expressed by Carter and Fortune (2008), that where the construction industry is concerned the perception of SC seems mainly biased towards the environmental concerns. They go on to state that this in turn could have a significant impact how SC is taken up and delivered in construction projects. Hence, a question remains whether an actual transformation has been made from what was called as 'green' construction (see section 2.5) to truly sustainable construction.

Hill and Bowen (1997) in their seminal work on SC are of the view that social element of SC should be based on the notion of social justice or equity as intended in the Brundtland report. This encourages the adoption of a wider perspective on the part of the decision makers looking beyond the boundaries of a single project. Based on this view the social 'principles' presented by Hill and Bowen (1997) include amongst others, more aspirational aims such as, 'poverty alleviation', 'fair and equitable distribution of social costs of construction', 'equitable distribution of social benefits of construction' and 'intergenerational equity' (see section 2.6.2.2). These are high level objectives requiring national government level interventions and therefore, are not useful when it comes to project level actions. In contrast, the social actions found through the QCA exercise appear to be more prescriptive and specific in nature. However, as stated in section 5.3.2.2, these objectives still require the project stakeholders to expand their horizons of attention and responsibility beyond the physical boundaries of a construction project. This has been captured by Sexton (2000) for example, in the 'horizons of influence, attention and responsibility in space and time' model shown Figure 5.3 below.

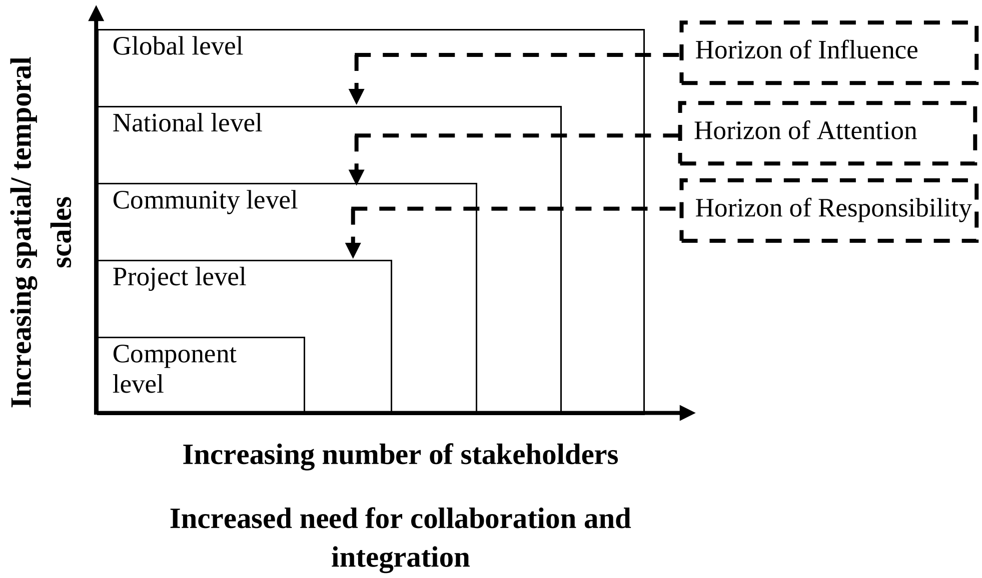


Figure 5.3: Horizons of influence, attention and responsibility in space and time (Source: Sexton, 2000)

The objectives of SC as discussed within this chapter cover a range of spatial levels as shown in Figure 5.3 above. Drawing on from the above discussion, the advisory documents' interpretation of SC can be mapped in the modified conditional matrix introduced in chapter 4 (refer to section 4.8.4.1). This is shown in Figure 5.4.

In mapping these objectives, the derived objectives within each document were scrutinised to identify the spatial scale (i.e. project level, community level, national level, etc) at which the impacts of addressing each objective would impinge upon. For example, the impact of addressing the economic objective of 'consider viability of local businesses' is at the local community level. This not only means that the benefits of addressing this objective would be experienced at the local community level, but also that the decision makers at construction project level should consider the impacts at local community level in making decisions in relation to this objective. Some objectives had impacts at a multiple number of scales. For example, the social objective of 'preventing opportunities for crime' has impacts at both project (by ensuring site security) and local community levels (by contributing to creating safe communities). It was necessary to a certain extent to use the judgement of the researcher in mapping some of the impacts.

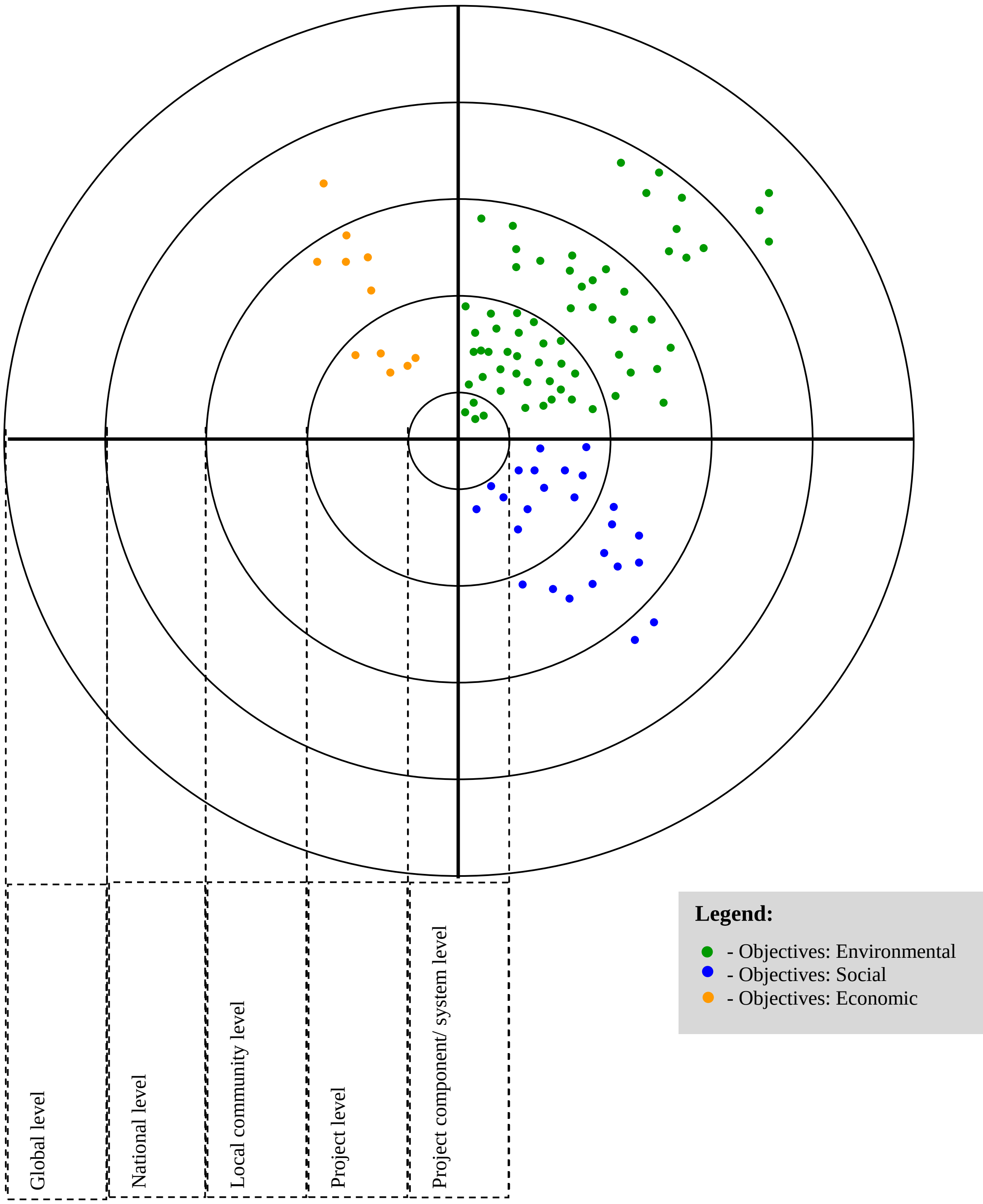


Figure 5.4: Advisory documents' views on SC

In looking at Figure 5.4, it is appears that most objectives requires project stakeholders to take into consideration the issues relating to project level only. However, there is also a high level of attention on the immediate environment surrounding a construction; i.e. local community level. Only environmental objectives are spread amongst all of the macro and micro level scales. Indeed, a majority of the environmental objectives at construction project level could be traced back national level policies and legislations, which have in turn been developed in response to various international level conventions and treaties. For example, The UK Biodiversity Action Plan published in 1994 was part of UK Government's response to the Convention on Biological Diversity signed at the 'Earth Summit' held in Rio de Janeiro in 1992 (HM Government, 2008). Such interconnections and flows between spatial scales could not be observed in relation to the social and economic elements to a significant extent.

As shown in Figure 5.3 above, as the spatial and temporal scales covered by the SC objectives expand, the uptake and implementation of SC becomes a more complex issue, requiring integration and collaboration amongst an increasing number of stakeholders. In order to address these issues successfully, the construction project level stakeholders' need to have a comprehensive understanding of SC, acknowledging the complex nature of the concept.

5.5 SUMMARY

The analysed advisory documents have been published to serve various aims or purposes. These stated aims of the documents could be categorised under eight broad themes. The most frequently stated purposes for producing advisory documents were to 'increase awareness and understanding' and 'providing guidance' for their intended users. Despite this, not all documents endeavoured to define or describe SC, so as to provide a conceptual background for their intended users. In reviewing the documents, it emerged that they addressed the concept of SC by discussing one or both of the two main categories of; characteristics of SC and objectives of SC. Altogether the analysis revealed 15 characteristics of SC. In total, ten categories of sub-elements emerged under environmental and social elements, whereas, seven sub-elements emerged under the economic element. Various objectives of SC were in turn identified under each of these sub-elements.

Overall, the results of the advisory document analysis led to the following inferences:

The main focus of the analysed advisory documents seemed to be upon setting objectives for achieving SC and recommending actions for its implementation. There is a lack of common understanding across the analysed documents in relation to the characteristics and objectives of SC. In contrast to the view that SC constitutes of the environmental, social and economic elements and the call for a joined up attitude to address all of these three elements, there is a clear significance placed upon the environmental issues. Objectives under the environmental sub-elements were far more widely cited within the documents in comparison to the objectives under social and economic sub-elements.

Overall, this chapter investigated how SC has been interpreted within the advisory documents produced for the industry. This addressed the first stage of the conceptual framework shown in Figure 3.3 and objective 3 of the research. The second stage of this framework highlights how the project stakeholders' perceptions of SC acts as a filter between these strategic level interpretations of SC and how SC is implemented at construction project level. Therefore, the next chapter of this thesis goes on to explore this by investigating how SC is interpreted by construction project stakeholders.

CHAPTER 6: PROJECT STAKEHOLDERS' PERCEPTIONS OF SC

6.1 INTRODUCTION

As stated in section 1.2, the first part of the aim of this research involves investigating the interpretation of SC within the UK construction industry. The previous chapter of this thesis (i.e. chapter 5) tackled this issue from a strategic level perspective by analysing and reporting on how SC has been interpreted within the advisory documents produced for the industry. This chapter on the other hand, investigates the above issue from the project level perspective by discussing some of the findings from the case study interviews in relation to the project stakeholders' perceptions on SC. Accordingly, this chapter addresses stage 2 of the conceptual framework presented in Figure 3.3. Similar to the document analysis findings, the stakeholder views on SC are also presented under the two main categories, characteristics and objectives of SC. A comparison of advisory documents' and project stakeholders' views on SC is also presented at the end of the chapter. Overall, this chapter addresses objective 4 and the research question RQ4 of this research.

6.2 PROJECT STAKEHOLDERS' PERCEPTIONS OF SC

This research employed an embedded case study design (refer to section 4.8.2.1). Accordingly, there were two main units of analysis within each case study. These were; (i) the individual project stakeholders and (ii) the process of implementing SC. The semi-structured interview guide developed, therefore, constituted of two main sections to address the aforementioned issues (refer to Appendix 2). The first section of the interviews focused on gaining insight into how the project parties viewed or interpreted SC (This has also been referred to as the project stakeholders' perceptions on SC within this thesis).

Overall, the respondents agreed that SC was an important issue that needed to be addressed. Some respondents noted that SC has now become an integral part of how they deliver construction projects. For instance, the respondent from the contractor organisation in CS2 stated,

> *'It's a cornerstone of what we do now in terms of all our projects' – CT2*

Some respondents felt that the rising attention towards SC has made the construction industry a 'whole lot better'. As was noted in section 2.6, historically, construction has been a highly polluting industry with a negative public image. Consideration of SC aspects has driven the industry stakeholders to take action to alleviate some these negative impacts. This is evident from the following quote by one of the respondents;

> *'I think generally the industry is getting better. In the old days people wouldn't have thought about our construction site around Considerate Constructors and the noise it made etc. you just wouldn't have given it a thought. Whereas, now people are far more considerate around it' – FM2*

This acknowledgement of the importance of addressing SC could be attributed to, *inter alia*, improved awareness, interest and concern towards sustainability issues from project parties. These factors are important in establishing what Robin and Poon (2009) refer to as a 'sustainable culture', which is instrumental in moving towards the practical implementation of SC. Many respondents interviewed revealed some level of personal interest towards addressing SC, with some even viewing it as a moral obligation. For example, one of the respondents from CS1 stated that addressing SC is important;

> *'...not just because it's the law. But because I have a very strong personal interest as well. I think that it's something that we need to do socially. I think it's something that we have to do' – CL1*

Despite this congruence of views on the importance of SC, further investigation revealed some variations in what the different respondents perceived as SC. The following two sections go on to discuss the findings in relation to the above.

6.2.1 Characteristics of SC

Altogether, seven characteristics of SC emerged from the case study interviews (see Table 6.1). There was general awareness also amongst the interviewees that SC should incorporate the three environmental, social and economic elements. This was mentioned by 75% of the respondents.

Table 6.1: Characteristics of SC: Project stakeholder perceptions

Characteristics of SC	CS1				CS2				CS3				Total no. of respondents mentioning the characteristic
	CL1	CT1	DT1	FM1	CL2	CT2	DT2	FM2	CL3	CT3	DT3	FM3	
1) Three primary elements: economic, environmental and social	√	√	√	√	√	√		√		√	√		9
2) Consider whole life cycle	√			√	√	√		√	√	√			7
3) Balancing between issues	√				√		√	√			√		5
4) Consider local context						√		√			√	√	4
5) Addresses global concerns	√							√					2
6) Looking at the bigger picture – maximizing the development potential											√		1
7) Flexibility in adapting to future changes											√		1
Total number of characteristics mentioned by the respondent	4	1	1	2	3	3	1	5	1	2	5	1	

Similarly, there was wide agreement that SC should incorporate a whole life cycle view of the construction. This was mentioned by 58% of the respondents;

> *'And the sustainability aspects of it come within the construction of the project, they come within the design of buildings and I guess they come within the use of the buildings once we've built them. And it's those three aspects that we try to address from a sustainability point of view'* - *CL1*

> *'The whole of it, how to use it, the social, economic issues come into it and everything else' – FM2*

Contractors, in particular, appear to slowly move away from focusing just upon issues in relation to the 'physical construction' of facilities towards the consideration of the whole life cycle issues. However, according to many of them, this appears to be a relatively recent trend in the construction industry. For example, the respondent from the contractor organisation of CS2 noted that;

> *'[CS2] was really the first hospital, where we actually introduced and brought into play real green initiatives in terms of the end product. Everything done up to that point has been very much focused on green delivery, and actually how we deliver projects from a logistics point of view' – CT2*

According to CT2, previously, attention towards SC has been primarily limited to issues in relation to the construction processes (for example, adopting lean construction practices, logistics on site) and use of sustainable, environmentally friendly materials (for example, sustainable timber, environmentally certified aggregates/quarry products, eco-paints). This could be partially attributed to the legislative changes towards the promotion of these particular SC practices. CT2 affirms that most of the aforementioned practices (in relation to construction processes and use of materials) have now become standard practice for their company.

Five interviewees highlighted that there is an inherent need for balancing between issues when considering SC. In section 5.3.1, this was referred to as making trade-offs. This is especially applicable when selecting objectives of SC to be addressed at project level. However, this raises a further question as to what criteria are being used by project stakeholders when making these trade-off decisions. Some explanations in relation to these criteria could be established through the discussions in section 6.2.2, under the objectives of SC.

Consideration of the local context was another characteristic that emerged through the analysis. In all three case studies, the local context within which the projects were situated in, presented some opportunities, as well as impediments, in addressing SC. Four of the interviewees highlighted that the local conditions played an important role in the decisions made in relation to what and how SC issues are addressed in practice at project level (this is discussed in further detail in section 8.3.4.4).

From the preceding discussions it appears that, in defining SC, a majority of the project stakeholders limit their attention to the immediate space surrounding a construction project (refer to Figure 4.10 and Figure 4.11). Most of the respondents showed a propensity to describe SC at a project component or project level perspective, with only four interviewees drawing attention to the immediate local context within which the project is situated upon. Only two of the respondents; an FM team member from CS2 and a design team member from CS3; drew attention to the larger scale consequences of SC, as evidenced by the following quote;

> *'a lot of the SC are driven by the wrong considerations. We just look at the bit we are interested in. The old one didn't have all these new technologies we've got them now, aren't we clever. Not the fact that we've just dug another hole in the earth to dig up all these material.'-FM2*

Design team members also considered future adaptability of designs as being a defining feature of SC. The two main concerns highlighted by designers in relation to future adaptability were; (i) the need for designing spaces that are flexible enough to adjust to future changes in stakeholder needs and/or technological advances and (ii) creating development plans for the whole site (i.e. making provisions for future developments) at the outset of projects. The latter also relates to the earlier references towards the need to consider the whole life cycle issues of the construction. The following quotes provide examples of attention given to these future adaptability aspects by design team members;

> *'It was 1999, at that time we were all using computers with these big monitors and every nurse station had one of those. It requires quite a lot of space and it was already very packed that we needed every little space. So we suggested to the Trust, and at that time it was very brave of them, to allow the design to be based on flat screens. Saying that there was no way back, it's only going to go that way. Yes, it was a little more expensive at the time, but each year they are going to become more affordable and you are going to save a lot; first, on use, because you are gaining the space and energy consumption is much lower. So they accepted that. And we designed for flat monitors. In 1999 it was quite a brave step...*
>
> *One of the first things that we did was the development control plans. Which is looking*

> *at where we are now, and where we want to be and how we are going to get there?. It was looking at the whole site and how we develop it... So one of the things with the DCP is to try and get an overall picture for the future. And too many sites do fire fighting, and you end sometimes later in the development 'if only I had known that' or something that they do stops them doing something else later'* – DT3

In looking at the characteristics of SC referred to by the project stakeholders, it appears that the buzz around the issues of SD and SC has resulted in creating a general level of awareness amongst project parties that SC should incorporate the three pillars of sustainability. This was the most widely mentioned characteristic by the interviewees. However, a number of interviewees used the terms 'green construction' and SC synonymously. The discussions in section 2.5 revealed that there are differences in the meaning of these terms. Indeed, the analysis of stakeholder interviews revealed that the term 'green' was being used mostly in reference to purely environmental initiatives. This was comparable to the conclusions in section 2.5. There was also some level of understanding on the need to consider the whole life cycle issues. However, in looking at the Table 6.1, it appears that deeper understandings on the other characteristics are fairly limited amongst the project parties.

6.2.2 Objectives of SC

As stated in section 6.1, similar to the advisory documents, the project stakeholders also showed a propensity to define or describe SC using the characteristics and/or objectives of SC. The main objectives of SC emerging from the analysis of project stakeholder interviews are presented in Table 6.2. Overall, 11 objectives were identified in relation to how the project stakeholders defined or described SC. All of these objectives, except two, could be categorised under the various environmental, social and economic sub-elements that were derived through the document analysis (see section 5.3.2).

Amongst these objectives, the highest level of focus was on the energy and carbon sub-element. When describing what SD means for the construction industry, the priority of most respondents was on energy related issues. Overall, 92% of the respondents viewed reducing energy consumption as an objective of SC. As shown in Table 6.2, there is a strong association between SC and aspects such as, energy efficiency, reducing energy costs and reducing carbon emissions for many of the interviewees. For example, one respondent from CS1 perceived SC to be about achieving a balance between three aspects. These were; (a) the environment of the building, (b) reducing energy usage and energy cost, and (c) reducing CO_2 production. The high level of focus on energy related concerns could be attributed to several reasons. Firstly, the addressing issues of energy efficiency and reducing energy costs can result in direct economic benefits for project parties, particularly the clients. For instance, the respondent from the NHS Trust in CS2 noted;

> *'Well, I think the obvious one is its ability for energy saving. The obvious one is around how it saves money and becomes more efficient I guess' –CL2*

As a result, while the above concerns in relation to energy and carbon emerged as environmental objectives in the previous chapter, it appears that at the project level, these objectives are pursued mainly due to economic motivations. As the Trust respondent from CS2 further highlighted, addressing energy efficiency was a chance to make a 'quick win' as it can deliver cost savings within a short period of time;

> *'It's always a quick win. It's a big expenditure but it's always a quick one to be able to say can you reduce the energy?' – CL2*

In all three of the case studies, energy supply was the responsibility of the NHS Trust. Therefore, for Trust representatives, saving energy costs was also a social responsibility. Saving money spent on energy means more money is available for spending on the primary focus of healthcare. As one NHS representative observed;

> *'... if we are not burning excessive energy we are not spending everybody else's money on anything other than health care, are we?' – CL2*

Secondly, the high emphasis placed on the energy and carbon related issues could also be attributed to the emphasis placed on these in policy and legislation. In fact, energy was a main policy focus, even before SD or SC came into prominence at national level. Thirdly, the energy performance targets are also built into the PFI procurement system. For example, there is a requirement for project parties to demonstrate how the energy performance targets are met within the designs for new builds in order to get the business case approval;

> *'We had to go to the DoH with our business case and we couldn't get past go unless we showed that our energy performance of the new build hit the target levels that have been set for us' – CL1*

Table 6.2: Objectives of SC: Project stakeholder perceptions

Objectives of SC	Corresponding sub-element	CS1				CS2				CS3				Total
		CL1	CT1	DT1	FM1	CL2	CT2	DT2	FM2	CL3	CT3	DT3	FM3	
Environmental Element														
1) Reducing energy consumption	Energy & Carbon	√	√	√	√	√	√	√		√	√	√	√	11
2) Reducing CO_2 production	Energy & Carbon	√	√	√	√		√							5
3) Use of environmentally friendly materials	Materials						√		√		√	√		4
4) Reduce waste (particularly, waste sent to landfill)	Waste		√				√							2
Social Element														
5) Ensure a better patient experience	Customer/ user satisfaction	√		√		√		√	√	√		√	√	8
6) Quality of internal environment	Internal environment	√			√			√	√		√	√	√	7
Economic element														
7) Consider whole life cycle costs	Whole life value	√	√	√	√				√					5
8) Reducing energy costs	Whole life value	√	√			√	√		√		√	√	√	8
9) Increasing efficiency (in use of energy, materials etc.)	Profitability	√	√				√				√			4
Other														
10) Achieving mandatory targets	-	√				√			√					3
11) Adopting lean approaches (i.e. lean construction)							√				√			2
Total		8	6	4	4	4	7	3	6	2	6	5	4	

Finally, the focus on energy and CO_2 reduction can also be attributed to the availability of support and guidance from external bodies. For instance, one of the respondents from the Trust in CS1 noted how they were able to develop their Trust sustainability strategy with the help of the Carbon Trust. In addition to the reduction of energy consumption and CO_2 production, the other environmental objectives that emerged through the analysis were the use of environmentally friendly materials (see section 6.2.1) and reducing waste (particularly waste sent to landfill).

The second highest mentioned sub-element was 'whole life value'. Objectives under this sub-element were mentioned by 83% of the respondents. The only other economic sub-element emerging from the analysis was 'profitability' (addressed through the efficient use of energy and materials). This was principally mentioned by the respondents from the contractor organisations. One respondent from a contractor organisation highlighted that improving efficiencies is a particular concern of SC, especially in the present economic climate.

There was also a high level of focus on ensuring user satisfaction. Out of the interviews conducted, 75% of the respondents mentioned that ensuring a better patient experience is a paramount aspect of SC in healthcare. In particular, the respondents from the Trusts and the design teams placed a high level of importance on this issue. Given the context of the case studies (i.e. acute care hospitals) addressing end user satisfaction (i.e. better patient satisfaction) was perceived by some of the respondents to be something that is implied and non-negotiable when discussing SC. This was highlighted by one Trust representative as follows;

> *'I think for us sustainability here is more around using those aspects to make the patient experience better' – CL2*

The findings also identified that user satisfaction could be ensured and improved through user/local community engagement activities during the initial phases of the SC implementation process (refer to section 7.3). This requires a level of facilitation from the project company, which is usually led by the contractor organisation. A good example of such initiatives leading to high levels of user satisfaction was observed in CS2, where the contractor and the design team jointly conducted workshops, engaging local groups in order to gain feedback on the design from the very outset (refer to section 7.3.2). End-user satisfaction is also affected by the quality of the internal environment. This was the only other social sub-element, in addition to end-user satisfaction, that emerged through the analysis of interviews. This was mentioned by 58% of the respondents, many of whom were from FM and design teams.

In addition to the above mentioned environmental, social and economic objectives, a further two objectives of SC also emerged from the interviews. Firstly, there was the view that one objective of SC was to achieve the mandatory statutory targets that have been set either by the national government or the Department of Health (DoH). This was viewed by one Trust representative as the equivalent of achieving SC at the most basic level, leading to the perception that SC is a by-product of fulfilling mandatory targets in relation to energy consumption;

> *'I think it's most simple. We have the statutory mandatory targets that we have to achieve, through Climate change Act of 2008. And they set us targets for carbon reduction. So if we weren't seeing sustainability in any other way then we need to hit those targets...By hitting those lower energy consumption targets, it also allows us to achieve lower levels of CO_2 reduction. So almost like a by-product at that time rather than as a prime focus, we were improving sustainability' – CL1*

The perception that SC is achieved just by meeting mandatory legislative targets poses the danger of SC been considered at a superficial level, leading some parties to claim they have addressed SC, when in reality they have only considered one or two issues that fall under the umbrella of SC.

Secondly, some of the respondents, particularly those from the contractor organisations, viewed adopting 'lean' approaches to be another objective of SC. For instance, one interviewee from a contractor organisation noted;

> *'It [i.e. SC] is about been lean'– CT2*

Various industry reports such as, the Egan report (DETR, 1998) have promoted the use of lean approaches within the construction industry as a solution for increasing industry productivity and project performance. This onus placed upon the economic element could explain the attraction of viewing 'lean approaches' as being equivalent to SC, particularly to those in contractor organisations, who need to ensure the profitability of their organisations. This relates to the earlier discussions in this section that SC is about increasing efficiency as well.

Considering the above, it appears that different stakeholders view SC differently, thereby placing higher emphasis on different SC objectives. This is discussed in detail in the following section.

6.3 PROJECT STAKEHOLDERS' PERCEPTIONS OF SC: DISCUSSION AND SYNTHESIS OF FINDINGS

It was evident from the interviews that the project stakeholders' views on SC were strongly shaped by the available legislations and regulations. One interviewee observed how people's views on SC have changed over the years shaped by changes to government priorities and legislations over the years;

> *'It seems almost incredible when we are in 2011 looking back at 2004/5 saving energy was the biggest issue. Getting the energy footprint of a building down was a big issue. But it was all focused around cost, cost reduction not around CO_2 reduction. And it was only around 2007/8 in my view that much greater emphasis started to be given towards the impacts on climate and the need to reduce carbon'-CL1*

Another interesting finding emerging from the analysis was the way learning environments had been created within project teams in relation to SC. This was especially highlighted on occasions, where a particular team member did not come into the project with clear understanding or prior experience on SC. On such instances, it was observed that the learning process was facilitated through the influence of other project parties within the project team, as well as the sustainability policies of their own organisations. The former is dependent upon factors such as, the level of involvement and integration of parties within the team (refer to section 8.3.2.4), existence of effective and efficient communication lines (refer to section 8.3.2.3) and knowledge and experience of the other project parties (refer to section 8.3.3.2). Good examples of such learning taking place were observed in both CS1 and CS2. In CS2 particularly, the project director from the Trust, who had an FM (i.e. catering) background, came into the project with no particular knowledge on SC. She noted that,

> *' it was really as part of the build you become more and more aware of what's happening... So that was how I started getting aware. But I had no background in sustainability. It was all learnt as being part of this project really. – CL2*

The aforementioned learning process could be facilitated by Knowledge Management (KM) practices both within project teams and across projects. Shelbourn et al. (2006) note, in order to achieve SC, the construction industry should develop organisational practices to 'promote knowledge creation, prior to sharing and re-use, along with the tools to support such processes'. However, application of this within the construction sector poses some unique challenges (Shelbourn et al., 2006) such as;

- Much of the knowledge in the construction sector resides in the minds of the individual professionals and,
- The intent behind the decisions made is often not recorded. This is mostly because a large part of the project-related information comprises numerous ad-hoc messages, phone calls, conversations and complex processes are required to track and record these.

In defining SC, most respondents directly associate SC with energy and carbon related objectives. This view is further evident within the overall context of the Health sector as well. The NHS Confederation report (2007) has noted that the NHS facilities are responsible for an annual usage of energy costing around £400 million and resulting in a net emission of 1 million tonnes of carbon. Reducing this high level of energy usage is beneficial from a business case (or economic) perspective, in addition to an environmental perspective. Furthermore, carbon and energy related issues are supported by a wide range of guidance from the NHS itself. These include, the NHS Carbon Reduction Strategy (2009) and Procuring for Carbon Reduction - P4CR (2012). It appears that, within the sector, there is a prioritisation of carbon and energy issues over the overall sustainability issues. A good example is the replacement of 'The Energy and Sustainability Fund' with the 'The Carbon and Energy Fund' within the DoH. This fund is used to support initiatives by NHS Trusts that meet certain levels of carbon and energy savings per £1000 of investment (Carbon and Energy Fund, 2011).

This high level of focus on carbon and energy within the NHS has been beneficial to some extent. A report by the NHS Sustainable Development Unit (2012) notes that improvements in building energy efficiency and availability of renewable energy has resulted in improvements made in carbon emission reductions within the NHS. The carbon footprint for NHS England for example, shows emissions have stopped rising and are levelling off. However, the report maintains that meeting NHS carbon reduction targets is still a significant challenge within the present context.

The focus on energy efficiency is further reinforced by the standard forms of contract employed in the PFIs. In CS2, one interviewee noted that provisions such as, energy payment mechanisms or pain–gain share agreements in their PFI contract have encouraged the project company to invest on renewable energy sources and other forms of energy saving mechanisms. Such a shared savings/risk scheme promotes joint responsibility between the Trust and the project company for energy consumption, allowing these parties to take a share of the rewards if energy falls below target levels and a share of the pain if energy consumption exceeds agreed target values.

Some respondents viewed that SC was achieved by meeting the mandatory regulations or statutory targets. Indeed, the Building Regulations stimulate the implementation of certain SC practices (Atkinson et al., 2009; Smith and Crotty, 2006). However, the UK building regulations are criticised by some for falling short of pushing the industry to achieve its full potential, for instance, in cutting CO_2 emissions. Halliday (2008) notes that the current standards for SC seem to be significantly below what is required of and possible for the industry to deliver. Building Regulations prescribe minimum standards and do not promote best practice in SC. The result is that most developments meeting these minimum standards have ignored some basic SC issues (Dair and Williams, 2006; Rydin et al., 2007). A joint report by the Construction Industry Environmental Forum (CIEF) and Construction Productivity Network (CPN) emphasises that a lack of standards and a range of new legislations are incapable of promoting a balanced approach to SC. Thus, there have been proposals to upgrade the Regulations further (at least for new housing) in order to ensure that all new buildings are carbon neutral by 2016 (Rydin et al., 2007).

Kibert (2002) has noted that for policy instruments to be effective, 'they must comprehensively and holistically address the wide range of activities directly or indirectly connected to the built environment'. An industry consultation carried out by the JCT has also revealed that the majority (84%) of the respondents thought that SC performance of the industry could be improved by industry specific documentation. However, there was a disagreement with respect to the type of documentation required (JCT, 2009). A survey carried amongst Architects by Adeyeye et al. (2007) have revealed that building design is affected by existing legislation (which are legally binding), but often not by policies. Adeyeye et al postulate that;

> *'.... respondents comply with Building Regulations because they are required to do so, therefore lack of enforcement might be another reason why measures are not being implemented. Furthermore, energy conservation policies are not compulsory and are thus reliant on the architect's discretion and the client's willingness to approve implementation in projects' (Adeyeye et al., 2007).*

The above view is supported by the findings within this chapter. As was noted by one Trust representative;

> *'My big disappointment about the PFI is that we are hitting the energy targets which help us to hit the CO_2 reduction targets for 2015, but we have very little in the form of sustainable forms of energy built into the building. And one of the big issues that we are trying to take forward at the moment with the project company is trying to take forward sustainability initiatives which we don't need to hit the energy targets.'- CL1*

The background of the respondents was also significant in determining the project stakeholders understanding of SC. The respondents from NHS Trusts largely viewed SC as reducing energy consumption/costs, reducing carbon emissions and ensuring user satisfaction by providing a better patient experience. On the other hand, the respondents from the contractor organisations placed a high level of importance on the issues of efficiency and profitability. Myers (2005) has observed that the large companies in the construction sector were now moving towards viewing SC from a more holistic point of view. He states that this is evidence of construction companies acknowledging that,

> *'… a business is no longer judged solely on the economic value added by a company's activity; it is also judged on the social and environmental value they add (or destroy)' (Myers, 2005).*

This was indeed supported by the case study interviews. However, associating SC with lean approaches by some respondents from contractor organisations supports the assertion that, in the mind-sets of the professionals in the contractor organisations, the highest level of emphasis is still on the economic element.

The above findings on the project stakeholder perceptions of SC could be summarised as shown in Figure 6.1. All in all, there is a high level of agreement that SC is an important issue that need to be addressed; yet, there is also some confusion as to what it actually means in practice. Thus, there is a need to improve understanding on SC amongst project level stakeholders. This is supported by RAND Europe's report on SD in the NHS (Ling et al., 2011). The next section of this chapter compares the project stakeholder perceptions of SC presented within this chapter with the findings in relation to the advisory documents' interpretation on SC (refer to chapter 5).

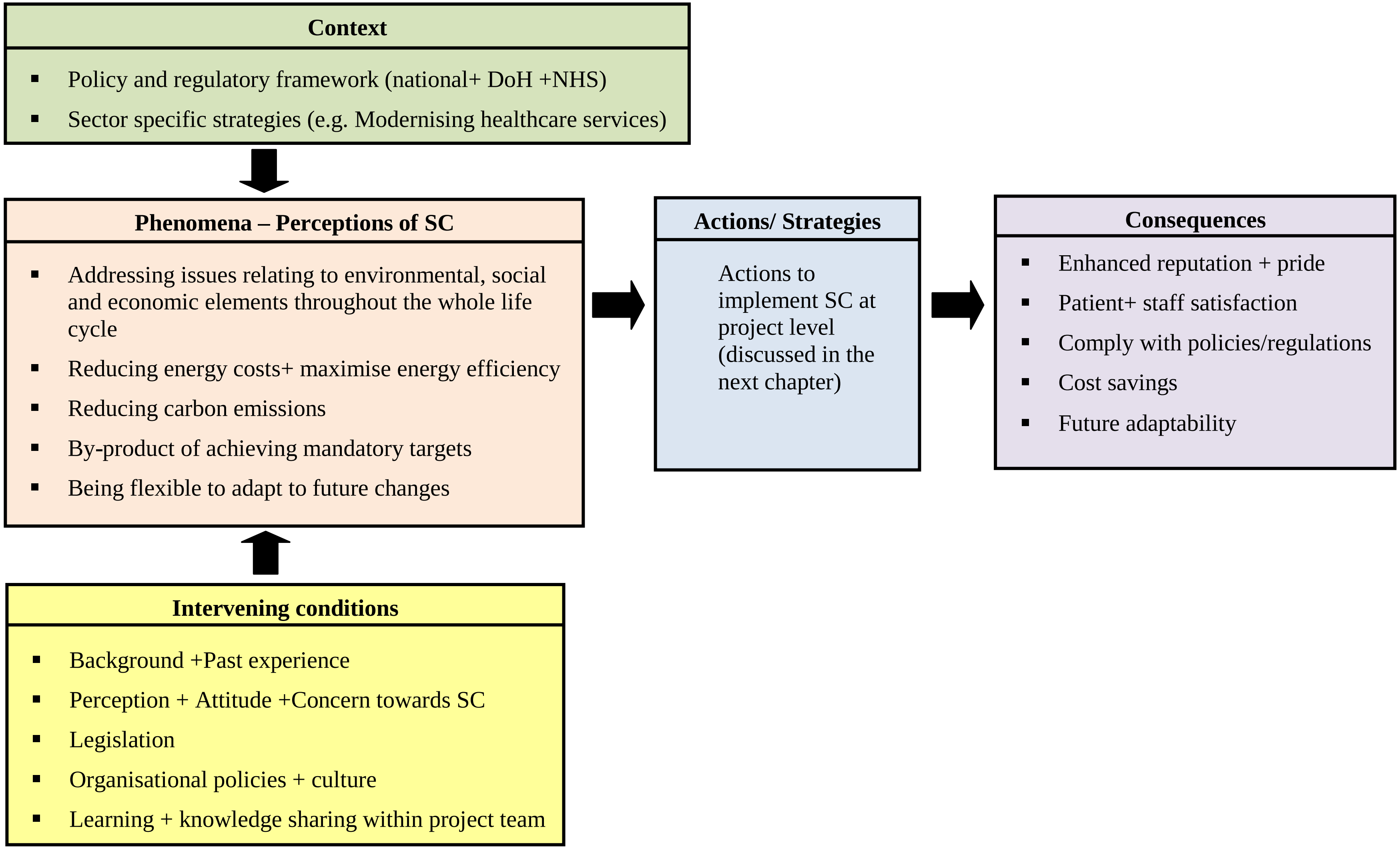


Figure 6.1: Project stakeholders' perceptions of SC

6.4 COMPARISON OF PROJECT STAKEHOLDERS' AND ADVISORY DOCUMENTS' VIEWS OF SC

The most commonly cited characteristics of SC found in the advisory documents were that SC (refer to Table 5.2);

i Consists of the three primary elements of environmental, social and economic aspects,

ii Considers the whole life cycle,

iii Requires a holistic approach aimed at synergy rather than compromise between objectives, and

iv Dependent upon the local context within which it is being applied.

The 1st, 2nd and 4th ranked characteristics above are moreover the same in the findings from the project stakeholders' perceptions on SC (refer to Table 6.1). Thus, there is conformity between the two analyses. The order of these characteristics was identified by the number of citations deduced from the interviews/documents.

The document analysis findings highlight the importance of adapting a joined up approach to SC in the advisory documents. Herein, particular attention was given to achieving 'synergy' between the different SC issues, thereby avoiding making compromises or trade-offs between different issues. Liu (2006) views this as making SC a concept of *'dynamic equilibrium'* in which harmony is constantly pursued in time. Thus, she uses the notion *'harmony-in-transit'* to relay how in any given point in time the potentially conflicting priorities in relation to social, environmental and economic aspects has to be harmonised to produce an acceptable consensus and direction towards attaining SC. However, in contrast, the project level view was that trade-offs were a necessary aspect when addressing SC. Trade-offs become necessary when no practical option available could provide benefits in all of the sustainable criteria (Kemp et al., 2005). Similarly, Hill and Bowen (1997) acknowledge that there is difficulty in optimising all the principles of sustainability at all times in practice. This calls for trade-offs and compromises to be made. On such occasions, Kemp et al. (2005) advocate making available the information on reasoning behind any trade-off and compromise decisions been made. Value judgements of key players in the decision-making process play a crucial role in selecting SC objectives for implementation, as well as, the extent to which those chosen objectives are addressed (Hill and Bowen, 1997). This in turn would determine the level of sustainability that has been achieved in a project.

In looking at the number of objectives derived, it appears that the stakeholders' views were mainly focused on a limited number of objectives. However, at the end of the interviews, each interviewee was given a list of SC objectives derived from the advisory document analysis (see sections 5.3). The list included a five point Likert scale where the respondents were asked to indicate their views on the level of importance for each listed issue. The respondents then went on to indicate that all the presented objectives were of importance. This could be taken as indicative of the need for a comprehensive guidance or framework on the above issues.

In terms of the objectives of SC, the document analysis findings placed a high level of emphasis on the environmental sub-elements. On the other hand, while some of the project stakeholders demonstrated a genuine concern for the environment and the sustainability of earth's systems, their consideration of SC is mostly rooted in economic considerations. This is evident for example, by the focus given to cost savings that could be achieved by energy efficiency measures and to the potential reputation and market share gains by taking on a 'green' image. The decisions made by the decision makers in relation to the SC objectives to be addressed appear, for the large part, to be based upon such economic considerations. The following quote by one of the interviewees is a good example of this;

> *'So much of the design around the PFI was focused on trying to get the energy consumption down and the energy performance of the buildings more efficient. To make it more cost efficient not make it more carbon efficient if you see what I mean' – CL1*

The Figure 6.2 below shows the stakeholder views on objectives of SC mapped on the modified matrix introduced in section 4.8.4.1.

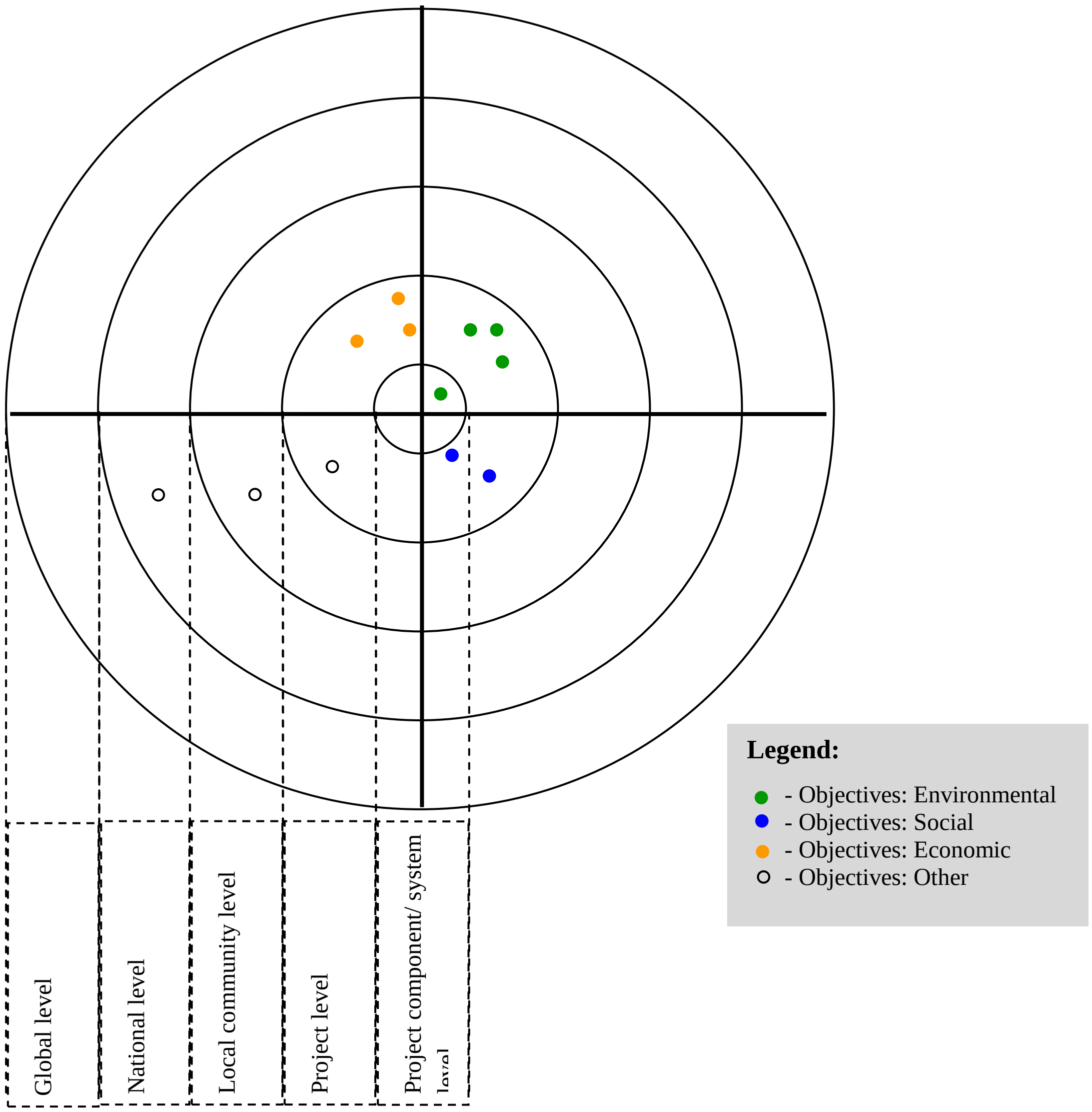


Figure 6.2: Project stakeholders' views of SC

Compared to the advisory documents' view, the stakeholders' view on SC objectives appears tighter in terms of consideration given spatial scales. The advisory documents' view, whilst giving higher attention to the project and local community level objectives, addresses impacts on all five spatial scales (see Figure 5.4). On the other hand, the impacts considered by the project stakeholders in relation to the environmental, social and economic elements of SC are for the most part limited to project level. The objective of meeting mandatory targets relates some of the project level considerations to the national level objectives.

6.5 SUMMARY

Overall, the project stakeholders view SC as an important issue that need to be addressed. There were some variations in how the different respondents defined/ described SC. Seven characteristics of SC emerged from the analysis of the case study interviews. The analysis revealed that there appear to be positive advances in terms of addressing certain aspects such as, consideration of whole life cycle issues, by project parties. Project stakeholders alluded to seven environmental, social and economic objectives of SC. In addition to these, 'achieving mandatory legislative targets' and 'adopting lean construction approaches' also emerged as additional objectives of SC from the analysis of stakeholder interviews. Different stakeholder groups appear to view SC by placing higher emphasis on different SC objectives. In general, the most level of emphasis was on reducing energy consumption, reducing energy costs and ensuring end user satisfaction. The project stakeholders' perception of SC is affected by factors such as, the stakeholder's background and past experience, personal concern or interest towards sustainability issues, prevailing legislative environment, organisational policies and approaches towards SC and learning and knowledge sharing within project teams. Whilst the environmental element was emphasised through the document analysis findings, the findings in relation to the project parties' perceptions revealed a higher level of emphasis on the economic issues.

The aim of this research, as stated in section 1.2, is to understand the interpretation of SC and to develop a framework that can assist in its effective uptake and implementation within construction project environments. Together, chapters 5 and 6 focused on the first part of this aim by investigating the interpretation of SC at strategic and construction project levels respectively. The following chapters go on to address the second part of this aim by investigating the process of implementing SC and developing a framework for the uptake and implementation of SC at construction project level.

CHAPTER 7: THE IMPLEMENTATION OF SC IN CONSTRUCTION PROJECTS

7.1 INTRODUCTION

The idea of this chapter is to present the findings in relation to the process of implementing SC within a construction project environment. This addresses the third stage of the conceptual framework shown in Figure 3.3 and the first part of objective five of the research (refer to section 1.2). The findings presented within this chapter have been derived using grounded theory analysis of case study interviews. The findings from this chapter are in turn used to develop the proposed framework for uptake and implementation of SC (refer to chapter 9) as stated by the aim of this research given in section 1.2. The chapter first discusses the wider contextual factors affecting the process of implementing SC at construction project level. The theory developed through the grounded theory process has been presented in the form of an emergent framework within the second part of the chapter. This emergent framework consists of four main phases. In-depth discussions on each of these phases are also provided within the chapter. Finally, a synthesis is provided comparing and contrasting the emerging findings with the available literature.

7.2 IMPLEMENTING SC WITHIN CONSTRUCTION PROJECT ENVIRONMENTS - THE WIDER CONTEXT

Each construction project exists within a context. Accordingly, there are wider contextual factors that need to be understood, which can affect the uptake and implementation of SC at project level.

At the highest level amongst these contextual considerations are the global developments in relation to SD and the widespread recognition of the significance of the construction sector in achieving the goals of SD. These global level developments have in turn been reflected in the EU and the UK national level policies. The construction industry specific advisory documents on SC discussed in chapter 5 have in turn been published taking into consideration the above macro level developments. However, the documents considered in chapter 5 were not sector specific and therefore, addressed the issue of SC at the generic construction industry level. When it comes to construction project level, these generic industry level considerations are often filtered through sector policies, guidance and regulations to reflect the sector specific conditions and requirements.

The case study projects selected for the purposes of this research were in the healthcare sector. Therefore, the DoH and NHS advisory documents acted as a filter in linking the national level issues to the project level. Several such sector specific documents were identified during the interviews. These included, the NHS Carbon Reduction Strategy, Health Building Notes (HBN)/Hospital Technical Memoranda (HTM) and BREEAM Healthcare. It was interesting to note that none of these documents (may be with the exception of BREEAM Healthcare) were directly addressing SC as a concept within the healthcare sector. Even BREEAM, although often used as a measurement tool for SC, is primarily an environmental assessment technique. Despite this, the requirements set out in these strategies, guidelines and regulations have a significant impact upon the decisions made at project level in relation to issues such as, which SC considerations should be addressed and to what extent these considerations should be addressed.

The HBNs set out the DoH's best practice standards in relation to planning and design of specific departments and service requirements of healthcare facilities. They are often used to support the economic case for investments by demonstrating Value for Money (VFM). HTMs on the other hand, set out the requirements in terms of standards for building components (e.g. windows) and the design and operation of engineering services (e.g. fire safety requirements). These HTMs are again supported by other technical guidance such as, the Model Engineering Specifications. The case study interviews revealed that the stringent regulations laid out in these documents in the health sector can sometimes act as a constraint in addressing certain SC practices. One such example was found in CS3. Here the window design put forward by the design team allowing for maximum day light penetration and natural ventilation, did not meet the minimum sill height and maximum allowed opening criteria set out in the HTM. A key problem here was the different interpretations of the regulation by the two parties (i.e. client or the Trust and the design team). The argument of the design team was that the regulation applies only to the patient rooms, whereas the Trust's interpretation was that it applied to the whole facility, including offices. One of the design team members noted that;

> *'Guidance isn't there, it doesn't say that. But their interpretation of the guidance is very rigid. It was a bit f a fight, but we managed to win that one' – DT3*

In addition, the respondents also noted BREEAM healthcare as another key document affecting the uptake and implementation of SC at project level. The DoH requirements state that all new build and refurbishment projects within the NHS estate must use BREEAM to assess their environmental performance. New build projects are required to achieve an 'Excellent' rating and refurbishment projects are required to achieve a 'Very Good' rating. However, the analysis revealed that this mandatory approach has opened up certain pitfalls that the project team members need to avoid. For instance, some interviewees noted that on occasion, contractors or designers were inclined to use BREEAM to guide their designs rather than to assess them, resulting in unfavourable outcomes (refer to section 8.3.4.3).

During the time of this research, there was a high level of focus on modernising the healthcare sector with the aim of providing the public with an improved and more responsive healthcare service. As a result, a heightened level of attention was given to the refurbishment of outdated hospitals that had a backlog of maintenance requirements. This context gave the Trusts an opportunity to justify SC requirements within the business case for projects. In fact, the prevailing policy and regulatory climate made it compulsory for Trusts to address certain SC issues in developing the business cases. However, despite this increased attention towards modernising healthcare facilities there was a lack of public funds available to achieve this. This meant that on all three of the selected case studies, Trusts had no option but to select PFI to procure the facilities. As one Trust representative noted;

> *'It was either PFI or nothing or don't do it. Theoretically, there was an alternative. In practice there wasn't. There was no public money available. There was no other way we could get procurement, where we could bring money in that would allow us to do it.' - CL1*

Likewise, the project stakeholders did not have any choice in selecting the procurement approach for these projects, giving due considerations to issues such as VFM or availability of expertise. There were several problems associated with this obligatory selection of PFI schemes. Foremost amongst these was the lack of the number of contractors with the relevant experience, expertise and capabilities to bid for the projects (refer to section 8.3.4.2). The clients in CS1 and CS2 both faced difficulties in attracting the stipulated minimum number of three contractors to bid for the project at the negotiation stage. This was a major drawback particularly for CS1, as the client did not have the opportunity to select a contractor giving due consideration to aspects such as, contractor's past experiences in relation to SC.

7.3 SC IMPLEMENTATION PROCESS – THE EMERGENT FRAMEWORK

The focus of this section is on discussing the activities in relation to implementing SC within construction project environments. The analysis revealed that these activities could be presented as a phased framework as shown in Figure 7.1. This emergent framework is first introduced within this section. The remaining sections of this chapter then go on to provide in depth discussions on the activities within each phase of the framework. Herein, it should be highlighted that the actions discussed here relate specifically to the implementation of SC, rather than the generic project procurement process. It is acknowledged that these two processes are closely related. Indeed, as discussed in further detail in section 8.3.2.2, in order to ensure successful implementation, SC should be embedded within the activities of the generic construction project process itself.

The grounded theory analysis revealed that the activities within the process of SC implementation could be divided into four distinct phases. These are; (i) conceptual phase, (ii) idea development/negotiation phase; (iii) construction phase and (iv) hand over/operation phase. These four phases emerged as distinctive due to several reasons. Firstly, the activities within each of these phases allocated varying levels of responsibility to the different project parties in relation to addressing SC. Herein, the term 'project parties' is used to refer to the four main groups of construction project team members that were selected for the semi-structured interviews (refer to section 4.8.3).

Secondly, the four phases are further characterised by specific outputs. Fulfilment of each of these outputs signifies the end of each phase. In order to ensure the successful implementation of SC, these outputs need to satisfy particular criteria. These outputs also act as linkages between phases. For example, in order to reach the end of the first phase (i.e. the conceptual phase), agreement must be reached within the client organisation in relation to the SC requirements for the project. These requirements then need to be incorporated into the project brief, which in turn is transformed into an output specification. The latter inter-links activities within this conceptual phase to those of the next phase (i.e. the idea development/negotiation phase) by providing potential bidders with insight into the client's SC requirements. The activities in relation to implementation of SC within each of these phases (discussed in the remaining sections of this chapter) suggest that there is a need to expand the traditional construction process activities to incorporate SC considerations.

Activities within each of these phases are in turn affected by influence factors that either facilitate or inhibit the effective implementation of SC (see Figure 7.1). Some of these influence factors include the wider contextual factors discussed in section 7.2. The grounded analysis revealed that the main factors influencing the implementation of SC at project level could be divided into two main categories as; internal factors and external factors. Internal factors have been categorised as 'internal', because they are within the control of project parties. Accordingly, proper management interventions were identified as necessary throughout the implementation process to control the negative effects and capitalise on the positive effects of these factors. External factors, on the other hand, are outside the control of the project team members. One example of an external factor is the legislative environment, which was identified as a key driver for considering SC in all three case studies. Another example of an external factor was the local context of projects. This includes opportunities and obstacles presented due to site conditions, local planning policies, as well as, socio-economic situation of the locale. For instance, both CS1 and CS2 were located in areas that were experiencing economic depression at the time the projects were initiated due to the decline of major local industries. Therefore, in the case of both CS1 and CS2, local economic regeneration was an important issue that needed to be addressed through the projects (refer to section 8.3.4.4).

In looking at the inter-relationships between these internal and external factors, the analysis revealed that the external factors had the ability to influence, not just the activities, but also the internal factors within each phase of the implementation process. One example of this is the effect the external changes to the policies and regulations had on the internal factors and activities of the negotiation/idea development phase in CS1.

In this instance, changes to Treasury rules meant that the project needed to be re-scoped in order to get approval for the Full Business Case. Due to this, the project had to undergo a long and challenging period of re-negotiation and re-designing before Financial Close could be reached. This in turn had an influence on the internal project environment, as both the Trust and the contractor were de-motivated and stressed. However, due to proper leadership and facilitation by the project management, the project parties were able to maintain focus on delivery and were ultimately able to come up with what they felt as a superior design for the project;

> *'On the positive side, the re-scoping concentrated minds on what was needed to give the project the best chance of success. When agreement was reached on the scheme it re-energised the project and made everyone focus on delivery. Further reiterations of the design actually enhanced and gave back benefits lost in the previous design' – CL1*

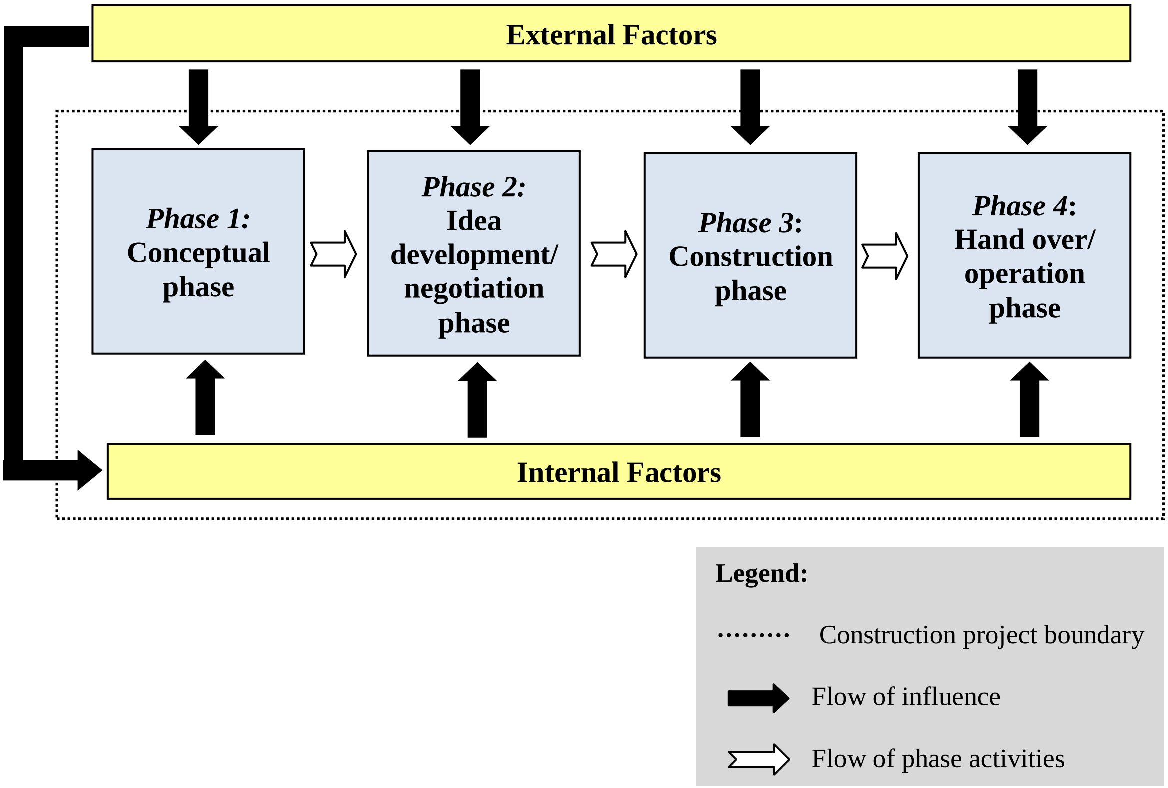


Figure 7.1: The emergent framework for implementing SC at construction project level

Although, the external factors had the ability to influence the internal factors, the analysis revealed that the internal factors did not have the ability to directly influence the external factors.

Whether the above mentioned internal and external factors acted as enablers (also referred to as drivers or facilitators) or barriers (also referred to constraints or impediments) depended upon the specific context of each case study. This further highlights the importance of contextual considerations in the uptake and implementation of SC that has been stressed throughout this thesis.

The Figure 7.1 depicts the above described emergent framework for implementing SC at construction project level. The figure shows the four main phases of the process and how these phases are affected by the internal and external factors. The remaining sections of this chapter go on to provide in depth discussions on activities within each of the four phases. In order to improve clarity, these discussions also include dialogue on how the activities are influenced by some of the internal and external factors. However, in depth discussions on these internal and external factors are provided in chapter 8 of this thesis.

7.3.1 The conceptual phase

This is the first phase of the SC implementation process (see Figure 7.1). The main focus of the activities within this conceptual phase is to provide the basis for the uptake and implementation of SC by laying out the client's requirements. The case studies revealed that the success of the SC implementation process is greatly increased when SC was considered from the very outset of a project. A good example of embedding SC within the project processes from an early stage was observed in CS2. In this case study, SC was identified as necessary by the Trust in establishing the need for the new built itself. It was acknowledged that the traditional way of doing things was not sufficient to address the need for modernisation and increased levels of efficiency.

As noted by respondents from the design and contractor organisations, client leadership is of paramount importance when it comes to implementing SC within construction projects. Putting SC requirements at the top of the client's agenda at this stage is therefore necessary to bring in positive responses from the contractors during the negotiation/idea development phase. Both the contractors and the design team members acknowledged that clear indication of client demand was one of the key drivers that encouraged them to put forward design solutions addressing a wider range of SC objectives. For example, one design team member noted that;

> *'But the consequence is that unless they* [i.e. clients] *put certain things in the brief, it's less likely that things will get achieved' – DT3*

The first phase of the SC implementation process therefore, was identified to include two main types of activities. These were; (i) activities in relation to establishing and prioritising client's requirements in terms of SC and (ii) activities in relation to communicating these requirements to potential bidders. Within the PFI procurement process, this latter category included activities such as, developing the strategic business case, obtaining outline planning permission, and placing of OJEU notice. Figure 7.2 below provides a detailed breakdown of the activities and internal and external influence factors identified within this phase.

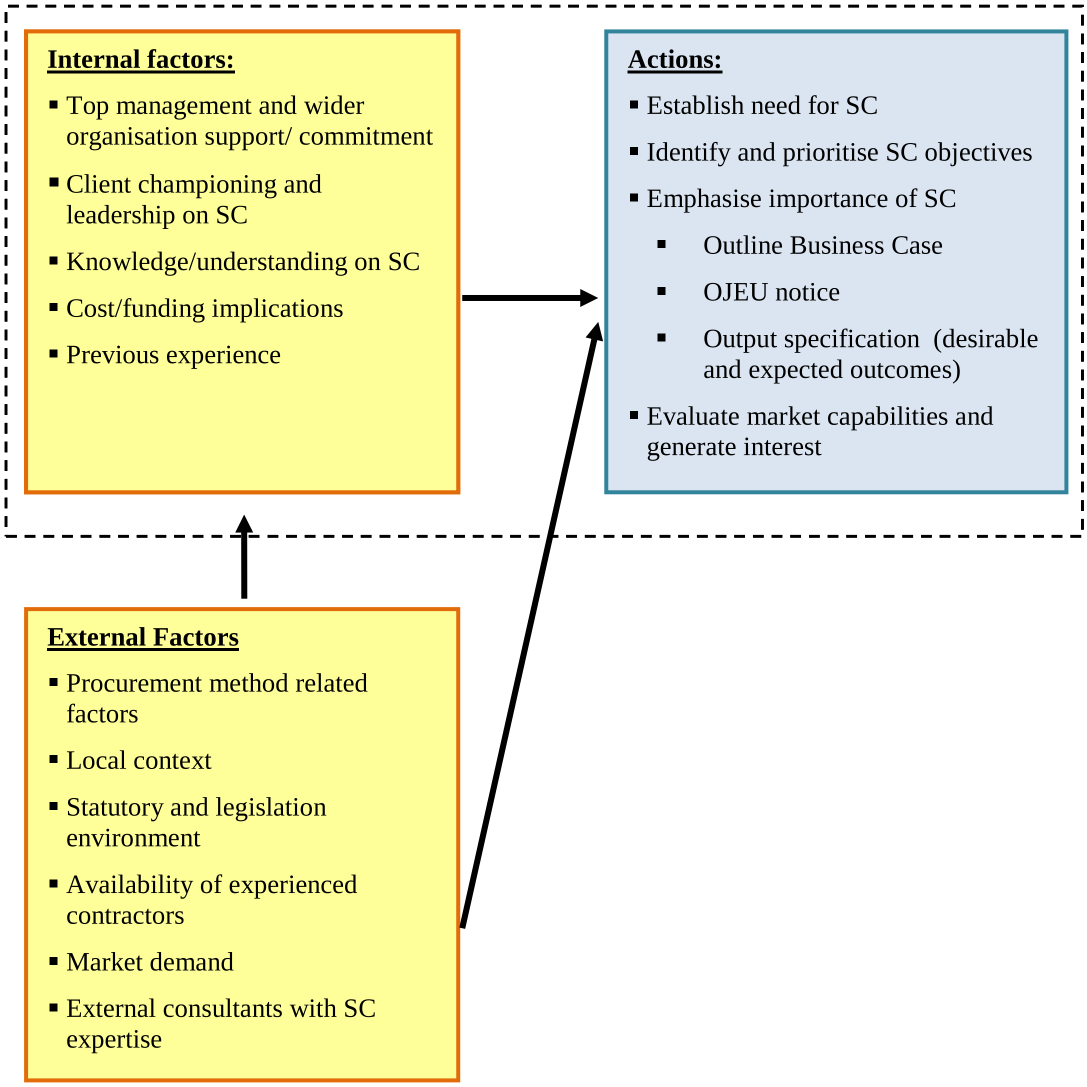


Figure 7.2: Implementing SC at construction project level - Phase 1: Conceptual phase

The first set of activities mentioned above relates to establishing and prioritising client requirements in relation to SC. When the construction client is a large organisation rather than an individual, as was the situation within the case studies, establishing and prioritising client's SC requirements also includes reaching agreement within the wider client organisation on these requirements. Within the context of the selected case studies this involved the project director, who leads the project team from the Trust's side, getting the approval for the outline business case from the top management of the Trust, the Strategic Health Authority and the DoH. The analysis revealed that the activities in relation to this often had to be repeated until agreement was reached between these various levels.

The second set of activities within this phase relate to the clear communication of clients' agreed SC requirements to potential bidders. Typically, within the context of PFI procurement process the client's needs are laid out in the output specification. Accordingly, the output specifications generally stipulate the 'nature and level of service required' by the clients (NHS Executive, 1999). Within the output specifications, SC requirements can be stated as either 'expected' or 'desired' requirements depending upon their level of importance. The inclusion of SC requirements within the output specifications is important as it provides contractors with an idea of the importance placed on these issues by the client. CS1 provided a good example of how the lack of attention given to this second category of activities resulted in lower than expected levels of achievements to be made in relation to SC. In the case of CS1, the Trust had failed to properly communicate their SC requirements (that went beyond meeting the mandatory legislative requirements) to the contractor by incorporating them in the output specification. The only requirement stated in the output specification referred to the need to comply with the NHS specific, as well as, non-NHS specific legislations. This could be further related to the discussions within the previous chapter, where it was discussed how some project parties viewed SC as a by-product of achieving mandatory legislative targets (see section 6.3). For example, the respondent from the Trust in CS1 noted;

> *'So that's a big weakness. What we did do was to say that they had to comply with the legislative requirements that were non-NHS specific' –CL1*

This failure on the part of the Trust to clearly communicate their SC requirements to the bidder provided an excuse for the project company to design, prioritising the issues of simplicity and cost reduction rather than SC. This resulted in numerous problems and disagreements between parties during the latter phases of the implementation process over the extent to which some SC issues were addressed. Thus, in hindsight, failure to clearly communicate their requirements to potential bidders was viewed as a missed opportunity by the Trust, when it came to achieving particular SC targets. The above scenario could be contrasted with CS2, where the client demand for SC was clearly conveyed to the contractor, who in turn responded positively, resulting in a design solution satisfying both parties.

One of the main internal factors affecting the activities within this phase was support and commitment from the top management and wider organisation within the Trust's side. This is especially important on occasions where the motivation to address SC originate from within the Trust project team, which is led by the project director, rather than the top level management of the Trust. This was the case in CS1, where the project director from the Trust side had to convince the upper management on the benefits of adopting SC practices. He observed that;

> *'It has been on occasion quite difficult to get the wider organisation to believe in climate change and to believe in sustainability and there are still quite a lot of people who don't think that it is real. So that's still an issue' – CL1*

This could be contrasted with CS2, where there was a high level of attention and interest given to sustainability issues by the top management and wider organisation within the Trust. Therefore, in CS2, the interest from these parties acted as a facilitator for the uptake and implementation of SC.

Another key internal factor affecting the success of this conceptual stage is the client's knowledge and understanding on SC. The previously mentioned failure to communicate the SC requirements observed in CS1 could also be attributed to a lack of knowledge and experience on the part of the Trust side. When the expertise is not available in-house, it is important to bring in outside experts at this stage. However, it was evident from the analysis that although clients almost always opted to employ outside consultants at this stage, they were usually general building consultants with no specific expertise in SC issues. As one Trust respondent observed;

> *'They are a general building services consultancy who had knowledge in the area rather than being specialists in the area. That was where we got our main advice around sustainability issues. In the main, I think we were very happy with the advice that they've given to us. So yes we did use specialist advisors, but specialist advisors who were general in nature' – CL1*

Although there was no indication of expert advisors being involved at this stage of the process, there was a tendency to appoint specialist sustainability officers closer to the operational phase. This was observed in all three case studies. In these instances, the responsibility of the sustainability officer was to monitor and report on the performance of the building (this is further discussed under the hand over /operation phase in section 7.3.4).

A further finding that emerged through the grounded theory analysis was the role of a sustainability champion within the implementation process. Whilst the whole SC implementation process benefited from this role, its impacts were especially significant within the first two phases of the implementation process. As mentioned earlier, the appointment of a specialist expert on sustainability issues often did not happen until towards the end of the construction phase. However, it became clear from the analysis that in all three case studies, one or more project parties assumed the role of championing SC. This was not an official role. The project parties who championed SC demonstrated a strong interest on sustainability issues (refer to section 8.3.1.1). These SC champions often viewed addressing SC as more of a moral obligation rather than a legal obligation. This was either as a result of strong personal interest in sustainability issues and/or due to policies and culture of the organisations they represented. In CS1, the project director from the Trust was a strong champion of SC. On the other hand, in CS3, SC was championed by the contractor and the design team. Both the project director in CS1 and the design team members from CS3 were driven by personal interests and commitments to address the SC issues. Conversely, the contractor in CS3 was driven more by the culture of their organisation as well as previous experience of working in other European countries.

As mentioned in section 7.3, this phase reaches conclusion when agreement is reached on SC requirements within the client organisation and in turn successfully communicated to potential bidders.

7.3.2 Negotiation/idea development phase

The second stage of the implementation process is referred to as the negotiation/idea development stage (refer to Figure 7.1). Accordingly, the activities within this phase fall into the following three main categories; (i) selection of a project team that is facilitating or supportive towards SC (ii) reaching agreement between project parties on the SC issues to be addressed and (ii) agreeing upon the extent to which these SC issues will be addressed and setting performance measurement targets. In order to ensure the success and satisfactory completion of this phase, all three aforementioned categories of actions need to be fulfilled. Figure 7.2 details the activities and internal and external influence factors identified within this phase.

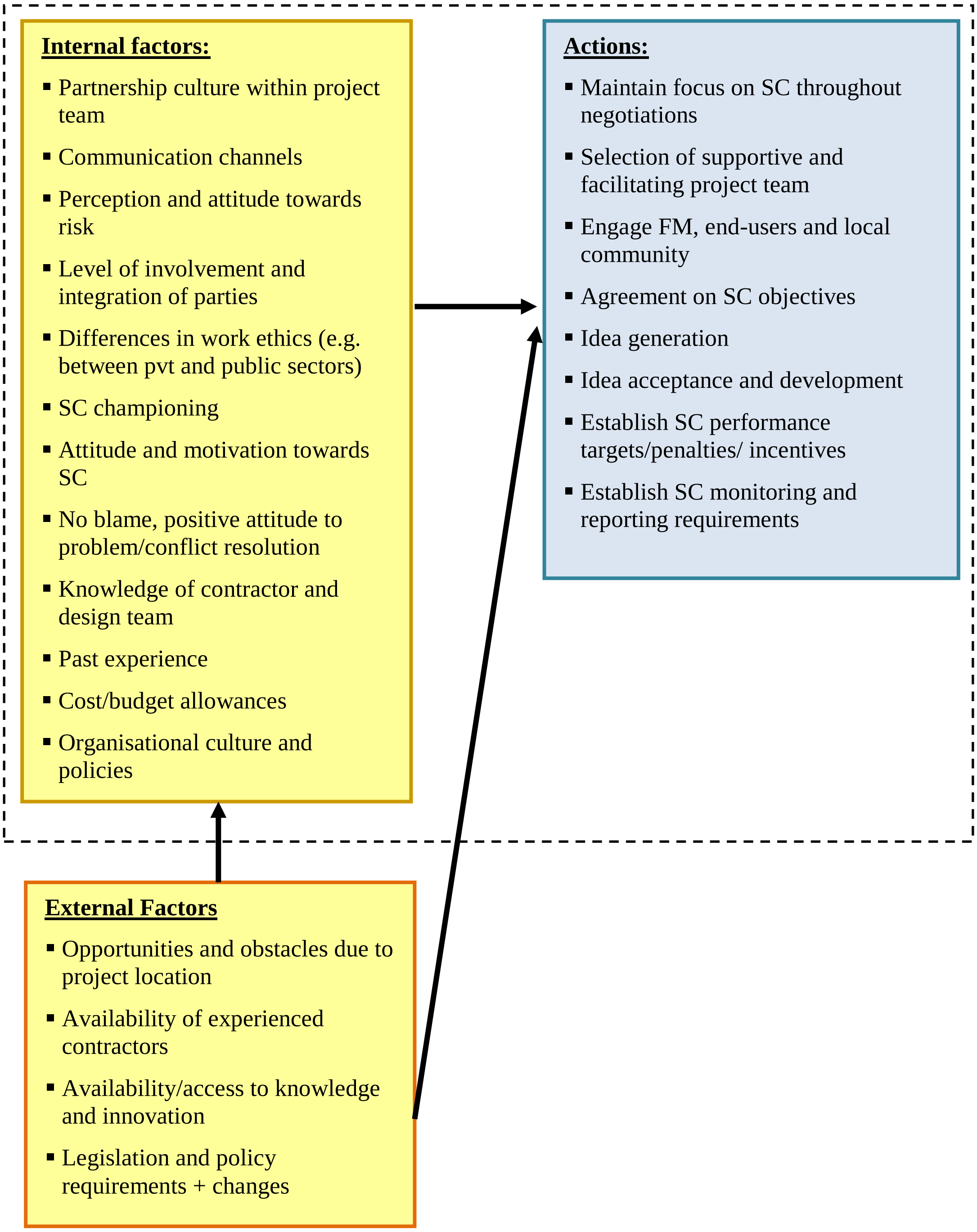


Figure 7.3: Implementing SC at construction project level - Phase 2: Negotiation/Idea development phase

The first set of activities during this phase relates to selecting a project team that has the capacity and willingness to facilitate the implementation of SC. The project parties', particularly contractors', capacity and commitment to facilitate SC depends upon a number of internal factors. These include the parties' knowledge and understanding on SC, the organisational culture and the value placed on sustainability issues within organisational policies, past experience and attitudes towards risk. A good example of how the above factors worked in a positive manner to result in a project team facilitating implementation of SC was found in CS3. In CS3, the contractor was a Swedish organisation who was new to the UK PFI market. During the negotiation/idea development phase of CS3, the contractor took the initiative of suggesting a number of SC options with particular focus on addressing the environmental objectives of SC. Most of these initiatives were informed through the contractor's previous experience in carrying out construction work in their native country. The process of idea development in CS3 was further facilitated by a knowledgeable and supportive design team that was committed towards sustainability issues. The design team respondent in CS3 particularly observed that whilst they are generally willing to design for SC, they are often hindered by reasons such as lack of funding and budget allocations. This barrier was overcome in CS3 due to the interest and motivation of the contractor (who is the main partner of the PFI project company) to address SC. For instance, the design team respondent from CS3 observed that;

> *'They wanted high quality and there was a budget for that and that was different from any other PFI I've worked in before or after' – DT3*

As a result, the design team in CS3 was able to respond positively to the call for a more sustainable, high quality and efficient building by the contractor and the project company.

The second set of activities within this phase involves idea generation and reaching agreement between project parties on the generated ideas. Depending upon source of idea generation on SC, the analysis revealed that the process of uptake and implementation of SC within a construction project environment could take the form of (i) a top-down approach, where the SC issues are driven by the client and/or (ii) a bottom-up approach, where the SC initiatives are brought up by a member of the project team (e.g. contractor or the design team). Comparing the findings from the three case studies during these first two phases, different approaches to idea generation on SC could be observed, resulting in different outcomes. A more top-down type of approach was evident in CS1. Herein, even though there was failure from the Trust's side to incorporate SC requirements into the output specification, sustainability issues were being strongly driven and advocated by the Trust's project director. Conversely, a more bottom-up type of approach was observed in CS3, where the Trust did not demonstrate a strong level of motivation or interest in addressing SC. The implementation of SC in this case was mainly driven by the contractor and the design team. Accordingly, such bottom-up approaches to SC idea generation were found to be particularly useful on occasions when clients did not clearly specify SC requirements. As one contractor noted;

> *'If the client isn't calling for major green initiatives we will always put forward... green initiatives so that they've got options when they see the prices. And we will try and lead them into a much greener solution to their projects' – CT2*

A balance between these top down and bottom up approaches was observed to bring about the best results as was evident from the CS2. As the project director from the Trust in CS2 noted;

> *'We knew what we wanted. But then you get [CT2] as builders, they come along and they'll offer you, well, why don't we do this? We may not have considered it at the time but that's how the partnership worked' – CL2*

The project team's ability to deliver a sustainable and fit for purpose facility in CS2 was attributed by both the client and the contractor to this partnership approach to idea generation.

One of the key benefits or selling points of PPP/PFI schemes has been their ability to draw in the skills and expertise of the private sector to bring about innovative design and construction solutions (refer to section 4.8.2.3). This is particularly useful when it comes to bottom-up idea generation. As is evidenced from the above discussions, in both CS2 and CS3, the public sector clients (i.e. the Trust) greatly benefited from the skills and expertise of their private sector partners in relation to SC. In both these cases, the private sector contractor put forward ideas that addressed SC over and above the requirements set by the Trust. However, this could be contrasted with the experience of CS1, where the contractor failed to bring in any substantial initiatives in relation to SC (refer to section 8.3.1.2). This emphasised the importance of factoring in the contractors' capabilities and experience, specifically in relation to SC, during the contractor selection process. However, CS1 was prevented from doing this due to the paucity of the number of PFI contractors available in the market (refer to section 7.2).

Ideas generated in relation to SC during this stage could be further categorised as either externally generated or internally generated. Externally generated options refer to those SC options that have been incorporated in order to meet the mandatory requirements set in legislations and/or regulations. On the other hand, internally generated SC options include ideas and initiatives of the project parties that go above and beyond meeting the mandatory requirements. During the period of 1999/2000, when CS3 was being designed, SC did not hold the level of priority that it does today. During this time, SC was not being driven by the building regulations or other legislative requirements to extent that it is today. However, the contractor in CS3 was resolved not to aim for the minimum regulatory requirements. Rather the aim was to deliver the facility to the highest possible standard. This commitment towards achieving high levels of SC performance of the contractor was in turn reciprocated by the design team. On the other hand, in CS1, the client requirements laid out in the output specifications only required the contractor to meet the NHS and non-NHS specific legislative requirements. There was no attempt on the part of the contractor or the design team to deliver SC options that went over and above these legislative requirements.

The second set of activities within this phase also involves reaching agreement between project parties on the generated ideas. The analysis revealed that this often requires a constant back and forth process until satisfaction and agreement is reached between all project parties. Examples of this back and forth processes were found in all three of the case studies. However, there were instances when complete satisfaction of all the parties could not be achieved despite repeating the process several times. In such instances, it was required to reach a level of compromise between parties. A good example of this was found in CS1. In here, there was dissatisfaction within the Trust on how the design team had modelled the thermal performance of the new construction. This is evidenced by the following quote from the Trust respondent;

> *'… they have tried to model thermally the performance of the building in the future. We have argued that they haven't done it well enough and have had it done again since and we believe that there will be problem areas' – CL1*

Although the modelling was redone to address the client's concerns, the Trust was still not fully satisfied with the outcome. Despite this, the parties decided to compromise and the process was continued based on this revised model.

The third set of activities within this phase involves reaching agreement between parties on the target levels of performance to be achieved in relation to the agreed SC objectives. This set of activities also includes setting performance measurement targets, which are generally attached to financial penalties. The respondents considered the setting of and agreeing upon performance targets, especially when they are attached to financial penalties, as a particularly difficult process. As one Trust respondent noted;

> *'Setting targets was difficult. ...there's a negotiation process involved. If the project doesn't perform the project company could be penalised for it not performing. When attaching targets that have financial impacts, there could be some bridges to cross'* - *CL2*

In setting performance standards, obtaining input from the building users in relation to their expectations on the standards of performance of the completed facility, emerged as an important factor. These inputs should relate not just to the design aspects of the facility but also to its operational performance, in particular, to the delivery of services during the operation phase. Not giving proper attention to gauging user expectations in relation to the latter sometimes resulted in dissatisfaction amongst users on the standards of performance delivered. This was the case in CS1, where only a few weeks into the FM contract, the hospital management received a large number of complaints about the standard of food being delivered by the FM company. However, none of the penalty clauses that had been built into the PFI contract to ensure the standards of performance delivered was triggered due to poor performance. This was indication that the level of service being delivered still fell within the performance levels stipulated in the contract suggesting a discrepancy between the assigned performance standards and the user expectations. Accordingly, it is important not just to set out clear targets for performance, but also to align these targets with the service levels expected by the users.

The project parties' perception and attitudes towards risks (refer to section 8.3.1.2) is an internal factor that affects the success of this set of activities. Construction industry, in general, is regarded as risk averse (Cheng et al., 2008). SC opens up new risks in addition to the traditional construction risks faced by the project parties. For instance, some stakeholders show a resistance to adopt new sustainable technologies and materials from a fear of the unknown and a lack of willingness to assume additional uncertainties and responsibilities. A good example of contrasting attitudes towards assuming risks by project parties was observed in comparing CS1 with CS2 and CS3. In CS1, there was a level of disappointment from the Trust's side with regard to the contractor's lack of willingness to assume risks and coming up with innovative solutions;

> *'They like simplicity, they like being told what to do. And they don't like the ambiguity of them deciding' – CL1*

As is evident from the following quote by the respondent from the Trust, there was some degree of going backwards and forwards in relation to assuming responsibility by parties;

> *'What the designers try to do, what the contractors try to do is to constantly bring this back to us signing off their design. And we said that's not our job. Our job is to tell you what we want, the output that we want. It is your job to actually deliver that output. They hated that and they still do. But it is the very nature of the risk transfer of a PFI contract, whether that's a good thing or not is another matter. Because all it does is build up problems down the stream' –CL1*

In contrast to this, in both CS2 and CS3 the contractors and the design teams demonstrated greater willingness to assume risks. This in turn led to these parties to take the initiative in putting forward suggestions, which often went above and beyond meeting the requirements initially set by their respective clients. One respondent from the contractor organisation of CS2 noted how they always gave their clients a more sustainable option even on occasions where SC was not at the top of clients' agenda;

> *'If we pick up that it is not at the top of the agenda for our client we will offer it at an option price. - CT2*

The analysis also revealed that the parties' reluctant attitude towards assuming risks relating to SC appears to improve with experience.

Another internal factor affecting the activities within this phase is the differences in work ethics between the public and private sectors. The following quote from the Trust's respondent in CS2 explicates some of these difficulties;

> *'It isn't the easiest relationship. You have a public sector organisation trying to work side by with a private sector organisation. And that's two different work ethics. We wanted as much design certainty as possible and cost certainty as possible. Don't forget we are a public body.' - CL2*

In order to overcome the above issues it was important that good communication channels were established between the different project parties. As was demonstrated in CS2, establishing good communication during this phase can result in inclusive and collaborative decision making overcoming the aforementioned difficulties. In the case of CS2, communication between parties was facilitated through regular face to face meetings. The project director from the Trust in CS2 noted;

> *'We had to go through the contractual hierarchy.... We'd have design team meetings throughout. So you would have the whole of their design team sit with our design team. It was an inclusive process, it wasn't always easy... But it was generally collective. Often times you would have the architects, our architectural advisors would talk to their architectural advisors. It was over a year worth of face to face discussions before we got out on the ground' - CL2*

The above could be contrasted with CS1, where the Trust's project director was frustrated with the distance between them as the client and the design team. He particularly allocated this to be a weakness of the PFI procurement system, even though the same issue was overcome in CS2 through better facilitated communication.

> *'... a big disadvantage of the PFI contract is the separation of the design team from us as the ultimate client. We have so many levels between us and the people who are designing the buildings. It's a great frustration.' – CL1*

Within the PFI model, the design team is contracted by the contractor organisation (see Figure 4.9). Therefore, it was typical to find during the interviews that the design team members referred to the contractor or the project company as their 'Client'. However, it is clear from the above discussions that there is a necessity for direct communication paths between the design team and the ultimate client of the construction (i.e. Trust).

Involvement and integration of all project parties is another internal factor that is influencing the activities within this phase. The analysis revealed various levels of involvement of parties during this phase. In all case studies, a strong partnership was evident between the contractor and the design team. There was generally a high level of involvement and participation of these parties within the decision process. In contrast, some respondents from FM organisations were dissatisfied with their level of involvement in the SC decision process. Although, FM was involved in the decision process in all three case studies, there was discontent on the level of input they had when it came to influencing the decisions been made. As one FM respondent observed;

> *'You've got to remember you have a PFI construction company, which is usually a massive multi-million pound contractor. Say £100-200 million contract and then you'll have a couple of million pounds a year FM contract. Which do you think is the more powerful player of those two? To some extent some of them did it. They all talk with their FM Teams. Some of them have bigger input than others'- FM2*

Engaging with local community groups is another internal factor that is particularly important during these first two phases of the implementation process to broaden the scope of SC issues considered. Indeed, the analysis found that involving the local community representatives within these early phases gave the communities a sense of ownership of the new hospitals. During this second phase of the implementation process, involvement and consultation with a variety of internal and external project stakeholders was found to be useful for developing a design solution that closely satisfied the stakeholder requirements. Within the case studies, these consultations were found to be conducted in both formal (e.g. organised meetings) and informal (e.g. information days) ways. In CS2 for example, during this second phase of the implementation process, the contractor took the initiative in organising workshops to incorporate the end user ideas into the design development process. This engagement process was continued throughout the negotiation/idea development phase until the design was finalised. One outcome of this consultation process was the altering of the orientation of the main entrance in order to make it more visible for patients upon arrival. The local community groups were keen and enthusiastic about the opportunity to provide input to the design process as was evident from the positive feedback given by the workshop participants.

The analysis also found that a number of problems could arise during the latter phases of the implementation process when proper stakeholder consultations were not carried out during this phase. One such problem was faced by the parties of CS1 during the hand-over of a completed section of the new build. Herein, a group of patients were driven to hold a protest demonstrating their dissatisfaction with the lack of a dedicated patient care unit addressing their particular user needs. The Trust on the other hand, was of the opinion that such a unit was not possible due to issues such as, feasibility and staffing. However, the users had not been kept properly informed on these during the negotiation/idea development phase, which in turn led to a mismatch between user expectations and what was delivered in practice.

The general buzz surrounding SC issues from national government level downwards was generally found to act as a facilitator to implementing SC during this phase. However, the analysis found that this high level of focus on SC also had the likelihood to act as an impediment to implementing SC. This was mainly because the buzz surrounding SC sometimes drove project parties to implement certain SC aspects without giving due consideration to the project contextual factors (for example, location and the type of service provided). A good example of this was the local council's decision to cap the number of car parking spaces in CS2 as a means of promoting more sustainable travel choices. This was one of the environmental objectives identified through the document analysis (refer to section 5.3.2.1). However, this initiative was not suitable for CS2 due to the location of the hospital, which was in between two major towns. Furthermore, as FM respondent noted, given that CS2 was an acute care hospital, the patients generally sought to arrive at the hospital using the fastest mode of transportation they had available. The lack of car parking spaces within this context was therefore a source of great frustration to the users;

> *'That's not been so successful. Because sometimes it's the nature of the business. If you're sick and you need to get to a hospital you come in the quickest fastest mode don't you? So that hasn't been as successful as we would have liked... It was the biggest thing that people complained about. They arrive on site anxious, not sure where they are going. They are terrified of being late for an appointment if they are coming to out-patients. It's not the best thing. People will argue I suppose. It's not the best model for an acute care hospital' -FM2*

Another external factor affecting the activities within this phase was the legislative environment in relation to SC. Whilst, the general legislative environment was found to be an enabler for implementation of SC, the constant changes and developments being made in this area were found to negatively affect the process. A good example of this was the lengthy re-scoping process undergone by CS1 in order to accommodate changes to legislation;

> *'We got to 2005 and found that we couldn't get the Full Business Case approved by the Department of Health. Treasury rules were changing. We couldn't meet the new treasury rules so we had to redesign and it took us a year to get to an agreement with the project company. So by July 2006, we signed the agreement in principle and then it took us another year to get to Financial Close. So, Financial Close in 2007. So an awfully long gestation period and if we deserved a price for anything at all, it was persistence I think. Because at times you feel like just giving up because it's so difficult' –CL1*

As was observed in the case of CS1, the commitment and motivation of the client as well as the project team is critical to manage and overcome the effects of such external factors.

The end of this second phase is marked when the project reaches financial close. In theory, reaching financial close means that the process of idea generation, negotiation and formulation of design solutions to deliver the agreed upon outputs has been completed. This would mean that all the requirements in relation to SC have been agreed upon between the client and the contractor by this time. However, in practice, some variations and additional considerations may still be taken into consideration even after this phase, if agreed upon by both the client and the contractor. A good example of introducing such an additional SC feature was observed in CS2, where the contractor brought forward the idea of using a lake source heating system after the financial close. The project team only had a small window of opportunity before the construction work commenced to reach an agreement and carry out the implementation. The adoption of this technology as a variation was again evident of the willingness to assume risks associated with novel SC technologies by both the contractor and the client. This also highlights the fact that the activities within the phases of the implementation process do not follow a rigid step-by-step structure. Rather, these activities (shown in Figures 7.2, 7.3, 7.4 and 7.5) are often carried out in a fluid, non-structured manner, allowing for the inherent complexities and contextual considerations within construction project environments. However, the analysis revealed that the generic nature of the activities within each phase, as discussed within the sections 0, 7.3.2, 7.3.3 and 7.3.4 of this chapter, remained more or less the same.

7.3.3 Construction phase

The third phase of the SC implementation involves the physical construction phase (refer to Figure 7.1). The activities within this phase are focused on the transformation of the concepts and ideas on SC developed during the previous phases into their practical functions. The activities within this phase results in the physically constructed facility ready to be handed over to the clients/users upon the completion of the phase. Consequently, activities within this phase involve the consideration of SC issues in relation to the construction site level activities and are for the most part, led by the contractor organisation. Figure 7.4 below details the activities and internal and external influence factors identified within this phase.

The physical construction phase activities could be divided into three main categories; i.e. (i) activities in relation to developing and implementing programmes and methodologies to address the SC objectives, (ii) activities in relation to gaining commitment and involvement of other stakeholders (e.g. suppliers, sub-contractors, local community) and (iii) activities in relation to monitoring, reporting and improving performance levels in relation to addressing SC. The analysis revealed that consideration of SC during this phase is fairly well-developed and given a higher level of focus compared to the other three phases of the implementation process.

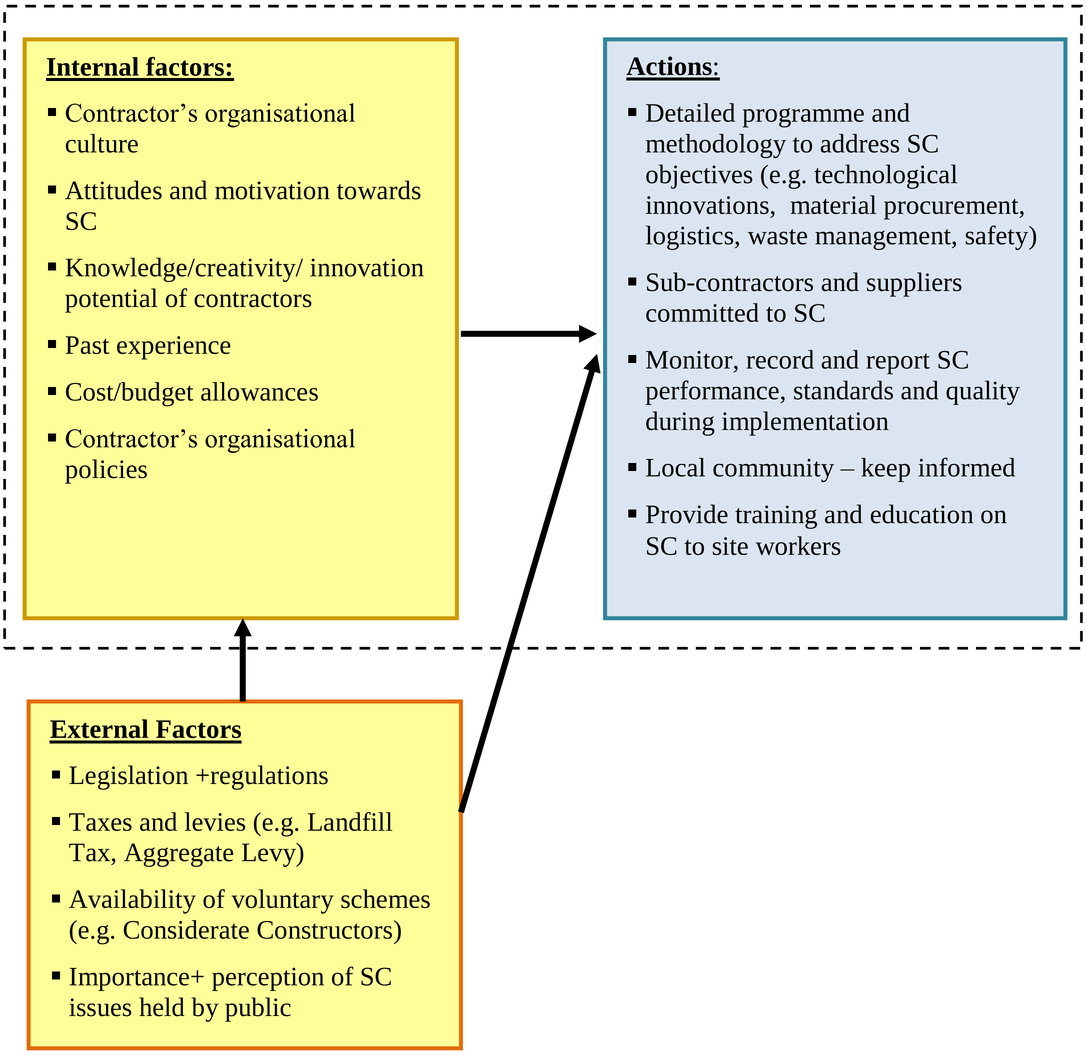


Figure 7.4: Implementing SC at construction project level - Phase 3: Physical construction phase

The activities within this phase are also affected by a number of internal and external influence factors. Similar to the previous phases, the exact nature and effect of these influence factors (i.e. whether the factors acted as facilitator or impediment) were also found to be determined by the specific contextual factors of each project.

The first set of activities within this phase as mentioned above, involves developing processes and methodologies to deliver the sustainable design solutions agreed upon during the negotiation/idea development phase. This is particularly facilitated by high levels of SC related knowledge, creativity and innovation potential within contractor organisations. In addition, this first set of activities also involves further developing and modifying the generic construction process activities and methodologies to incorporate SC considerations. In relation to this, aspects which were given a high level of attention in all three case studies included; focus towards waste reduction (including recycling/re-use, minimising the amount of waste sent to land fill), use of sustainable and sustainably sourced materials (e.g. use of eco paints, sustainably sourced timber and quarry products) and adoption of lean construction practices.

The high level of focus given to the aforementioned issues was to a certain extent driven by external factors affecting this phase of the implementation. These external factors included, the legislative and regulatory environment promoting SC, Taxes and Levies (e.g. Landfill Tax, Aggregate Levy), as well as, the importance placed on sustainability issues by the general public. The latter was associated with the reputation of organisations. Project parties (particularly, contractors and clients) from both CS2 and CS3 viewed implementing SC practices as a means of improving the reputation of their organisations. However, the issue here is that, these activities alone only address SC at the most basic levels (i.e. product/component level and project level, as shown in the Figure 5.4). In order to address SC in a more holistic and comprehensive manner focusing on the other activities identified within this and the other phases of the implementation process, is crucial. The analysis further found that often the aforementioned methodologies and processes for delivering sustainable design solutions would be decided during the previous phase (i.e. negotiation/idea development phase) of the implementation process. In such instances, the activities during this phase involved, modifying these decided upon processes and methodologies, taking into consideration the local and site level conditions.

The second set of activities within this phase is focused upon gaining the commitment and involvement of other stakeholders such as, sub-contractors and suppliers, who play a key role in the activities during this phase. Consideration given to sustainability issues by these parties has an impact on the overall SC performance within the construction process as well as the constructed facility. As explained in section 2.6, the concept of SC incorporates considerations with regard to both of these aspects. Much of the responsibility for gaining commitment towards SC from these other stakeholders lies with the contractor during this phase. CS2 demonstrated some good examples of initiatives taken by the main contractor in ensuring that the sub-contractors were committed to SC. For instance, the contractor took an active role by intervening to take corrective action, when it was revealed that one of their sub-contractors was underpaying some construction workers. A good example of supplier involvement facilitating the SC implementation was observed in CS1. Here, the involvement and engagement with a specialist supplier allowed the contractor to successfully adopt a modular assembly system during the construction phase. The input from the supplier in relation to the preparatory work required, helped the contractor to meet ambitious installation targets whilst not compromising on aspects such as, access or maintainability.

The analysis also found that there were benefits in continuing the local community engagement activities described within the first two phases, during this construction phase as well. However, the analysis revealed that the purpose of conducting community engagement activities within this phase differs from that of the previous phases. The main purpose of conducting stakeholder engagements during this construction phase was to keep these parties informed, whereas, the main focus of these engagement activities during the previous two phases was on obtaining inputs. The contractor organisation in CS2 in particular, gave a high level of attention to conducting stakeholder engagements during this phase. One such example was a safety awareness project, which was carried out with the participation of children from three local schools. Given the context of case studies, such exercises were useful for giving the local community a sense of involvement and ownership over the new facility.

The third set of activities identified within this phase involves the monitoring, recording and reporting the SC performance and quality standards being achieved. These actions were important to keep the project parties, particularly the client, informed on the progress being made, as well as any problems or issues encountered. Provision of training and education on SC to site level workers is an internal factor that can impact on the quality and standards of SC performance achieved during this phase. In all three case studies, training activities were carried out to provide site level workers knowledge and awareness in relation to some aspects of SC (such as, health and safety, recycling and waste management).

Overall, internal factors such as, contractors' past experience, attitude and motivation towards SC and their organisational culture were identified to play a crucial role in determining the level of attention given to SC within this phase. These factors can drive contractors to perform above and beyond the SC requirements stipulated in project briefs during the construction stage. In CS3 for instance, the contractor opted to use triple glazing instead of the required double glazing in windows, even though the energy costs were borne by the Trust. As was noted by the respondent from the design team in CS3;

> *'There's no benefit for the consortium, who are running the building to do actually anything more than what they have to do. Obviously they'll do what they have to do legally. So it is interesting how in this case the contractor still did certain things, such as the triple glazing, which was quite good.' – DT3*

In this instance, the contractor of CS3 was a Swedish company committed to SC. The use of triple glazing was normal practice for them from their experience within the Swedish construction industry. Thus, the contractor's initiative to use triple glazing in this instance was driven by both their past experience as well as organisational culture.

Some of the external factors affecting the activities within this phase were discussed at the beginning part of this section. In addition to those, the availability of voluntary codes and schemes for benchmarking purposes was another external factor that affected SC implementation during this phase. Conforming to schemes such as, Considerate Constructors by contracting organisations for example, was observed within all three case studies. Obtaining good ratings from such schemes were seen by contractors as a means of enhancing their company reputations (which in turn could be translated into a business benefit).

The main output of this construction phase is the completed facility. Therefore, this third phase of the implementation process reaches completion when the facility is ready to be operational.

7.3.4 Hand over/operation phase

The fourth and final stage of the process is called the hand over/operational stage (see Figure 7.1). Although this has been introduced as a separate phase following the completion of the construction phase, given the type and scale of the three case studies, significant overlapping of the construction and operation phases could be observed. However, as mentioned in section 7.3.2, the generic nature of the activities within this phase could be identified and remained the same across the case studies. These activities and the internal and external influence factors affecting them are shown in Figure 7.5.

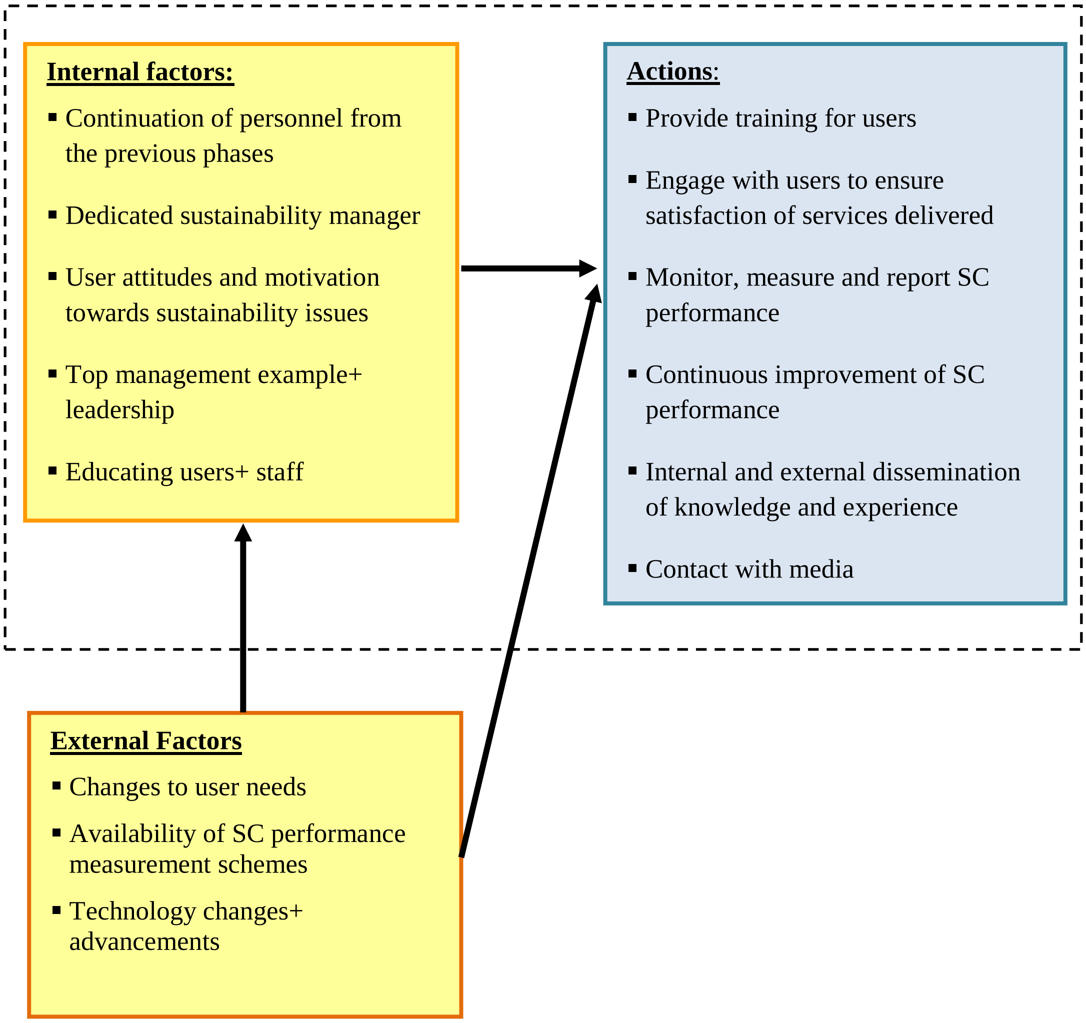


Figure 7.5: Implementing SC at construction project level - Phase 4: Hand over/operation phase

The activities within this phase can be categorised into three main types. These are; (i) activities in relation to providing training and improving engagement of building users to ensure the sustainable operation of the facility, (ii) activities in relation to continuously improving the sustainable performance levels of the completed facility and (iii) activities in relation to dissemination of knowledge and experience gained in relation to SC implementation process.

The first set of activities within this phase is crucial for ensuring that the performance levels and standards set at the idea development phase in relation to aspects such as, energy conservation are actually realised in practice. Providing training for users of the facility (particularly, the hospital staff within the context of the case studies) and improving their awareness and commitment towards sustainability issues are essential for achieving this. The analysis revealed a range of initiatives undertaken by the project companies as well as the Trusts during this phase to increase the awareness and commitment of users towards sustainability issues. These included;

- Using 'house-keeping' to push the energy reduction agenda (e.g. Turning off computers)
- Arranging energy awareness weeks
- Top management training and example (e.g. participation in programmes such as 'energy gyms')

It is interesting to note that most of the user training initiatives emerging through the analysis were focused upon issues relating to the energy sub-element. It appears that there is room for expanding these user training initiatives to incorporate the other sub-elements of SC as well.

The second set of activities within this phase relates to continuous improvement of SC performance of the completed facility. In order to achieve this monitoring and reporting the current levels of SC performance is important. The client representatives were keen to highlight the importance of appointing a dedicated sustainability manager at this stage, even though within the PFI schemes the responsibility for the operation of the facility lies with the project company. The analysis revealed that the Trusts in all three case studies had opted to appoint a dedicated person with the responsibility for carrying out the performance monitoring, measurement and reporting activities in relation to SC during this phase. In both CS1 and CS2, this role was referred to as a sustainability manager or advisor.

> *'I have a sustainability advisor now, so he's the guy that has all the facts and figures now' – CL2*

> *'We have employed a sustainability manager whose job is to try and persuade people to behave better within the building. We employed her in the middle of the last year' – CL1*

However, in CS3, this role was specifically related to energy management.

In the discussions carried out under the second phase of the implementation process (refer to section 7.3.2), the importance of obtaining input from the facility's users in setting performance standards was highlighted. The analysis revealed that this input was particularly important to ensure user satisfaction during the hand over/operation phase of the implementation process. Continuing this dialogue with the users throughout this hand over/operation phase (for example, by facilitating discussions between the FM provider and users) can help ensure that the FM services continue to be delivered to the expected standards. It emerged through the analysis that the activities in relation to performance monitoring during this fourth phase could also be carried out with the involvement of users. One such example was the introduction of a Helpdesk linked to performance parameters in CS2. The idea of this was to automatically identify any non-compliance or service delivery problems through the user complaints. These identified problems were then linked to the payment mechanism to automatically generate the penalties/deductions the project company incurred for non-compliance.

Overall, the analysis found that Trusts in all three case studies showed commitment towards continuously improvement of the SC performance levels of their respective facilities. This is evidenced from the following quotes by the Trust respondents;

> *'I think we are continuing to look at it. So we are not standing still' – CL2*

> *'One of the big issues that we are trying to take forward at the moment with the project company is trying to take forward sustainability initiatives, which we don't need to hit the energy targets' – CL1*

The third set of activities identified during this stage involves the dissemination of knowledge and experience gained from the SC implementation process. The analysis revealed that this dissemination could take two forms. Firstly, external dissemination involves sharing the knowledge and experience gained by the project parties with those that are outside the project team. A good example of this external dissemination was observed in CS2 as demonstrated by the following quote by the Trust's project director;

> *'It has been the subject of a number of interests, we get quite a number of people coming in. Myself and a colleague, we were out in New York last year talking at one of the New York hospital conferences. Because they were interested in how we've used green and sustainability into the health care environment. Actually, we are also going out to Sweden in the next couple of months. Because in Sweden, there's a big project there and they also want to look at how we integrated sustainability elements to the new built' –CL2*

The second type of dissemination activity is referred to as internal dissemination. This involves using the knowledge and experience gained from implementing SC within one project in the subsequent projects carried out by the project parties. The contractor organisation of CS2 provided a good example of such internal dissemination of knowledge and experience as shown by the following quote;

> *'..So lots of initiatives are now starting to build into our new projects..., based on the experience we've had on [CS2] and other projects. So now it's a cornerstone of everything that we sell. Be it our hospital projects, our commercial projects, each bid we put in is the greenest submission we've ever made. And we strive to get Excellence in all of the benchmarks that actually sit alongside those projects' – CT2*

However, the analysis revealed that the dissemination of experience (particularly, external dissemination) was for the most part limited to the positive experiences. Sharing of negative experiences could also be important for learning purposes even though it is difficult to achieve in practice due to the reputations and images of the project parties involved.

Overall, the success of the activities within this phase was improved by the continuation of personnel from the previous phases of the implementation process. Indeed, all four phases of the implementation process were found to benefit from continuity of project personnel (refer to section 8.3.2.6) as this allows the SC implementation process to progress with minimum disruptions, particularly when progressing from one phase to another. During the hand over/operation phase, the continuation of project personnel from the previous phases was helpful in ensuring that the facility is operated the way it was intended. Continuation of project personnel throughout the implementation phases was also found to be useful in encouraging project parties to take into consideration the whole life cycle issues from the early stages.

The significant external factors affecting the success of activities within this phase were the potential changes to user needs and technological advancements that could occur over time. The analysis revealed that the smooth functioning of the hand over/operation phase greatly improved on occasions where, foresight was used by the project parties to accommodate for such changes during the design of the facility (i.e. the negotiation/idea development phase).

The preceding sections of this chapter provided in depth discussions on the process of implementing SC within construction project environments. The analysis of case studies led to the development of the emerging framework for SC implementation, which was presented at the beginning of this chapter (refer to Figure 7.1). The next section goes on to further discuss these findings by comparing and contrasting them with the available literature in order to strengthen the discussions presented and increase credibility of the research findings (refer to section 4.6).

7.4 DISCUSSION AND SYNTHESIS OF FINDINGS

The grounded theory analysis led to the development of the emergent framework for SC implementation comprising of four main phases (shown in Figure 7.1). There are a number of existing frameworks and models that lay out the generic phases of a construction project. May be the best known amongst these is the outline plan of work developed by the Royal Institute of British Architects (RIBA). This plan presents the activities within the processes of managing and designing building construction projects and administering building contracts, organised into a number of ‘work stages’. Whilst the RIBA outline plan of work presents these work stages in a generic manner, it acknowledges that the sequence of the work stages and the activities contained within the stages vary depending upon the type of procurement used. Winch and Carr (2001) have also developed a 10 phase model for the generic construction process. Their model is based upon the RIBA plan of work and the ‘Code des Marches Publics’ developed in France. Similarly, OGC (2005) has also put forward a framework detailing the key stages of the construction procurement process. All of these frameworks and models have been useful in developing a common language for construction sector activities.

Despite the availability of these different frameworks and models, adoption of a systematic phased approach with clearly delineated activities in delivering construction projects has proven to be an improbable task, as evidenced by the experiences within construction project environments. This could be attributed to the complex nature and context specific characteristics of construction projects. For instance, Winch and Carr (2001) note that even though the RIBA plan of work has been in existence for over 40 years, its experience in endeavouring to ‘provide a model procedure for the methodological working of the design team’ has not been particularly successful. One example of this is the amount of design variations that occur after the stages D and E of the RIBA plan, despite warnings against making any changes to the size, location, shape or cost aspects of designs after these stages (see Winch and Carr, 2001). However, some authors have postulated that the strict guidelines associated with the PFI schemes act as deterrents to making such changes, thereby allowing PFI projects to adhere to a relatively rigid systematic process. Nevertheless, as discussed within the preceding sections of this chapter, the case study analysis revealed that this was not always the case.

Similar to the above observations made in relation to the generic construction process, the SC implementation process was also found to not adhere to a strict, step-by-step structure. Although a common set of activities and influence factors could be identified within each phase, the order in which these activities were carried out differed from one project to the next based upon the contextual factors of each construction project. In other words, the actions identified within each phase of the implementation process were not carried out in the same identical order across the case studies. These discussions highlight the importance of allowing for flexibility within the emergent framework for SC implementation process. The level of attention given to fulfilling all of the identified activities within each phase would determine level of success of the SC implementation process. This may include going beyond meeting only the minimum requirements set in the mandatory legislation and regulations, towards exceptional achievements in SC that are over and above the minimum requirements set in legislations.

So far there has been a lack of attention given to gaining detailed understanding of the SC implementation process grounded in the project level realities (i.e. bottom up approach) within existing literature. Most of the work in this area to date have focused upon prescribing actions from a top down perspective. This research discovered that exploring the SC implementation process grounded within the realities of construction project environments was useful in establishing interrelations between various actions and influence factors. Furthermore, even though this study has been carried out within the context of PFI projects, most of the identified actions within the implementation process phases are transferable to project environments using other types of procurement as well. NAO (2009) observes that good practices needed to ensure the success of PFI projects (such as, setting clear output specifications) are transferable to other non-PFI projects, highlighting that good practice can flow in both directions between PFI and non-PFI.

The local context of projects was repeatedly emphasised throughout the discussions within this chapter as a factor affecting implementation of SC within construction projects. Planning system regulates the development of land and is hence, responsible for determining the national and local context of construction projects. Accordingly, the planning system has a key role to play in underpinning SC (Harman and Benjamin, 2005). Harman and Benjamin (2005) have particularly noted that planning system has the ability to encourage higher standards of building performance than those stipulated through building regulations. They further highlight that the planning system has the ability to introduce 'area-based' measures in order to improve building performance in areas that are outside the scope of building regulations. Furthermore, Kibert (2008) observes that how the distribution of different types of developments is determined by the planning system has a number of consequences on addressing aspects of SC at project level. He notes that segregation of buildings by type (such as, residential, commercial, government, etc.) forces people to increase their use of automobiles or public transport to commute from one type of building to another. Concepts such as, '*New Urbanism'* seek to provide a solution to this by mixing building types and designing urban areas to encourage pedestrian movement. Ideally, availability of all daily needs within a 10 minute walking distance of the place of an individual's residence is preferred (Kibert, 2008). However, the analysis of case studies highlighted that decisions on which SC issues to be encouraged for each project through the planning system should be made taking into consideration the realities of each individual project. As was discovered in CS2, the blind implementation of certain regulations (such as, limiting the number of car park spaces) without giving due consideration to factors such as site location is not recommended. Such actions could in fact, impact negatively on the overall sustainability of projects due to reasons such as, reduced user satisfaction.

While the need for clearly specifying client requirements for SC emerged as an important finding within the conceptual phase, the extent to which these requirements can be precisely described, assessed and communicated to third parties remains in need of further clarification (Lutzkendorf and Lorenz, 2007). In the case studies, varying levels of prescription were observed in relation to specifying client requirements for SC, resulting in different outcomes in terms of the overall performance of SC implementation process. Client's demand for SC itself could be improved by several mechanisms such as (Lutzkendorf and Lorenz, 2007);

- Changing the values and concerns of societies and strengthening the willingness of individuals and corporations to take responsibility for society and environment.

- Leadership by public authorities (use of demonstration projects and by incorporating SC requirements into tendering procedures).
- Acknowledgement of financial benefits of SC.
- Harnessing the property sectors methods and instruments such as, risk analysis, valuation and transaction analysis to communicate the benefits of SC.

According to Sexton (1997), much of the inefficiencies in addressing SC could be attributed to the fact that it is undertaken only as a superficial change on top of an unchanged core organisation. Similar views have been expressed by Bell (2005) and Liu (2006). Bell (2005) views attempts such as, determination of ecological footprints to be just preliminary steps in the path towards SC, which can only be fully realised through a comprehensive cultural change. Liu (2006) states that traditional cultures, attitudes and result oriented policies, as well as, the low level of attention given to the initial stages of the construction process as the main obstacles for implementing SC in construction projects. Further, new level of 'technological sophistication', as well as co-operation required by SC, need drastic changes to be made to the 'traditional' industrial structures (Rohracher, 2001). This also calls for a change of cultural values and change in attitudes of parties involved in the pursuit of SC. These observations were supported by the case study findings. The analysis found that attitudes and value placed on SC by parties as a major influencing factor for implementation of SC. Therefore, training and education programmes, which could in turn help improve the attitudes and knowledge of parties on SC are useful to facilitate the uptake and implementation of SC.

7.5 SUMMARY

This chapter addressed part of objective 5 of this research (refer to section 1.2) by analysing and detailing the actions needed for implementing SC within a construction project environment. The findings of the grounded theory analysis led to the development of four phased emergent framework for the implementation of SC. Each phase of this emergent framework includes a set of activities and influence factors. The cross-case analysis revealed that the activities within the phases did not always follow a strict, structured order. Furthermore, even though these activities and the influence factors could be identified as generic in nature at a high level, their exact nature and characteristics were found to vary, depending upon the context of and realities within each project. The discussions on each of the phases of the process highlighted the need for proper management facilitation to ensure the success of the SC implementation process. This chapter also briefly introduced the influence factors that affect the success of the activities within each phase. The next chapter goes on to further elaborate upon these influence factors.

CHAPTER 8: FACTORS INFLUENCING THE IMPLEMENTATION OF SC WITHIN A CONSTRUCTION PROJECT ENVIRONMENT

8.1 INTRODUCTION

The process of implementing SC within a construction project environment, as discussed in chapter 7, is affected by a number of influence factors. Upon closer evaluation, it emerged that a generic set of influence factors affecting the overall success level of the SC implementation process, could be identified. All together 23 such influence factors emerged through the analysis under the two main categories of internal and external factors. Discussions in chapter 7, elaborated upon some of these influence factors. This chapter provides in-depth discussions on each of these 23 factors. Within the latter part of the chapter, the findings in relation to the influence factors identified from the case studies are compared with the findings from the advisory documents, as well as other established literature. This chapter addresses the research question RQ6. Overall, this chapter together with chapter 7 fulfils objective 5 of the research.

8.2 TYPES OF INFLUENCE FACTORS

Altogether, 23 factors influencing the implementation of SC at construction project level emerged through the analysis. These included 18 internal factors and five external factors. These factors are shown in Table 8.1 below.

Table 8.1: Factors influencing the process of implementing SC at construction project level

Internal Factors (IF)	**Cultural factors**	
	IF 1:	Attitudes, commitment and motivation of parties
	IF 2:	Perceptions / attitudes towards risk
	IF 3:	Differences in work ethics (e.g. private and public sectors)
	IF 4:	No blame, collaborative, positive attitude to problem solving
	Organisational/ managerial factors	
	IF 5:	Top management support and commitment
	IF 6:	Integration / alignment of SC and project objectives / processes
	IF 7:	Communication channels
	IF 8:	Level of involvement and integration of parties (i.e. within project team)
	IF 9:	Engagement of users and local community
	IF 10:	Organisational policies and culture
	IF 11:	Continuation of project personnel throughout implementation phases
	IF 12:	Learning and knowledge sharing within project team
	IF 13:	Client demand and leadership
	IF 14:	Suppliers and sub-contractors committed to SC
	Resource factors	
	IF 15:	Cost/ Funding implications
	IF 16:	Availability of knowledge , creativity and innovation
	IF 17:	Previous experience
	IF 18:	Training, education and development
External Factors (EF)	**External factors**	
	EF 1:	Legislation and regulatory environment
	EF 2:	Availability of expertise (experienced contractors and consultants)
	EF 3:	Availability of guidance and performance measurement tools
	EF 4:	Opportunities /obstacles due to local context
	EF 5:	Perception of and importance attributed to SC issues by the public

As mentioned in section 7.3, the ‘external factors’ refer to those influence factors that are outside the control of project parties, whereas, the ‘internal factors’ are within the control of project parties. The effect of internal factors on the success of the SC implementation process could therefore, be managed through proper management interventions. Upon further scrutiny, it was identified that three different types of management facilitations were required to effectively manage these internal factors. These included cultural facilitation, organisational/managerial facilitation and resource facilitation. Accordingly, the 18 internal factors were categorised into three main types as, cultural factors, organisational/managerial factors and resource factors. Whether these factors acted as enablers or barriers to the success of the SC implementation process, depended upon the context each project and the nature and extent of management facilitation received.

Unlike the internal factors, the effect of the external factors was observed to be, by and large, uniform across all three case studies. The obvious exception to this was factor EF 4, which was determined by the local context within which each project was situated. The following sections provide detailed discussions on each of these factors.

8.3 INTERNAL FACTORS

8.3.1 Cultural Factors

Cultural factors refer to those factors that affect the attitudes and mind-sets of project parties towards SC. The analysis identified four main cultural factors that affect the success of the SC implementation process. These factors are discussed in detail below.

8.3.1.1 Attitudes, Commitment and Motivation of Parties Towards SC

Project parties attitudes, motivation and commitment towards SC was identified as a significant influence factor when it comes to implementing SC at construction project level. Gallie et al. (1998) argue that ‘commitment’ derives mainly as a result of the values held by individuals, as opposed to any policies and/or practices. For instance, they state that,

> *‘The issue of commitment...transcends the managerial agenda. The commitments made by individuals represent the values they hold and priorities among which they distribute their choices and actions...’ (Gallie et al., 1998).*

A positive attitude and commitment towards SC meant that project stakeholders had a motivation for addressing SC issues, other than the fact they were required to do so by legislation. A good example of such a positive attitudes and interest towards SC are evidenced by the following quotes by the project director from the Trust side in CS1 and a design team member from CS3;

> *'Not just because it's the law, but because I have a very strong personal interest as well. I think that it's something that we need to do socially. I think it's something that we have to do. I think in truth it's too late already. But a lot of the adverse impacts are going to happen anyway. But I think we need to address the issues as much as we can in all the buildings that we produce' - CL1*

> *'Nowadays, everyone talks about sustainability...I started bit more before that and it was part of our normal design process. Because, for me, it was part of what you do anyway. How to make it as efficient as possible and energy saving and all those other aspects. Now, it's compulsory and everyone talks about it. When we started it was not at all common place. And many contractors wouldn't worry too much about it at all and Trusts too. There were not many directives on those. We started talking because we passionately believed and we wanted to. That's how we started' - DT3*

The level to which these attitudes and motivations of parties towards SC translated into practice depended upon the level of influence those individuals had on the decision-making process within the project teams, as well as, the willingness of and facilitating environment created by the other project parties towards addressing SC. Therefore, when it was the project director for the Trust who showed strong interest in SC, such as was the case in CS1, it acted as a strong driver for implementing SC in the project. However, in the case of CS1, this driver was impeded by a lack of enthusiasm and initiative from the other project parties. This could be compared with the experience in CS3, where the parties championing SC were the contractor and the design team. There was no strong interest from the Trust towards addressing SC. However, they were encouraged and persuaded by the contractor and the design team to accommodate the new and innovative ideas put forward to them. In the cases where the project parties demonstrated a positive attitude and commitment towards SC, there was a higher likelihood to realise achievements that were over and above those required by legislation. This was the case in CS3 as demonstrated by the following quote;

> *'Also they [i.e. CT3] didn't go for the minimum requirements, in say, thermal insulation and everything else. They said just go to the maximum you can. So that was all built into the concept. It was [CT3] and it was us as a design team that said let's go for the highest standard' - DT3*

On the other hand, when there was no strong interest or motivation in project parties towards SC, there was a tendency to address only the minimum mandated requirements. This was the case in CS1;

> *'... We are hitting the energy targets, which help us to hit the CO_2 reduction targets for 2015. But we have very little in the form of sustainable forms of energy built into the building... So I think the designers have designed for simplicity and to reduce cost rather than trying to achieve the sustainability targets that we might have hoped to achieve' (CL1)*

However, in the case of CS1, the effects of lack of commitment and motivation towards SC on the part of the contractor and designers was exacerbated by a lack of initiative on the part of the client in laying out the SC requirements at the very outset of the project (see sections 8.3.2.2 and 8.3.2.9).

The above discussions illustrate that despite the motivation to address SC by some, the negative attitudes of others can sometimes result in derailing the attempts at implementing SC. Respondents from all three case studies acknowledged the difficulties faced with people that regard SC issues with negativity. For example, one respondent noted;

> *'Some people think it's an absolute load of rubbish, an absolute waste of time and money and resources' –FM2*

A study by IISD has highlighted the importance of education to improve people's attitudes towards SD (Michalos et al., 2009). It appears that the construction industry could greatly benefit from step changes in its current attitudes and practice, in order fully engage in SC practices.

8.3.1.2 Perceptions/Attitudes Towards Risk

The research revealed that the SC implementation process is facilitated by a willingness to assume risks by project parties. As mentioned in section 4.8.2.3, one of the key selling points of PFI as a procurement method has been its potential to bring in private sector expertise. Some researchers have noted that today, PFI schemes are being pursued more and more for their novel methods of risk allocation (see section 4.8.2.3). However, this requires the private sector contractor to take on a certain level of risk associated with the design and construction of the facility. Whilst construction projects are inherently associated with risks (Lam et al., 2007), SC opens up new risks in addition to these traditional construction risks, due to various factors such as, the innovative technologies involved and lack of experience of parties. Some stakeholders are reluctant to adopt certain SC options (particularly those involving technological innovation) from a fear of the unknown and the additional uncertainties and responsibilities involved. This resistance mostly comes from those stakeholders who stand to suffer as a consequence of any failures of such technologies or materials. Although, it is possible to translate this risk into monetary terms, the risks of losing reputation, impact on schedule, technology failure and reduced performance remain (Nelms et al., 2005; Pearce, 2003; Rohracher, 2001; Sjostrom, 2001). Rahman and Kumaraswamy (2002) postulate that the goal of optimal risk management should be about minimising the total cost of risk of a project (not necessarily to each project party) and minimising risk itself (whichever party's risk it may be).

Within the case studies, significant variations were observed in the attitudes of the contractors in relation to their perceptions of risks associated with various SC solutions. In CS1, the contractor was reluctant to assume the risks associated with the design of the facility. As is evident from the following quote by the Trust respondent, there were attempts by both parties to pass off the responsibility to the other;

> *'What the designers try to do, what the contractors try to do is to constantly bring this back to us signing off their design. And we said that's not our job. Our job is to tell you what we want, the output that we want. It is your job to actually deliver that output. They hated that and they still do. But it's the very nature of the risk transfer of a PFI contract, whether that's a good thing or not is another matter. Because all it does is build up problems down the stream' – CL1*

This was in contrast to what was observed in CS2 and CS3, where the previous experience and attitudes of the contractors and design teams resulted in a positive attitude towards assuming risks associated with SC options. This is supported by the inferences made by Rahman and Kumaraswamy (2002). They state that factors such as, attitude and perception of parties towards risk, play an important role in determining how and to what extent the parties assume risks. Although, some risks can be considered as generic, their exact nature, extent and importance is very much dependent upon the context of a specific project and can vary as the project progresses. This makes risk allocation often an implicit process, which is dependent upon the qualitative judgment and past experience of parties (Rahman and Kumaraswamy, 2002).

8.3.1.3 Differences in Work Ethics between Project Parties

Different work ethics between project parties (for example,. between private and public sectors) was another cultural factor identified as having an impact on the success of the SC implementation process. This is especially relevant within the context of this research, as the PFI projects have public sector clients working together with private sector contractors. As was discussed in section 7.3.2, the different work ethics of project parties particularly affected the activities of the negotiation/ idea development phase. These differences include (Boyne, 2002);

i Bureaucracy (Public sector organisations in general have more formal and risk-averse decision making processes with little room for flexibility).

ii Red tape (This is regarded as a 'side-effect' of bureaucracy and implies and adherence to 'rules rather than results' and 'processes instead of outputs').

iii Managerial autonomy (Compared to the private sector, the public sector managers have little freedom to be reactive as they see fit to situations).

Furthermore, there are differences in the importance placed on values. Buelens and Van Den Broeck (2007) refer to research that indicate private sector put much higher value on economic rewards compared to the public sector. In CS2, efficient communication between parties (facilitated through regular project meetings) was useful in overcoming these inherent differences in work ethics between parties (refer to section 8.3.2.3).

8.3.1.4 No Blame, Collaborative, Positive Attitude to Problem Solving

The analysis revealed that the SC implementation process could benefit from a collaborative, no blame attitude to problem solving and decision making. Construction industry has often been criticised for its adversarial nature (Construction Industry Institute - CII, 2012; Bishop et al., 2008, Latham, 1994). Bishop et al. (2008) observe that the productive system of construction work effectively institutionalises hostility and forms a culture of distrust. In section 8.3.1.3 above, it was stated that SC incorporates a higher level of perceived risk for parties compared to traditional construction practices. All of these factors highlight the benefits of a collaborative, positive approach to problem solving when it comes to implementing SC project level. In CS1, such an approach helped the project team to get through a period of high stress brought upon by negative external influence factors during the negotiation/idea development phase. Here, the changes to existing legislation during the phase meant that the project parties had to work together in a collaborative manner to re-scope the project to meet the new legislative requirements. The activities during this re-scoping process were significantly facilitated by the collaborative, positive attitudes of both the client and contractor organisations. Accordingly, the parties succeeded in coming up with, what they perceived as a more efficient and user friendly design, as a result of the re-scoping process.

8.3.2 Organisational/Managerial Factors

Altogether, the analysis identified 10 organisational/managerial factors that influenced the SC implementation process. These factors are the result of the organisational structure, the management processes and leadership within the project team. The below sections discuss these factors in detail.

8.3.2.1 Top Management Support and Commitment

The analysis identified the significance of the support and commitment from top management of organisations as a factor facilitating the SC implementation process. In the case studies, this was found to be an important enabler throughout all the four phases of the SC implementation process. CS1 illustrated difficulties faced in gaining the commitment of top level management of the Trust at the conceptual phase to 'accept' the need to consider SC.

> *'It has been on occasion quite difficult to get the wider organisation to believe in climate change and to believe in sustainability and there are still quite a lot of people who don't think that it is real. So that's still an issue. Less of an issue now than say 3 years ago. Three years ago, when I put the strategy forward about CO_2 reduction there was a great deal of scepticism within the trust board itself about whether it really mattered, whether it was real. And even if it was real whether anything we could do would make a jolt of difference. So quite a lot of flat earth people' –CL1*

In this case, the project director for the Trust was faced with difficulties in getting the top management on board with the sustainability agenda, especially during the early years of the project. The analysis further revealed that improved awareness on sustainability issues could partly help to alleviate such resistance. On the other hand, in CS2, the enthusiasm and commitment demonstrated by the top level management from the Trust during the hand over/operational phase towards addressing issues such as energy efficiency, acted as a motivation to the other staff to adapt these practices as well.

Top management support and commitment is important to ensure that the SC implementation process is facilitated through resource factors as well as the other organisational/managerial factors. It further provides 'symbolical value' (Lindner and Wald, 2011) by motivating project team members to give due consideration to SC aspects by legitimising time and other resources devoted to it.

8.3.2.2 Integration and Alignment of SC and Project Objectives/Processes

The analysis found that the success of the SC implementation process was greatly improved on occasions where, SC objectives/processes were integrated into the generic project objectives/processes. The SC implementation process was even further facilitated, when this integration was carried out at the very outset of a project. CS2 provided a good example of early integration of SC and project objectives leading to positive outcomes. In contrast, CS1 illustrated the problems that could emanate from a failure to align SC and project objectives/processes at the outset of the project.

> *'One of the big issues that we are trying to take forward at the moment with the project company is trying to take forward sustainability initiatives, which we don't need to hit the energy targets and we don't need to hit the CO_2 reduction targets that are set in legislation at the moment. But I think we can do to improve even further our reduction in CO_2 production. So we have no solar panels. We have no wind turbines. We have none of the other things that you might expect. We don't even have a great deal in terms of automatic controls within the building for lighting, we don't have the extent of LED lighting that we might expect if we were designing the building now'* - *CL1*

The above findings are further supported by a research carried out by Swarup et al. (2011). After investigating 12 sustainable office buildings in the US, they have observed that early inclusion of SC strategies can have positive effects on achieving SC goals. Ryan (2004) has also observed that the incorporation SC requirements in output specifications as key to 'giving life to sustainability aspirations' within construction projects. In this respect, Value Management (VM) has been identified by some authors as a helpful mechanism to achieve commitment for SC at the early stages of the implementation process. In the UK, VM workshops are conducted at pre-brief, briefing, outline/final sketch design and pre-construction stages (Abidin and Pasquire, 2005) and therefore, could help ensure adherence to the SC agenda throughout the lifecycle phases. However, one important issue to keep in mind here is not to sacrifice SC initiatives for the sake of VM activities.

8.3.2.3 Communication Channels

The success of the SC implementation process was significantly facilitated by efficient and effective communication between project stakeholders. Effective communication channels are necessary to ensure that all project parties are in agreement in relation to factors such as, which SC objectives are to be addressed and to what extent should these objectives be addressed. Although it has been categorised under the organisational/management factor category, efficiency and effectiveness of communication channels is also partially determined cultural factors. An example of a facilitating culture enabling good communication channels was observed in CS3. Here, the respondent from the design team highlighted how a 'willingness to listen' and accommodate ideas and views on the part of the contractor facilitated idea generation in relation to SC. He stated that,

> *'So it was all this willingness to listen by the main contractor and the developer and participate and allow for all these issues' – DT3*

On the other hand, CS1 provided a good example of poor communication channels between the client and the design team during the negotiation/idea development phase resulting from a lack of managerial/organisational facilitation. Here, the client attributed the distance between them and the design team, which he referred to as 'a great source of frustration', to be an inherent characteristic of the organisational structure of the PFI procurement system. Such structural barriers can however, be overcome through organisational/managerial facilitation. A good example of using of such organisational/managerial facilitation to overcome the communication barriers due to 'distancing' of the client and design team was observed in CS2. Here, conducting regular, face to face meetings between the design team members and client's design advisors greatly facilitated the success of the negotiation/idea development phase of the implementation process.

The effectiveness and efficiency of communication channels also has an impact on other internal influence factors such as, the involvement and integration of project parties (section 8.3.2.4), learning and knowledge sharing within project team (section 8.3.2.8) and collaborative, positive attitude to problem solving (section 8.3.1.4).

8.3.2.4 Level of Involvement and Integration of Project Parties

The level of involvement and integration of project parties was another organisational/managerial factor identified as influencing the success of the SC implementation process.

The research found that in general, there were high levels of integration between contractors and design teams within the case studies, which was facilitated by the organisational/managerial structure of the PFI schemes. This was useful to ensure the buildability of the design and that the construction was carried out according to the design, without the contractor opting to go for cheaper alternatives. However, the investigation further identified that there were needs for improvement in the levels of integration of the other parties. Additional management facilitation is needed to achieve these improvements. It especially emerged that the respondents from the FM organisations were dissatisfied with their level of involvement within the SC decision process. This could be attributed to the differences in organisational sizes (and therefore, the levels of power and authority) of the contractor and FM organisations, who are partners in the project company. Involvement from FM is important to ensure not only that the buildings are managed and operated in accordance with the design, but also to ensure that the design is fit for operational needs of the facility. One respondent from a FM organisation noted that;

> *'Whilst these were being built, we saw a big variance between the amounts of operational input that went into the design. There are PFIs out there that the FM companies that run them think that the design is pretty poor for operation, primarily around access and things like that. That's one of the things that keep coming up' – FM2*

In addition, as discussed in section 8.3.2.3, the level of integration between clients and design teams (particularly within the context of PFI procurement) is also highly reliant upon the effectiveness of communication channels.

Use of integrated teams has been advocated by a number of parties to overcome the barriers within construction project environments caused by fragmentation. Fragmentation of parties within construction project processes is the result of a number of factors. Buildings, compared to most manufactured products have a longer life-span, which could be divided into several life cycle phases. Different construction project stakeholders play key roles during these different life-cycle phases (refer to section 7.3).

Depending upon the type of procurement method selected, this set up could mean that there is only a limited amount of interaction and coordination occur amongst the stakeholders that are involved in different phases of a construction. This could result in several drawbacks, such as disregarding life-cycle implications due to lack of input from different stakeholders (Cheng et al., 2008). Compounding the issue is the lack of a common language (Dammann and Elle, 2006) between these different parties.

In order to be considered fully integrated, a construction team needs to satisfy the following criteria (Baiden et al., 2006);

i. Have a single focus and objectives for the project.

ii. Operate without boundaries among the various organisation members.

iii. Work towards mutually beneficial outcomes by supporting each other and sharing achievements.

iv. Have the ability to make more accurate time and cost estimates utilising the collective skills and expertise of parties.

v. Freely share information amongst members without restricting access to specific professions and organisational units.

vi. Have a flexible member composition so that it can respond to change over the project duration.

vii. Offers the members the opportunity to contribute to the delivery process.

viii. Have equitable relationships and respect for members.

ix. Have a no blame culture.

The above could be aided by cultural and organisational/managerial facilitation on factors such as, efficient and effective communication channels (see section 8.3.2.3), continuation of project personnel throughout implementation process (see section 8.3.2.7) and collaborative decision making and problem solving (see section 8.3.1.4).

8.3.2.5 Engagement of Users and Local Community

Discussions in section 8.3.2.4 highlighted the importance of involving and integrating all parties within the construction project team in order to ensure the success of SC implementation process. This section focuses on the importance of involving the other project stakeholders, who are external to the project team. Foremost amongst these stakeholders are the end users of the facility and local community. Since the case studies in this research were hospital projects, the local community also represented the end users. The analysis of case studies identified, engagement of users from the early stages of the implementation process helped to improve the levels of user satisfaction achieved, by helping to identify and prioritise objectives of SC that are most important to the final users. CS1 provided an example of lack of user engagement within the early stages of the implementation process leading to a misalignment of user expectations and what was actually delivered on site (refer to section 7.3.2). On occasions, where the engagement of local community groups/end users was carried out successfully (as was the case in CS2), it emerged that this resulted in establishing a sense of ownership and involvement within the community towards the new facility. In addition, review of the available literature also suggest that engagement with end users has the ability bring about user-builder innovations (Slaughter, 1993 cited Rohracher, 2001).

8.3.2.6 Organisational Culture and Policies

The research identified that the culture and policies of organisations that formed the project team as an important factor that affected the success of SC implementation process. The uptake and implementation of SC was facilitated on occasions where, consideration of sustainability issues had been incorporated within the culture and policies of organisations. This was observed in both CS2 and CS3. For example, in the case of CS3, the contractor organisation had a high level of emphasis on SC embedded into their organisational culture and policies. The level of attention given to sustainability issues within the culture and policies of organisations also had an impact on shaping the attitudes and motivations of the individuals who are employees of those organisations. One example of this was the respondent from the FM organisation in CS1, whose attitudes towards SC was directly influenced by his company's policies. On the other hand, the interest and motivations of individuals towards SC sometimes resulted in organisational wide changes to the way the wider organisations looked at and approached sustainability issues. A good example was the project director of CS1, who put forward a paper to his Trust calling for wider recognition of sustainability issues in its practices.

8.3.2.7 Continuation of Project Personnel Throughout Implementation Phases

This is especially important to ensure linkages between the main phases of the SC implementation process. It was observed that continuation of project personnel helped in developing a sense of ownership and commitment in relation to the project within the project parties. In all three of the case studies, the high level project team members representing different project organisations, more or less remained constant from the conceptual phase until the hand over/operation phase. On occasions where a person left the project team, replacing them with another party who was already involved in or familiar with the project was found to result in the least level of disruption to the project team dynamics and the project processes. A good example of this was observed in CS2, the project director from the Trust, who left the project after the negotiation/idea development phase, was replaced by an existing project manager who was involved in the project from the initial stages. This ensured that the new project director was familiar with, not only the specifics of the project, but also the other project parties, resulting in a smooth transition with minimum disruption.

8.3.2.8 Learning and Knowledge Sharing Within Project Team

As previously discussed in chapters 6 and 7, there were instances where some members of the project team came into the project with no background knowledge in SD or SC. Several interviewees stated that they did not have any past experience or specific knowledge on SC, but learned of these as a result of being part of the project team. Therefore, ability to gain new knowledge and experience on SC issues emerged as an important enabler during the implementation process. The importance of KM was highlighted in section 6.3 in order to achieve this. The analysis identified effective knowledge sharing within a project team could be affected by several cultural, as well as organisational/managerial factors. These include, *inter alia,* parties' attitudes and commitment towards risk (section 8.3.1.2), communication channels (section 8.3.2.3), level of involvement and integration of parties (section 8.3.2.4) and the organisational cultures and policies (section 8.3.2.6). These aspects are further supported by Lindner and Wald (2011) who have identified, 'knowledge culture', 'management commitment', 'project culture', 'mistake tolerance' and 'informal networks' as important factors that affect the knowledge sharing within project teams.

8.3.2.9 Client Demand and Leadership

Client leadership is imperative to the success of any construction project. Accordingly, implementation of SC is also vastly facilitated by client demand and leadership. Client leadership in terms of SC should incorporate key considerations such as (adapted from Construction Clients' Group, 2008);

- Providing a clear vision for the project in terms of SC,
- Provision of adequate resources,
- Developing a detailed brief incorporating SC requirements,
- Setting clear SC objectives and 'definition of success' (i.e. performance measures),
- Championing of best practices,
- Clear collaborative procurement policy and,
- Working within the project team

In general, there was wide agreement amongst the interviewed contractors that client demand was a key driver for implementing SC within construction project environments. Due to the high capital costs associated with SC initiatives, the contractors were often concerned that incorporating such initiatives within bid proposals on occasions where there were no specific demand for these initiatives from clients, would negatively affect their competitive advantage. Other researchers have made similar inferences about the importance of client demand and leadership when implementing SC.

Pitt et al. (2009) have found client demand as one of the key drivers of SC. Similarly, Adetunji et al. (2003) have found that the clients and employees form the two highest ranking stakeholders when it comes to implementing SC. They postulate that the increasing number of green consumers is evidence of stakeholders using their buyer power on companies to exert pressure to be more sustainable (Adetunji et al., 2003). According to JCT (2009), there is a higher tendency amongst construction clients now, to shift away from focusing on lowest price towards evaluating bids on the basis of price and quality and other sustainability criteria. This is important because the lack of change in customer demand in this regard, reduces the supply chain's confidence to deliver innovative products (Innovation Growth Team, 2010). 'Agenda 21 on SC' has observed that 'measures to change market demand are the most promising method for achieving substantial change in market-oriented economies' (Du Plessis, 2002). However, in order for such an approach to be effective it is necessary that the consumers, or in this case the construction clients, are well informed and are aware of the available choices (Warnock, 2007). One down side to increased client demand is the danger of minimising SC to a mere 'PR tool'. As one interviewee observed;

> *'..some… clients … just fancy having a green building and knock the old one down because it's 'sexy.' You know it is good PR' -FM2*

The danger of the above approach is the tendency to pass off anything as SC.

As was discovered within the case studies, not all construction clients possess the ability to provide leadership to the SC implementation process and therefore, will rely upon the assistance of the rest of the project team to reach the project objectives (Construction Clients' Group, 2008). On such occasions, there is a need for the other project parties to take the initiative in leading the clients towards SC by educating them on the benefits (Pitt et al., 2009). CS1 and CS3 both lacked client leadership in relation to SC; in terms of developing clear project briefs incorporating SC requirements and setting clear SC objectives to be achieved at the outset of these projects. However, in the case of CS3, there was strong interest and motivation on the part of the project team (particularly the contractor and the design team) to incorporate SC into the project. They were able to lead the client towards taking on a number of SC initiatives. In contrast, in CS1 there was a lack of enthusiasm or interest from the contractor and design team to incorporate high levels of SC considerations into the project. The result was that the design was only carried out to meet the minimum regulatory requirements. Therefore, it is necessary to highlight that the client interest and leadership is only capable of taking things so far in terms of addressing SC issues in projects. In order to be successful, the clients' interest in terms of SC needs to be reciprocated by the other project parties. Selecting a project team that is facilitating and supportive towards addressing SC is important to ensure this.

8.3.2.10 Suppliers and Sub-Contractors Committed to SC

Success of the SC implementation requires the main contractor to take the lead in ensuring that the suppliers and sub-contractors are committed to SC. Good examples of this was found within both CS1 and CS2 as was discussed in section 7.3.3. Implementation of SC cannot be viewed in isolation from the supply chain or the sub-contractors involved. The use of subcontracting is commonplace within the construction industry, especially in large scale projects. The reliance on sub-contractors means that many main contractors only undertake the management and co-ordination activities during the implementation process. However, Humphreys et al. (2003) have observed that as main contractors have become more and more aware of the potential cost savings lying with the subcontractors, the prevalence of unfair practices has also increased.

8.3.3 Resource Factors

Altogether, four resource factors were identified as influencing the success of the SC implementation process through the analysis. Herein, resources mainly refer to the availability of funds and knowledge and expertise on SC issues. The following sections provide detailed discussions on these factors.

8.3.3.1 Cost/Funding Implications

The perceived high capital costs of SC options and availability of funding was a main resource related factor that affected the success of the SC implementation process. As previously mentioned in section 8.3.2.9, the high capital costs of some SC initiatives often prevented contractors from putting forward SC proposals at the bidding stage on occasions where these have not been specified by clients. As one respondent from the contractor side noted;

> *'There's a lot of capital involved in bringing the green initiatives into reality and the pay back is over 10, 15, 20 years. Therefore, to put a high capital cost in at the bid stage would make us not competitive' –CT2*

A similar observation was also made in relation to the design team members. Even though, most designers were willing to incorporate SC aspects into their designs, they were often constrained by the availability of funding.

> *'They don't want to build old, inefficient… most designers, their heart is in the right place although they can't always afford to' – FM2*

Indeed, the respondents from the design teams often noted that availability of funds was a major facilitator that encouraged the development of design proposals meeting high standards of SC requirements. As one design team respondent noted;

> *'They wanted high quality and there was a budget for that. And that was different from any other PFI I've worked in before or after'* – DT3

The general perception in the industry that SC requires higher capital investments than conventional buildings has also been identified within the literature as one of the foremost barriers to adopting SC (Robichaud and Anantatmula, 2011; Halliday, 2008). This increase in capital costs in delivering a more sustainable building compared to a conventional building has been quoted to be around 2% by Kibert (2008). However, a report to the California Sustainable Building Task Force has identified that this increase in investment could lead to life-cycle savings that are 10 times greater than the incremental cost increase (Kibert, 2008). In addition, a study on the PNC Firstside Centre, which is a 647,000 square-foot, environmentally and economically sustainable workplace in Pittsburgh, USA, has found that this building costs 20% less to operate than its traditional, comparably sized sister building located in Philadelphia (Lockwood, 2006). An opposing finding to these perceptions of high capital costs associated with SC initiatives has been made by Kuprenas (2010); who based on data collected from over 30 large, public sector educational building program projects, has come across the 'surprising discovery' of little cost impact when implementing green/sustainable measures.

The ability to make cost savings was one of the key factors driving the consideration of SC issues at project level (refer to section 6.2.2). However, van Bueren and Priemus (2002) note that as environmental costs are mostly external costs, market prices 'give wrong signals' to those that are taking decisions on SC. For instance, they state that 'the too low prices of current flows such as water and energy usually mean that investments to save on such flows are not cost effective'. Another factor to take into consideration in relation to this is the unequal distribution of costs and benefits between different players in the decision process. Typically in a building project, the stakeholders (such as, designers, contractors, investors) that are responsible for making the decisions on design and cost are not the ones to reap the benefits of those decisions (such as, associated cost reductions) during the operation phase (Cheng et al., 2008). This was particularly an issue within the context of the case studies, where the energy payments remained the responsibility of the public sector (i.e. the NHS Trusts). In such instances, building in measures within the project contracts (such as, pain share/gain share arrangements) were important for providing incentives for other project parties, to take such SC objectives into consideration. Commitment of project parties towards SC, as well as good communication and partnership attitude between parties are also important to overcome any barriers due to cost/funding issues.

8.3.3.2 Availability of Knowledge, Creativity and Innovation

As per the discussions in chapter 6, there are certain disparities and deficiencies in relation to the individual stakeholder interpretations of SC. Zou and Couani (2012) have found that the lack of expertise and limited creativity and innovation in relation to SC amongst design team members are two of the foremost factors acting as barriers to implementing SC. Similarly, Shelbourn et al. (2006) have also stated that achieving SC is not possible without new resources of knowledge and expertise. In particular, further knowledge resources are needed in relation to good practice, standards, enhanced process models, as well as, capacity development in decision making (for example, to enable taking into account, the contextual considerations in decision making). Shelbourn et al. stress that new modes of knowledge creation and management are important aspects in achieving the above mentioned. Indeed, recently there has been a joint call by the government and industry calling on firms associated with SC practices to share their knowledge and expertise in low carbon research, in order to create a knowledge database (Business Green, 2012). However, even when there is sufficient technical knowledge available, the implementation process could be ineffective if there is a lack of support from the cultural/managerial environment within the project team (refer to section 2.6.3).

8.3.3.3 Past Experience

The past experience of parties in relation to SC was another factor that affected the success of the SC implementation process. Although it did not emerge from the interviews that clients considered past SC experience of the contractors as a specific bid evaluation criteria in either CS2 or CS3, both of these cases benefited from the contractors' previous experiences in this respect. In comparison to CS1, in both the aforementioned cases, the contractor was observed to be more forthcoming in putting forward creative and innovative SC solutions (see section 8.3.3.2) and had less of a risk averse attitude when considering SC options (see section 8.3.1.2). In CS3, the contractor (who was originally from Sweden) benefited from previous experience in working in their home country, where incorporation of certain SC options was considered the normal practice. The respondent from the design team in CS3 noted;

> *'When I raised the question about windows, what about triple glazed windows?, their design manager said, for us in Sweden it's normal. It's more expensive to use double glaze because you have to special order. Standard production is triple glazed' (DT3)*

There was also some evidence of parties learning from both positive and negative experiences of SC implementation. Such experiences were observed to provide project parties with new levels of knowledge and confidence (for instance, in providing better leadership to address SC) to incorporate higher levels of SC initiatives into their new projects.

8.3.3.4 Training, Education and Development

SC, as a concept is still at its development stage within the construction industry. There is some level of confusion and disagreement within the advisory documents (refer to chapter 5), as well as amongst project stakeholders (refer to chapter 6) on what SC means and how it could be implemented within construction project environments. Within this context, the training, education and development of project stakeholders was identified to positively impact the SC implementation process.

Within the case studies, SC related training activities were mainly found to be carried out during the construction and hand over/operation phases. During the construction phase, providing training for site workers facilitated the achievement of certain SC objectives such as, health and safety, employing a skilled workforce, waste minimisation through recycling, etc. During the hand over/operation phase, providing training and education to building users helped in shaping user behaviour to ensure that the constructed facility is operated in an optimal manner to achieve the SC performance standards. In CS2, these training and education activities were further facilitated by the example of the top management of the hospital, who themselves went on training courses;

> *'And I think the good thing is that we are not resting. We are about to do a huge push on energy reduction from a house keeping perspective. Getting people to turn off their computers and that sort of thing. We have a big energy awareness week. We've got the chief executive and the chairman going on one of this carbon gym things' – CL2*

The analysis did not identify any specific or formal training and development activities to improve project parties' knowledge and understanding on SC issues during the earlier stages of the implementation process. However, there was some evidence of project parties' knowledge and perceptions of SC improving during these phases, facilitated mainly by factors such as, learning and knowledge sharing within project team (refer to section 8.3.2.7), organisational policies (refer to section 8.3.2.6) and the availability of guidance (refer to 8.3.4.3).

8.3.4 External Factors

In addition to the above discussed internal factors, five external factors were also identified through the analysis as influencing the success of the SC implementation process. These factors are discussed in detail below.

8.3.4.1 Legislation and Regulatory Environment

Legislation and regulatory requirements emerged as a strong driver for the uptake and implementation of SC throughout this research. For instance, in the case studies one driver for reducing energy consumption was the requirements set by the DoH in order to get business case approval for the projects. The Trusts had to demonstrate that the new builds were able to achieve the target levels for energy performance set by the DoH, as a prerequisite to proceeding to the next stage of procurement.

Whilst legislative and regulatory requirements were generally found to be a driver, the investigation also identified that sometimes efforts to address SC could be hindered by existing legislations. One such factor was the complexities of and incomparabilities surrounding some of these legislations/regulations. The main frustration in relation to the comparability between requirements was the number of different targets that had to be achieved, especially in relation to CO_2 reduction (refer to Appendix 4). As one respondent noted;

> *'But it is so complicated. It's been made so complicated that it's almost unmanageable in its complexity. We have to actually deal with two different carbon trading arrangements, one the EU carbon trading standards. And the other one, Carbon Reduction Commitment, which the Department of Energy and Climate Change have introduced. And to try and manage both of those at the same time is almost unattainable...' – CL1*

A further example of conflict between regulatory requirements was found in the case of CS3, which involved the refurbishment of an existing Victorian building. In this instance, the flexibility the design team had in what SC options could and could not be included was limited by the regulations protecting listed buildings.

8.3.4.2 Availability of Expertise (experienced contractors and consultants)

Availability of expertise in the form of contractors and consultants, with knowledge and experience on SC, was another factor that emerged as affecting the success of the SC implementation process. Engagement of external consultants can help alleviate drawbacks due to lack of in-house expertise, particularly for clients that are new to adopting SC practices. Zou and Couani (2012) recommend engaging specialists for activities such as specification writing, compliance monitoring, providing cost advice and training in such instances. In the case studies, there was lack of evidence of clients employing external consultants to specifically address SC issues during the conceptual phases. Whilst it was observed that the clients always employed consultants at this stage, this was in relation the general construction activities (i.e. design, engineering, costing). No consideration was given when selecting these consultants to assessing their ability to provide support and expertise on SC aspects. This was particularly an issue on occasions where clients lacked the previous experience in relation to implementing SC.

Similarly, as discussed in section 8.3.3.3, the availability of contractors with knowledge and experience on SC is also important to the success of the SC implementation process. This poses a problem, particularly within the context of PFI procurement, as the number of contractors with the capabilities and resources to bid for such projects is limited (refer to section 7.2). A survey by NAO (2009) has revealed that less than half the PFI project teams that were operational at the time were led by parties with previous PFI experience, let alone SC experience.

8.3.4.3 Availability of Guidance/Performance Measurement Tools

The availability of guidance and performance measurement tools was another external factor identified through the analysis as influencing the implementation of SC. In the healthcare sector, there is a minimum requirement for all new build projects to achieve a BREEAM rating of ‘excellent’ and all refurbishment projects to achieve a rating of ‘very good’. Such tools for measurement of SC provide a means of benchmarking best practice. Accordingly, the investigation identified that the project parties attributed high levels of achievements in these measurement tools with improved reputation of organisations. However, this association was also found to result in some poor practices, such as allowing the design to be led by the measurement tool criteria, without giving due considerations to specific contextual requirements of each project. This was identified as a particular pitfall in using guidance, particularly measurement codes such as BREEAM;

> *'Speaking for BREEAM, sometimes it's misused. Sometimes people use BREEAM to lead design rather than designing and measuring with BREEAM to see how sustainable your design is. If you use BREEAM to lead the design you'll end up in a mess' – CT2*

The danger in the above approach was that the ultimate design outcome, although may be rated high, may not be suitable for the context and or its intended purpose. In addition, there are other drawbacks associated with the BREEAM assessment process such as, difficulties in attaining high scores for refurbishments, ability for designers to 'play to the system' to obtain a rating regardless of the level of actual environmental benefits and not having provisions to weigh the SC solutions to the relative needs of specific sites and locations (NAO, 2007).

The extent to which the respondents found the available guidance easy to understand depended upon the background of the respondents. The project team members, particularly those from the Trust or FM side, who did not have a technical background, found some of the available guidance difficult to grasp at first. This was particularly an issue for the current project director from the Trust in CS2 (who initially came into the project with a catering background) and the respondent from the FM organisation in CS3 (who had a nursing background).

> *I personally won't* [refer to any advisory documents]. *I personally don't have that particular knowledge – CL2*

> *In the early days; I'm a nurse by back ground; I had to get a technical guy to explain them to me. But now after four five years on, I can actually grasp them a lot better than I did before. – FM3*

In these occasions they either opted to not refer to the documents themselves, relying upon other project team members with technical backgrounds to interpret them, and/or refer to the documents with the assistance of technical personnel.

8.3.4.4 Opportunities/Obstacles due to Local Context

The importance of considering the local context when implementing SC had been stressed throughout this thesis. The local context could present opportunities, as well as obstacles when it comes to implementing SC. The location of CS2, which was in close proximity to a large lake, for example, presented the project team of CS2 with the opportunity to consider including a lake source heat pump for this project.

The local contextual considerations also affect the determination of SC objectives to be prioritised during the initial phases (e.g. conceptual phase) of the implementation process. Both CS1 and CS2 were located in areas that have experienced economic depression owing to the decline of major local industries. Therefore, in the case of both these projects local economic regeneration was identified as a major consideration driving the need for a new hospital development. In CS1 for example, the new hospital was viewed by the Trust as providing an opportunity to 'boost the local economy' and a 'source of civic pride'. In both these cases, consideration of local community issues supported justification of the project in developing the business cases for the projects.

8.3.4.5 Perception of and Importance Attributed to SC Issues by the Public

The importance attributed to SC issues by the public was another external factor that influenced the implementation SC at project level. This factor also had an influence on a number of internal factors discussed within this chapter such as, the project parties' attitude, commitment and motivation towards SC issues, top management support and commitment and client demand. For example, in CS3, the contractor organisation of the PFI consortium at the time was new to the UK PFI market. The organisation saw the delivery of a more sustainable, innovative facility as a significant factor for breaking into the market. This resulted in the contractor organisation driving the design team and the Trust to consider SC aspects and deliver a facility to standards that surpassed the minimum regulatory and legislative requirements at the time. For instance, the project had achieved higher standards, when it comes to addressing certain aspects of sustainability (e.g. insulation) than those specified by the Building Regulations. As the respondent from the design team noted;

> *'It was their first PFI project in UK. So they were trying to break into the market. All this contributed to them being willing to discuss many things that otherwise wouldn't be discussed' – DT3*

It was evident that there was a certain amount of pride attached to achievements made in relation to various SC initiatives in case studies. For instance, in CS2, the SC aspects addressed within the project were viewed with a sense of pride by both the Trust and the contractor. As the respondent from the Trust observed,

> *'There's a certain amount of pride being a health care organisation when you can actually say you are doing something'*-CL2

This was also true in relation to the contractor organisations. Some respondents from the contractor organisations were particularly keen to refer to their organisations as the 'greenest' in the industry. This was used by them as a 'selling point' with future clients.

8.4 DISCUSSION AND SYNTHESIS OF FINDINGS

The above sections discussed internal and external factors that were identified to influence the process of implementing SC at construction project level through the analysis of case studies. In addition to this, the analysis of advisory documents also revealed some influence factors that affect the SC implementation process. This section presents a summary of these factors identified from the advisory document analysis. The influence factors derived through the advisory document analysis could be presented under six main categories as shown in Table 8.2 (Note: these categories were developed using the QCA approach discussed in section 4.7). These derived factors, which are discussed below, support the findings that emerged from the case study analysis.

Embedding SC during concept and development stages of project was mentioned in seven (i.e. 39%) documents. This category includes actions in relation to incorporating SC criteria in establishing the business cases for projects. Two documents highlight that establishing the need for the project is the first step in addressing SC. Establishing the business need for the proposed project, includes setting out a 'range of solutions that would meet the business objectives and justifying the proposed project'. This in turn will ascertain whether carrying out a construction project is actually the best way to meet a particular business need (OGC, 2005). However, within the case studies, although the need for the projects could be justified, compromises had to be made in relation to selecting the procurement approach. This was because the clients did not have a 'choice' in selecting the procurement approach due to the lack of public sector funds (refer to section 7.2). The documents also highlight the importance of all the project stakeholders being made aware of the project's SC objectives.

Table 8.2: Factors influencing the implementation of SC: Advisory document analysis findings

Factor category	Document Code																		Total
	M1-2011	M2-2010	G3-2009	R4-2009	R5-2009	P6-2008	G7-2008	R8-2007	P9-2007	M10-2006	P11-2005	G12-2005	P13-2004	G14-2004	G15-2003	G16-2002	M17-2002	G18-2001	
Embedding SC during concept and development stages of project						√		√	√		√		√		√		√		7 (39%)
Motivation and leadership from the project parties			√			√			√					√	√		√		6 (33%)
Stakeholder engagement			√	√		√	√		√		√		√				√		8 (44%)
Integration and involvement of parties			√			√			√					√	√		√		6 (33%)
Training and awareness						√		√	√				√		√		√		6 (33%)
Performance measurement and feedback			√		√	√		√	√		√		√		√	√	√		10 (56%)

A further 33% of the documents have highlighted that in relation to the project team, implementing SC calls for strong commitment and leadership from clients and construction team members. G18-2001 states that in order to promote SC within the industry as a whole, this leadership role should also involve the key clients and construction organisations disseminating information on progress that has been made in relation to SC in projects undertaken by them. In order to ensure commitment to SC, the need for selecting project team members with 'tried and tested levels of commitment and experience' not relying solely upon fee competition has also been highlighted.

The third category of actions in Table 8.2 is the consultation and engagement of stakeholders or all interested parties. Eight (i.e. 44%) of the documents have mentioned this. Herein, the term 'stakeholder' refers primarily to those stakeholders that are outside the project team (e.g. users, local community). It has been highlighted that adopting a 'one size fits all' kind of solution is not suitable as this will fail to robustly address the needs of each group of stakeholders. The engagement of stakeholders should be carried out in a timely manner to be effective. For instance, it is recommended that the members of the supply chain should be engaged at the earliest possible instance. Similarly, there should be representation from the demand side, especially from those involved in operating the building, at workshops from the early stages of the project.

It is also advised that the project teams should function in an integrated manner encouraging multi-disciplinary working amongst parties. The government's Strategy for SC (P5-2008) has set the target that 40% of the work of different parties of the industry (i.e. clients, consultants, main and specialist contractors, product manufacturers and suppliers) should be conducted through integrated project teams by 2012.

The next key set of factors was identified under the category of training and awareness. This includes improving the understanding and awareness on SC amongst the project team members, as well as the end-users of the facility. Documents recommend actions such as, providing induction, continuous professional development and awareness training events to achieve this. The employment of a fully trained and skilled work force in projects is also highlighted.

Performance measurement and feedback was the highest cited set of influence factors in the documents with 56% of the documents mentioning it. The factors included under this category included, *inter alia*; adopting appropriate indicators/standards allied to a systematic process of independent benchmarking at each stage of life cycle, benchmarking and sharing best practices and transparency about decision processes. Herein, a question arises as to which extent measurable or quantifiable targets can be set, particularly for some of the social aims of SC (see section 5.3.2.2). As a means of overcoming this issue some documents (for example, UK Green Building Council, 2009) have recommended measuring only those SC aspects that could be monitored and measured quantitatively until some form of quantitative measurements are developed for the other issues. However, this once again compromises the holistic nature of SC.

The influence factors derived under the above mentioned six main categories cover three cultural factors (i.e. IF1, IF2, IF4), seven organisational/managerial factors (i.e. IF5, IF6, IF7, IF8, IF9, IF12, IF13, IF14), three resource factors (i.e. IF16, IF17, IF18) and two external factors (i.e. EF1, EF3) identified through the case study analysis.

In addition to the above, some work has been carried out by a number of researchers that have identified influence factors when implementing SC. Du Plessis (2007) for example have proposed that implementation of SC is affected by three types of 'inter-dependent and multi-dimensional enablers' (see Figure 8.1). These include; (i) technological enablers, (ii) institutional enablers and (iii) enablers related to value systems (which include both how things are valued and the social, spiritual or moral values that guide decisions). Similar to this, van Bueren and Priemus (2002) note the barriers to the uptake and in turn the effective implementation of SC can be viewed from a technological and an institutional perspective. In comparing the three types enablers mentioned by Du Plessis to the findings from the grounded theory analysis some similarities could be observed. For instance, Du Plessis' technological enablers are similar to the resource factors identified through the analysis findings. The institutional enablers mentioned by Du Plessis are incorporated within the organisational/managerial factors identified through the analysis. Similarly, the value system enablers are incorporated within the cultural factors derived through the analysis. As Du Plessis has approached the categorisation of influence factors from a generic industry wide perspective, no differentiation has been made between the internal and external factors.

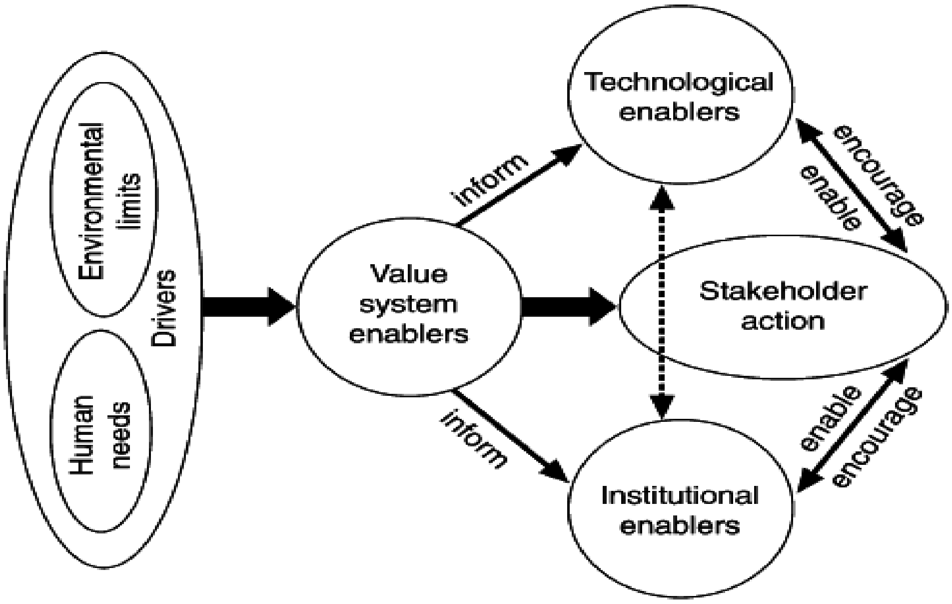


Figure 8.1: A strategy for enabling SC (Source: Du Plessis, 2007)

Sourani (2006) have put forward eight categories of factors that he declares as important for the UK public sector clients to better address SC when developing procurement strategies. These categories include; knowledge and perception factors, organisational and management factors, political and regulative factors, contractual factors, instrumental factors, logistical factors, strategic factors and financial factors. All of these categories, except contractual factors, correspond with the factor categories developed through the grounded theory analysis. The introduction of contractual factors is important for Sourani's study as he particularly looks at the integration of SC with procurement strategies. However, this study mainly looked at the SC implementation process from a managerial perspective. Therefore, factors such as 'establishing SC performance measures and standards' and 'establishing SC monitoring/reporting requirements and penalties/incentives' (that Sourani categorises as contractual factors) have been included as actions within the negotiation/idea development phase in this study (see section 7.3.2).

In addition, Pitt et al. (2009) have identified eight drivers and eight barriers SC that is available in literature. While he does not categorise these factors, they cover all four of the factor categories that emerged through the case study analysis.

The main differences between the factors identified by the above mentioned various sources appear to be two-fold. The first difference is in terms of the number of factors identified and their categorisation and the second relates the contextual differences between the studies. The influence factors identified within this study, as stated earlier, mainly relates to the process of implementing SC at construction project level. On the other hand, the factors put forward by Sourani relates specifically to the development of procurement strategies within public sector client organisations. The studies by Van Bueren and Priemus, Du Plessis and Pitt et al. have taken a generic industry perspective to the identification of factors. The factors identified through the analysis of advisory documents, on the other hand, show a mixture of perspectives. These contextual differences also affect the categorisation of identified factors as discussed above. This further reinforces the importance of contextual considerations in addressing SC as highlighted throughout this thesis. Therefore, considering the above, it could be postulated that the factors developed through this study provides a comprehensive picture of influence factors affecting the success of SC implementation process at construction project level that require managerial interventions.

8.5 SUMMARY

The activities and the decisions made in each phase of the SC implementation process (see chapter 7) are affected by two main sets of influence factors; internal and external factors. Altogether, 18 internal factors and five external factors emerged through the analysis. Higher level (i.e. national, industry level) interventions are necessary in order to effectively address the affect of the external factors on the SC implementation process. The internal factors require cultural, organisational/managerial and resource facilitation from the project level management. These factors identified through the grounded theory analysis were compared with the findings from the advisory document analysis as well as existing literature. The main differences between these different sets of influence factors pertain to the number of factors identified and the context within which the factors have been identified. The influence factors identified through the grounded theory analysis mainly relates to the management of the process of implementing SC within a construction project environment. Overall, this chapter (together with chapter 7) fulfils the fifth objective of the research.

The aim of this research involves understanding the interpretation of SC and developing a framework that can assist in its effective uptake and implementation within construction project environments. Chapters 5 and 6 mainly addressed the first part of this aim (i.e. the interpretation of SC), whereas chapters 7 and 8 addressed issues in relation to implementing SC. The next chapter uses the findings in relation to the above to develop a framework for the uptake and implementation of SC within a construction project environment.

CHAPTER 9: DEVELOPMENT OF A FRAMEWORK FOR THE UPTAKE AND IMPLEMENTATION OF SUSTAINABLE CONSTRUCTION WITHIN CONSTRUCTION PROJECT ENVIRONMENTS

9.1 INTRODUCTION

The aim of this research, as stated in section 1.2, is to understand the interpretation of SC and to develop a framework that can assist in its effective uptake and implementation within construction project environments. This chapter therefore, presents the proposed framework addressing the uptake and implementation of SC within construction project environments. This fulfils the sixth and final objective of this research. The findings and key conclusions from chapters 5, 6, 7 and 8 are used to justify the need for the proposed framework and to develop its component areas. The developed framework aims to provide the project parties with a comprehensive level of understanding on the concept of SC, as well as the requirements for its successful implementation at project level. This chapter also discusses the validation of the developed framework through interviews with members of the academia and industry practitioners.

9.2 ASSESSING THE NEED FOR A FRAMEWORK

The construction projects have a variety of stakeholders who are involved in the decision making process when it comes to implementing SC at project level. These stakeholders come from different backgrounds and therefore, have varying degrees of knowledge and understanding on SC (see section 6.3). These project stakeholders' understanding of SC has not yet being fully facilitated through the range of advisory documents available. There is no comprehensive picture of SC provided in the advisory documents addressing the characteristics, objectives and actions to be considered in implementing SC (sections 5.3.1, 5.3.2 and 5.4). Furthermore, there is a perception amongst some stakeholders that SC is achieved just by fulfilling mandatory legislation/regulation targets (for example, in relation to carbon and energy) that have been set at sector (e.g. healthcare) and/or national level for the industry (section 7.2). However, it is apparent from the discussions in section 6.3 that these mandatory targets only set out minimum base level requirements and do not facilitate achieving SC in any substantial way. Hartman (2012) for example, observes that the reductive approach of building regulations and certification systems has diminished SC to a series of checklists and credits. Therefore, the current situation in relation to the uptake and implementation of SC could be facilitated through a framework that could help in broadening the project stakeholders' views in relation to SC. This requirement was further validated by the fact that the project stakeholders identified a wider range of SC objectives as being important, when presented with a comprehensive list at the end of the case study interviews (refer to section 6.4).

The emergent framework of the SC implementation process brought to light the interconnected nature between the activities within the process phases and the influence factors that affect the success of these activities. The lack of attention given to fulfilling all the activities within the phases and effectively managing the influence factors was observed to bring about poor or sub-par levels of achievements in terms of SC. Whilst some of the identified influence factors are external to the construction project, most are internal project factors and are therefore, within the control of project management (refer to chapter 8). A pro-active approach by the project management is necessary to minimise the effect of negative influence factors (i.e. barriers) and maximise the effect of positive influence factors (i.e. enablers).

The above discussions make it apparent that there are inefficiencies and clear room for improvement in the 'uptake' and 'implementation' of SC within the context of construction project environments. Herein, the term 'uptake', as stated in section 3.3, refers to the understanding and comprehension of SC issues by project parties, whereas, 'implementation' refers to practical measures that are required in addressing those issues.

Ugwu and Haupt (2007) highlight the lack of flexible user-friendly tools for decision support as contributing to the gaps in implementation of SC. Similarly, Adeyeye et al. (2007) have observed that it would be useful to have a guidance document, which could provide a 'quick guide' for construction professionals on practices and techniques required to meet SC requirements. A review of available frameworks addressing issues in relation to the uptake and implementation of SC (see Augenbroe et al., 1998; Matar et al., 2008; Hill and Bowen, 1997; OGC, 2005; Khalfan et al., 2006) revealed that there is a lack of a comprehensive framework adequately addressing all of the aforementioned issues. A key issue with all the reviewed models and frameworks was the lack of integration with the strategic (i.e. national) level objectives for SC (refer to section 3.4). This is particularly important in order to ensure that what is achieved in terms of SC at construction level is in line with the goals for SC (and in turn SD) set at strategic level.

Considering the above discussions, it is clear that there exists a need for a holistic, comprehensive framework addressing the issues relating to both the uptake and implementation of SC. Such a framework should be clear and easily understood by a variety of stakeholders with diverse backgrounds, who are involved in the different phases of the implementation process. The framework should also have a means of aligning and integrating the project level objectives and actions for SC with the objectives/goals set at larger scales (i.e. local, regional, national).

9.3 THE PROPOSED FRAMEWORK FOR UPTAKE AND IMPLEMENTATION OF SC

This section presents the proposed framework for the uptake and implementation of SC within a construction project environment (see Figure 9.1). The framework consists of four main component sections. The first section addresses the wider contextual factors that affect the uptake and implementation of SC within a construction project environment. The understanding and appreciation of these contextual factors facilitates the understanding of SC, which is addressed through the second section of the framework. How this understanding is transformed into project level actions are addressed through the third section of the framework. Finally, the fourth section of the framework presents the influence factors that affect the process of implementing SC. The framework also highlights the need for feedback, not just at project level, but also from project level to national level. Discussions on each of these sections are provided within the following sections of this chapter.

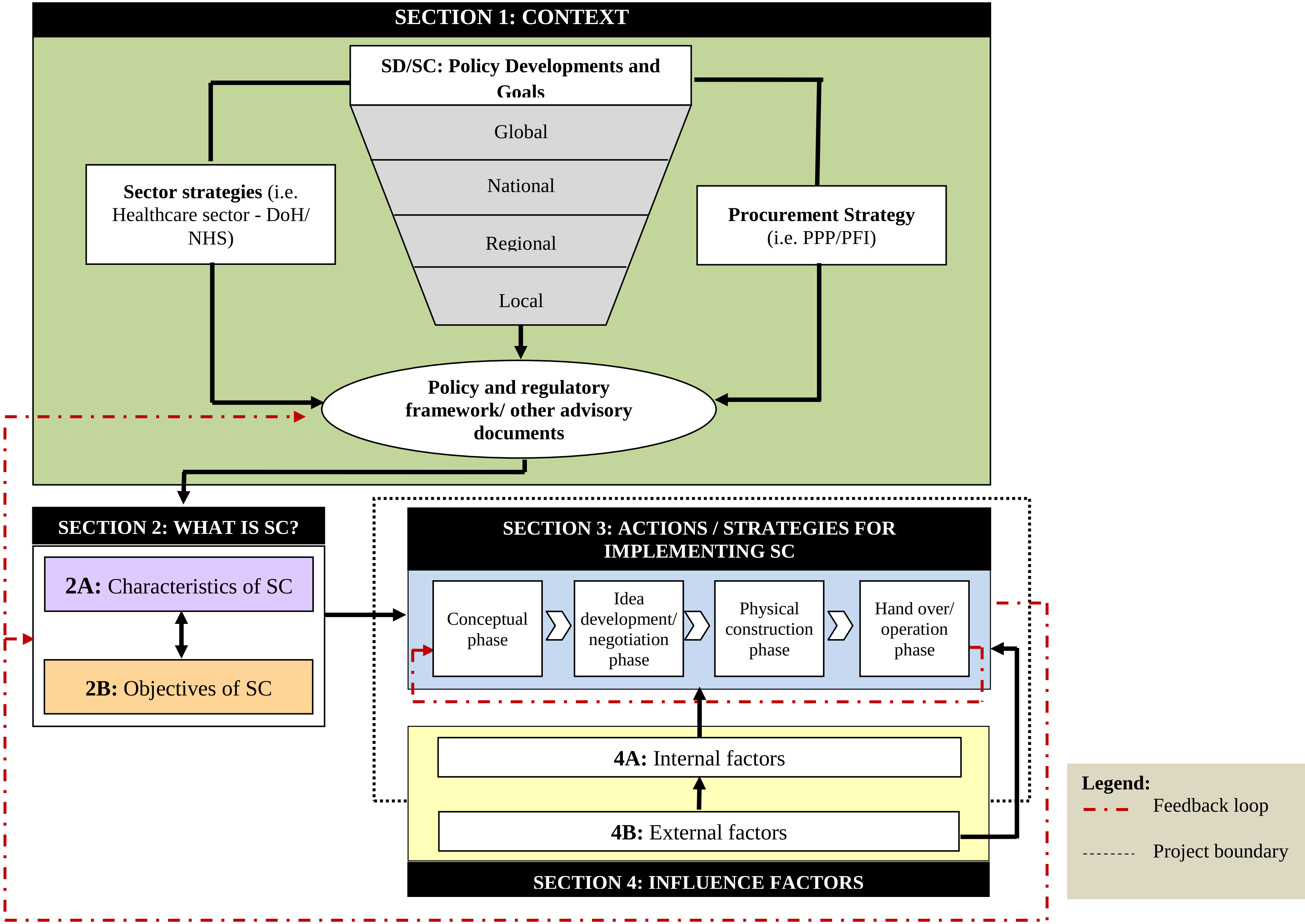


Figure 9.1: Proposed framework for uptake and implementation of SC

SECTION 1: CONTEXT

What is it?

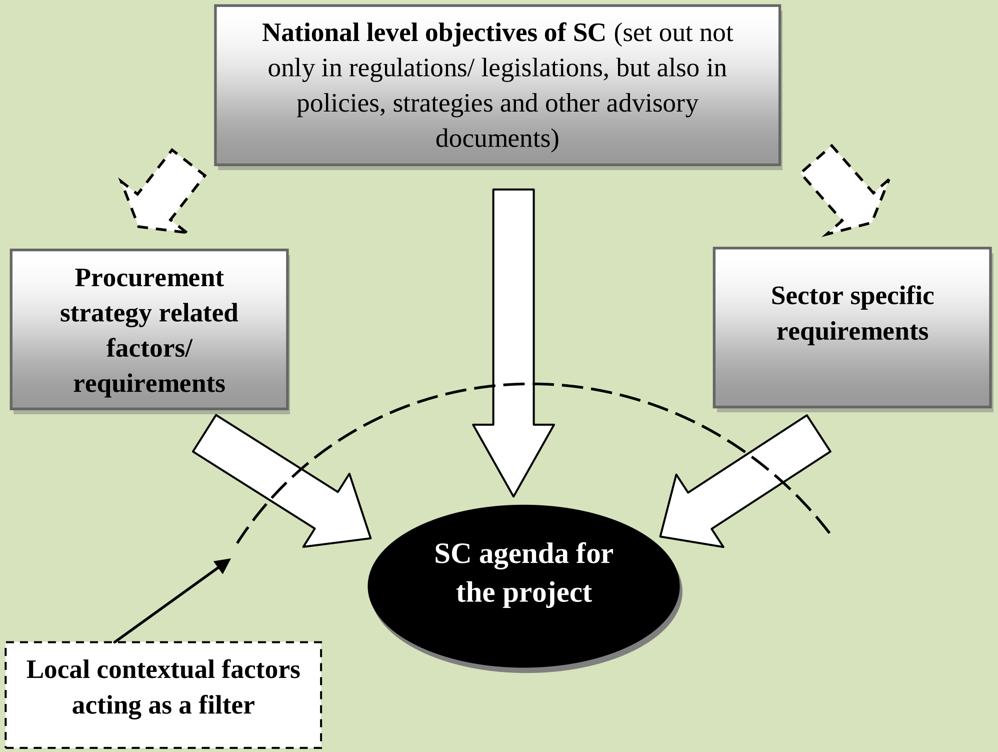
- This section of the framework highlights the contextual factors that affect the uptake and implementation of SC within a construction project environment.
- Main contextual factors identified are; national level SC objectives, sector specific SC requirements and procurement strategy related requirements. The local context of a project acts as a filter between the above considerations and the project level.

Who should do it?

- There is a need to assign responsibility to a project team member (preferably from the client organisation) to collate a list of SC advisory documents that are relevant for the project and disseminate these to all the project parties. This should be done at the outset of the project, as part of communicating client requirements in terms of SC.
- The responsible person could be the project director, sustainability champion or the procurement manager for the client side.

Limitations to avoid

- The blind application of the requirements/suggestions set in the collated documents should be avoided. The documents (particularly, the measurement tools) should not be used to ‘lead’ the design. Instead, the suitability/ applicability of the requirements set in these documents to the specific context of each project should be evaluated.



SECTION 2A: THE MAIN CHARACTERISTICS OF SC	
➢ **Addresses three primary elements; environmental, social and economic**	These primary elements of SC are also known as 'dimensions', 'three pillars' or 'triple bottom line'. The issues to be addressed under each element are often inter-related and not mutually exclusive. In other words, each element 'overlaps and relates with the others', so that decisions taken with regards to one element will have implications on the others.
➢ **Holistic approach aimed at synergy and not compromise**	A holistic approach to SC should incorporate the following (Adapted from Hardi and Zdan, 1997); ▪ The whole system as well as its parts ▪ The well-being of social, environmental and economic elements and their component parts and the interaction between parts (these have been included in section 2B as indicators and objectives of SC). ▪ The positive and negative consequences of construction activities in monetary, as well as non-monetary terms, reflecting the costs/benefits to humans and environment. Making compromises between the issues to be addressed should be avoided where possible. This will help to achieve SC in a balanced way and optimise benefits. However, on occasions where trade-offs become necessary, it is recommended that 'open and explicit attention to the reasoning behind trade-off and compromise decisions' are made available (Kemp et al., 2005).
➢ **Consider the local context**	The objectives to be achieved under each element of SC are 'context dependent'. They should reflect the local circumstances, needs and priorities and therefore, will vary from project to project. Judgment and interpretation on the part of the decision-makers plays a key role in identifying issues to be addressed, as well as, prioritising them. Moreover, this means that there is no 'right answer' to be achieved when it comes to implementing SC. The final outcomes will be shaped by not only the legislative and regulatory requirements but also the perspectives and requirements of clients and other stakeholders.
➢ **Consider whole life cycle of construction**	SC should consider the life cycle of the 'construction' as opposed to the life cycle of the 'project'. Hence, the impacts (in terms of environmental, social and economic elements) as well as user requirements should be addressed through a whole life cycle perspective.

SECTION 2B: IDENTIFICATION OF SC OBJECTIVES

Introduction:
This section of the framework presents a comprehensive list of SC objectives to be addressed under each of the three main environmental, social and economic elements of SC. These objectives are presented under different environmental, social and economic 'indicators' for ease of reference. These indicators and objectives have been developed at a generic level and are hence, applicable to all types of construction projects. Attention should be given to the contextual factors given in section 1 and characteristics of SC given in section 2A of this framework in selecting and prioritising SC objectives.

Priority level: The priority level of each indicator (and in turn the objectives), should be determined by the client at the conceptual stage. These prioritised indicators and objectives should be clearly communicated to the rest of the project team at the end of this phase.

Performance measures: Where possible, it is important to establish performance measures for each objective, in order to facilitate performance monitoring, measurement and reporting. Setting of performance measures should not be a one sided task undertaken by the client. Rather it should be done in collaboration with the project team.

E1: ENVIRONMENTAL ELEMENT OF SC

Indicators	Objectives	Priority level				Performance measures
		Very important	Important	Desirable	Not important	
1.1 Carbon and Energy	1.1.1 Achieve zero-carbon in new builds 1.1.2 Reduce carbon emissions 1.1.3 Use energy efficiently 1.1.4 Monitor/reduce energy consumption 1.1.5 Use renewable energy 1.1.6 Generate energy on site					
1.2 Waste	1.2.1 Reduce impact of waste 1.2.2 Prevent/produce less waste 1.2.3 Recycle/reuse materials 1.2.4 Reduce amount of waste sent to landfill					

1.3 Pollution (water, air, land, noise, light)	1.3.1 Minimise risk of water pollution 1.3.2 Improve air quality 1.3.3 Reduce nuisance 1.3.4 Prevent/reduce impact of emissions 1.3.5 Minimise spatial pollution 1.3.6 Reduce air pollution 1.3.7 Minimise light pollution at night					
1.4 Biodiversity	1.4.1 Protect and enhance biodiversity 1.4.2 Practice habitat creation and restoration 1.4.3 Avoid threats to local environmentally sensitive sites, sites of special scientific interest and protected species 1.4.4 Consider long term impacts of construction on bio-diversity 1.4.5					
1.5 Water	1.5.1 Encourage efficient use 1.5.2 Monitor consumption 1.5.3 Use environmentally friendly water supply systems 1.5.4 Encourage water recycling					
1.6 Materials	1.6.1 Minimise use 1.6.2 Maximise utilisation 1.6.3 Local sourcing 1.6.4 Reuse and recycle 1.6.5 Use of secondary or recycled materials 1.6.6 Use of sustainably sourced materials 1.6.7 Use low energy materials 1.6.8 Use of renewable materials 1.6.9 Use of low maintenance materials 1.6.10 Avoid materials harmful to environment and humans					

1.7 Transport	1.7.1 Reduce amount of congestion/transport 1.7.2 Promote use of public transportation 1.7.3 Limit land required for roads and car parks 1.7.4 Reduce car use 1.7.5 Promote sustainable travel choices					
1.8 Climate change adaptation	1.8.1 Adoption of flood and coastal erosion risk management approaches 1.8.2 Ensure resilience and adaptability to climate change					
1.9 Land use	1.9.1 Encourage the use of most appropriate sites for development 1.9.2 Protect areas of natural beauty 1.9.3 Encourage a mix of land uses					
1.10 Landscape	1.10.1 Provide quality landscaping to improve ecological value					

E2: SOCIAL ELEMENT OF SC

Indicators	Objectives	Priority level				Performance measures
		Very important	Important	Desirable	Not important	
2.1 Health and wellbeing	2.1.1 Reduce the incidence rate of fatal and major injury accidents 2.1.2 Improve working conditions 2.1.3 Reduce cases of work related ill health 2.1.4 Provide Occupational Health Support on projects					

2.2 Local community/ stakeholder relations + impacts	2.2.1 Consider the needs of local communities 2.2.2 Fully engage the local community in the development process					
2.3 Social cohesion, inclusion and equal opportunities	2.3.1 Providing equal opportunities in employing ethnic minorities, women and disabled people 2.3.2 Foster better social relations 2.3.3 Respecting and treating stakeholders equitably					
2.4 Customer/ user satisfaction	2.4.1 Ensure customer/end user requirements are met 2.4.2 Ensure usability of systems					
2.5 Culture and heritage	2.5.1 Enhance or preserve existing culture and heritage 2.5.2 Sympathetic to local styles of architecture 2.5.3 New developments to reflect the cultural/historic context of area					
2.6 Accessibility	2.6.1 Ensure equity by enabling all in society to have access 2.6.2 Access to green space					
2.7 Crime prevention and security	2.7.1 Minimise opportunities for crime/ provide safe environment for residents					
2.8 Quality of life	2.8.1 Improve quality of life now and for future generations					

2.9 Aesthetic and visual impacts	2.9.1 Attractive high quality developments (attractive building detailing, choice of materials)					
2.10 Internal environment	2.10.1 Ensure indoor air quality 2.10.2 Provide visual comfort 2.10.3 Provide thermal comfort 2.10.4 Ensure acoustic performance					

E3: ECONOMIC ELEMENT OF SC

Indicators	Objectives	Priority level				Performance measures
		Very important	Important	Desirable	Not important	
3.1 Whole life value	3.1.1 Consider whole life value of constructed facility					
3.2 Training/ education	3.2.1 Provide training/education on SC issues to project stakeholders 3.2.2 Disseminate knowledge and best practice					
3.3 Local economy	3.3.1 Ensure viability of local business 3.3.2 Promote economic regeneration 3.3.3 Support local trades and businesses during construction activity 3.3.4 Generate employment/training prospects					
3.4 Profitability	3.4.1 Improve profitability of project					
3.5 Future adaptability and reuse	3.5.1 Reduce risk of obsolescence					
3.6 Business opportunity	3.6.1 Improve business opportunities					
3.7 Competition	3.7.1 Improve competition					

SC IMPLEMENTATION PROCESS AND INFLUENCE FACTORS

Phase		Conceptual phase	Idea development/ negotiation phase	Physical construction phase	Hand over/operation phase
SECTION 3:	ACTIONS	▪ Establish need for SC ▪ Identify and prioritise SC objectives ▪ Emphasise importance of SC (E.g. Outline business case, OJEU notice, Output specification - desirable/expected outcomes) ▪ Evaluate market capabilities and generate interest	▪ Maintain focus on SC throughout negotiations ▪ Selection of supportive and facilitating project team ▪ Engage FM, end-users, local community, supply chain ▪ Agreement on SC objectives ▪ Idea generation ▪ Idea acceptance + development ▪ Establish SC performance targets/penalties/incentives ▪ Establish SC monitoring and reporting requirements	▪ Detailed programme and methodology to address SC objectives (E.g. technological innovations, material procurement, logistics, waste management, safety, etc.) ▪ Sub-contractors and suppliers committed to SC ▪ Monitor, record and report on SC performance, standards and quality ▪ Local community – keep informed ▪ Provide training + education on SC to site workers	▪ Provide training for users ▪ Engage with users to ensure satisfaction of services delivered ▪ Monitor, measure and report on SC performance ▪ Continuous improvement of performance ▪ Internal + external dissemination of knowledge and experience ▪ Contact with media
SECTION 4A:	Internal factors	▪ Top management and wider organisation support/ commitment ▪ Client championing and leadership on SC ▪ Knowledge/understanding on SC ▪ Cost/funding implications ▪ Previous experience	▪ Partnership culture within project team ▪ Communication channels ▪ Perception +attitude towards risk ▪ Level of involvement and integration of parties ▪ Differences in work ethics (e.g. between pvt and public sectors) ▪ SC championing ▪ Attitude and motivation towards SC ▪ No blame, positive attitude to problem/conflict resolution ▪ Knowledge of contractor and design team ▪ Past experience ▪ Cost +budget allowances ▪ Organisational culture+ policies	▪ Contractor's organisational culture ▪ Attitudes and motivation towards SC ▪ Knowledge/creativity/ innovation potential of contractors ▪ Past experience ▪ Cost + budget allowances ▪ Contractor's organisational policies	▪ Continuation of personnel from previous stages ▪ Appointment of a dedicated sustainability manager ▪ User attitudes and motivation towards sustainability issues ▪ Top management example + leadership ▪ Educating users+ staff
SECTION 4B:	External factors	▪ Procurement method related factors ▪ Local context ▪ Statutory and legislative environment ▪ Availability of experienced contractors ▪ Market demand ▪ External consultants with SC expertise	▪ Opportunities +obstacles due to project location ▪ Availability of experienced contractors ▪ Availability/access to knowledge + innovation ▪ Legislation and policy requirements + changes	▪ Legislation + regulations ▪ Taxes and levies (e.g. Landfill Tax, Aggregate Levy) ▪ Availability of voluntary schemes (e.g. Considerate Constructors) ▪ Importance +perception of SC issues held by public	▪ Changes to user needs ▪ Availability of SC performance measurement schemes ▪ Technology changes + advancements

9.3.1 Section 1: Contextual Considerations

According to the Agenda 21 on SC (Du Plessis, 2002), 'there is considerable evidence to suggest that the dominant driving forces for [SC] will remain external to the construction industry'. Therefore, this first section of the framework lays out the wider contextual considerations affecting the uptake and implementation of SC at construction project level.

At the highest level amongst the wider contextual considerations driving forward the SC agenda is the profound focus placed upon the goals of SD at the global level. In the Rio+20 conference held in June 2012, seven priority areas were highlighted as needing special focus in moving towards SD. These include decent jobs, energy, sustainable cities, food security and sustainable agriculture, water, oceans and disaster readiness. The construction sector has direct impacts on a majority of these focus areas; including decent jobs, energy, sustainable cities, water and disaster readiness. These high level goals for SD are to be pursued at different spatial scales (i.e. national, regional and local) (Fischer et al., 2007; Mehta, 2009). However, it is stressed that there should be a level of cohesiveness between the goals set at these different levels.

The intense international focus has resulted in making SD a central issue when it comes to policy development in many countries, including the UK. At present, the UKs commitment to certain aspects of SD has gone beyond being mere policy objectives to legal obligations. One example is the target to reduce the GHG emissions by at least 80% by 2050. The high level of emphasis that has been placed on SD at national level in the UK during the past two decades is being continued by the coalition government. There is expressed commitment by the coalition to take SD from being a 'separate green issue' that is the focus of a few government departments to a core strategic issue (DEFRA, 2011). As a first step towards achieving this goal, recommendations have been made in the publication 'Mainstreaming Sustainable Development' (DEFRA, 2011) that the Environmental Secretary will sit in the key Cabinet Committees on domestic policy (including the Economic Affairs Committee).

All of this attention towards SD, both at global and national levels, has resulted in a high level of focus been placed on the construction industry in attaining the goals of SD. Within the UK, a number of key industry reports (for example, Low Carbon Innovation and Growth Team, 2010 and UK Green Building Council, 2009) have stressed the need for best practice within the industry to ensure that the aforementioned SD goals are met. However, the present economic climate means that the construction industry is required to take on various initiatives to address SC, whilst at the same time facing a slowdown of the economy. There is evidence that the current economic climate has indeed affected the construction industry activities negatively. For instance, as the largest client of the industry, the spending cuts in government has meant that around 280,000 jobs has been lost since 2008 in the sector (GVA, 2011). Despite this slowdown of the economy, the pressures remain for the industry to address SC issues, particularly in the face of legally binding commitments. The result has been an increasing number of different government policies, initiatives, incentives and other advisory documents on SC that has been identified by some as a source of confusion for project level stakeholders in implementing SC.

Project level implementation of SC is further affected by the procurement strategy adopted in acquiring a particular facility. Depending on the type of procurement strategy chosen, there could be particular enablers or barriers acting upon the SC implementation process. For example, there is a wide spread perception that PFI procurement present greater scope for effectively addressing SC issues (Bosher et al., 2007; National Audit Office - NAO, 2007). This is due to a number of reasons, such as the large scales of investments involved, the ease of influencing the small number of parties and the long-term involvement of contractors (refer to section 4.8.2.3). The Green Alliance (2004) is of the highly optimistic view that PFIs have the ability to transform the whole of UK's construction sector towards greater overall sustainability. On the other hand, some authors have criticised PFI as an inefficient way for governments to finance the public projects (Bosher et al., 2007). However, PFI procurement provides an opportunity for the procuring authorities to give consideration to long-term investment needs not being constrained by the short-term affordability issues. Therefore, in theory, PFI allows more scope to implement SC options, by justifying any high up-front costs (i.e. capital costs) through VFM gains over the life of the construction. However, as Green Alliance (2004) observes SC has not yet been sufficiently embedded within the PFI process. This means that any success in terms of SC achieved within these projects could be largely attributed to the commitment, motivation and expertise of the project parties involved (refer to section 8.3.1.1).

In the UK, PFI procurement is been employed by various sectors. These different sectors have different priorities and user requirements, which will in turn affect the prioritisation of SC objectives. Different mechanisms also exist in these different sectors for money allocation, as well as guiding and monitoring outcomes (Green Alliance, 2004). The healthcare sector (from which the case studies of this research were drawn from) provides an interesting testing ground for exploring uptake and implementation of SC (see section 4.8.2.4). However, whilst a lot of emphasis has been placed on making the operations of the health sector more sustainable, relatively less attention has been given to the SC of healthcare infrastructure.

Considering all of the above, it is clear that the issue of uptake and implementation of SC within a construction project environment cannot be looked at in isolation. All of the above mentioned contextual factors will have an influence in determining the SC agendas to be followed at project level. This means that the project stakeholders need to appreciate and be aware of these wider contextual factors, when making project level decisions in relation to SC. The first section of the proposed framework, therefore, draws attention to these contextual considerations. These considerations discussed above could be summarised as;

- The global and national level developments and goals on SD, which will in turn be filtered through to the construction sector through policies and other advisory documents on SC.
- The sector (e.g. healthcare) specific requirements in terms of SC.
- Procurement strategy (e.g. PFI) related factors.
- The local conditions (e.g. opportunities/barriers presented due to location of project such as site conditions, local community needs and local planning regulations) that determine the applicability of the above mentioned three contextual factors to a particular construction project.

Therefore, awareness of these factors, as well as their potential impacts is important to successfully undertake and manage the process of uptake and implementation of SC. During this process, any construction project should have an assigned person who is responsible for identifying and aligning all aforementioned requirements to achieve the goals of SC. This responsible party should identify the policies and regulations on SC to be considered for the project and should then disseminate them to the stakeholders involved in the project. This will help provide clarity around the aforementioned contextual factors to the project parties. The assigned person can be the project director, the procurement manager or a champion/expert on SC from the client side. The person responsible should also make sure to keep up to date records of the policies/regulations and circulate them when changes occur in the wider context (i.e. sector level, national level, etc.). This will help overcome the problems faced in CS1, particularly in relation to the disagreements between client and design team/contractor on some of the guidelines and regulations used in designing the facility.

9.3.2 Section 2: Understanding SC

The effective uptake and implementation of SC is not possible without the stakeholders responsible for decision making, properly understanding the concept of SC. Insufficient understanding on SC could result in many claiming their opinions/actions as sustainable without having to substantiate them with comprehensible arguments in relation to the nature or characteristics of SC (Christen and Schmidt, 2012). Such an understanding should first emanate from a comprehension of the characteristics or nature of SC (see section 9.3.2.1). This understanding of the characteristics of SC should in turn form the basis upon which objectives of SC are set for a particular construction project (see section 9.3.2.2). Hence, Section 2A of the proposed framework aims to provide the project parties with a comprehensive view on the nature (i.e. characteristics) of SC, which would in turn lead on to the delineation of the objectives of SC within Section 2B of the framework.

There is some evidence suggesting that there is a lack of understanding or poor interpretation of policies and guidance by stakeholders at project level (Carter and Fortune, 2008; Cox et al., 2002). This was further corroborated by the case study findings presented in chapter 6. Hence, there is a clear need for providing project stakeholders with improved understanding on the aforementioned issues in relation to SC. This could be facilitated at the national or industry level by providing education and training programmes on SC issues to the construction industry professionals. Some training programmes focusing on specific aspects of SC are currently being conducted by institutions such as, BRE. However, there is a need to compliment these courses on specific issues with others aimed at providing a comprehensive, overall picture of SC. This training and development should address not only the technical skills and know-how, but also the non-technical skills requirement of project parties. A survey amongst employers of construction professionals has revealed that almost two thirds of organisations felt that SC had brought about little or no change in the skills requirement of construction professionals (Sayce et al., 2009). However, discussions in sections 8.3.1.1 and 8.3.3.2 make it apparent that successful uptake and implementation of SC is facilitated by a specific set of knowledge, skills and attitudes of project parties. Sayce et al. also postulate that the above view of construction employers will change with time, as awareness and understanding on SC improve. Such a change in expectations and requirements of employers will in turn require the Higher Education Institutions (HEI) to rise to the challenge, by equipping graduates with the relevant knowledge and skills required to maintain employability (Sayce et al., 2009). In addition, a study by Lourdel et al. (2005) comparing engineering students' perceptions of SD before and after a training course on SD has found that the students' visions of the concept became richer and broader following the training. They note that before the SD course the students mainly focalised on environmental and economical aspects, whilst after the course an increased number of words were quoted covering issues such as, social and cultural aspects, the stakeholders, the principles of SD, as well as making allusions to complexity, temporal and spatial dimensions. Therefore, it is recommended that the training and education programmes on SC should cover the following aspects;

- Providing a broad and balanced understanding of SD, including key debates surrounding the concept.
- Providing a foundation of environmental, social and economic context and impacts of construction.
- Developing the ability to work and function creatively within interdisciplinary contexts.
- Developing skills for holistic thinking, problem-solving and change management.
- Developing abilities to incorporate and justify qualitative as well as quantitative criteria in decision making.

SC as a concept is still at the early stages of development. Given the rate of constant change and developments being made in the area, it is important that the aforementioned training and development programmes on SC issues should not be one-off activities. The construction project parties should be encouraged to continuously develop and refresh their knowledge and skills on SC related aspects.

9.3.2.1 Section 2A: Characteristics of SC

Herein, characteristics refer to the distinguishing traits, qualities or properties of the concept of SC. Altogether, 15 characteristics of SC emerged from the document analysis exercise (see Table 5.2). Out of these, the four characteristics presented in Section 2A of the framework emerged as the most prominent characteristics SC after taking into consideration the findings from the document analysis, the case study interviews, as well as the existing literature. Hence, the decisions made in relation to objectives of SC and activities for implementing SC within the next two sections of the framework should be founded upon these four characteristics, which are summarised below.

Firstly, there is wide agreement that SC incorporates the three main environmental, social and economic elements. These primary elements of SC are also known as 'dimensions', 'three pillars' or 'triple bottom line'. An important factor to be taken into consideration here is that the issues to be addressed under each element are often inter-related and not mutually exclusive. In other words, each element 'overlaps and relates with the others'. Thus, the project parties should recognise that decisions taken with regard to one element will in turn have implications on the others.

Secondly, SC should consider the whole life cycle of construction. The emphasis is on the 'construction' as opposed to the life cycle of the 'project' (refer to section 2.6.1). Herein, it is important to consider SC as a 'process', rather than a 'product' that need to be delivered at the end of the physical construction phase. Hence, the impacts (in terms of environmental, social and economic elements) as well as user requirements of a proposed construction should be addressed through the whole life cycle perspective.

Thirdly, SC incorporates a holistic approach aimed at synergy and not compromise. A holistic approach to SC should incorporate (adapted from Hardi and Zdan, 1997); firstly, the whole system as well as its parts; secondly, the well-being of social, environmental and economic elements and their component parts and the interaction between parts; and finally, the positive and negative consequences of construction activities in monetary as well as non-monetary terms reflecting the costs/benefits to humans and the environment. Making compromises between the issues to be addressed should be avoided where possible. However, the realities at project level means that such trade-offs are an integral part in implementing SC. This was highlighted throughout the interviews by the case study respondents (refer to section 6.3). Therefore, providing an 'open and explicit' reasoning behind the compromised decisions made (Kemp et al., 2005) should be considered.

Fourthly, it is also important to consider the local context within which the project takes place. The importance of considering the contextual concerns in operationalising sustainability has been widely acknowledged (See Kiewiet and Vos, 2007; Mehta, 2009; Pezzey, 1992). However, these local interpretations must share the general features of the concept, 'based on a broad strategic framework for achieving it' (WCED, 1987). The actions to be achieved under each element of SC are 'context dependent'. They should reflect the local circumstances, needs and priorities and will therefore, vary from project to project. Judgment and interpretation on the part of the decision-makers play a key role in identifying issues to be addressed, as well as, prioritising them. The aim should be to achieve SC in a balanced way and optimise benefits. Moreover, this means that there is no 'right answer' to be achieved when implementing SC. The final outcomes will be shaped not only by the legislative and regulatory requirements but also by the perspectives and requirements of clients and other stakeholders.

9.3.2.2 Section 2B: Identification of SC Objectives

Section 2B of the framework presents an extensive list of SC indicators (i.e. to indicate which areas to be considered under SC) falling under each of the three main elements of SC (refer to section 5.3.2). These include ten indicators each under the environmental and social elements, and seven indicators under the economic element. SC objectives are presented under each of these indicators. Both the indicators and objectives mentioned above have been derived from the document analysis findings as presented in chapter 5. These objectives have been developed at a generic level and are hence applicable to all types of construction projects.

Although only a limited number of SC objectives emerged through the analysis of case study interviews (refer to section 6.2.2), when presented with this comprehensive list at the end of the interviews, the respondents identified all of the stated objectives as very important to achieving sustainability in projects. This provides further evidence to highlight the need for a comprehensive, single source to provide guidance for project stakeholders on SC. Therefore, a Section 2B has been developed as an integral part of the proposed framework to address the aforementioned. The table provided within this section of the framework comprises of four main columns. The first column presents the indicators identified under each of the main environmental, social and economic elements. The second column presents a comprehensive list of SC objectives that should be addressed when implementing SC. In the third column of this table, the project parties can indicate the priority level attributed to each of the aforementioned objectives. The contextual factors discussed within Section 1 of the framework (refer to section 9.3.1) as well as, characteristics of SC (refer to section 9.3.2.1) should form the basis for prioritising these objectives. What the proposed framework suggests here is that, the main aim of the project should not be to achieve 'all' of the SC objectives set within the table (which is impossible in any project), but to fulfil the priority areas and objectives 'right'.

At the initial conceptual stage, the responsibility of determining which SC objectives are important for the project lies with the client (refer to section 9.3.3 below). However, these objectives should be further refined at the idea development phase, taking into consideration the input from the other project stakeholders. At this point, it is important to ensure that the needs of all relevant stakeholders throughout the life cycle of the project are taken into consideration as much as possible within the set objectives. The setting of SC objectives should also incorporate input from the stakeholders who are outside the project team (e.g. users, local community). Proper communications need to be facilitated amongst project parties, as well as between project parties and external stakeholders, during this objective setting process (see section 7.3.1).

The fourth and final column of the table in Section 2A requires the setting of performance measures and standards in relation to the agreed upon SC objectives. This will facilitate the activities of performance monitoring, control, measurement and reporting in relation to each SC objective identified. Setting performance measures and standards for SC has often been observed to be a challenging task, particularly within the context of one-off projects, due to the cutting edge developments involved (JCT, 2009). Herein, it is necessary to first determine the expected standards of performance in relation to each agreed upon (or prioritised) SC objectives. Where possible, performance targets satisfying SMART (i.e. **S**pecific, **M**easurable, **A**chievable, **R**epeatable/**R**ealistic, within a **T**imeframe) criteria should be set for each agreed upon SC objective. However, it is also important that the performance targets and measures should not be overly prescriptive or unrealistic (JCT, 2009). The performance targets should be accompanied by performance measures to monitor and ascertain the level of achievement of the targets. These performance measures should be relevant and appropriate not just to the context of each SC objective, but also to the context of each construction project. The project parties responsible for achieving each performance target should be required to provide evidence of regular progress monitoring towards each target.

The process of development of performance measures and standards should not be a one sided task carried out by the client. Rather it should be done in collaboration with the other project parties. In particular, there should be a meeting of minds between the client and the contractor in terms of the expected levels of performance in relation to each SC objective. In order to ensure compliance, the agreed upon performance standards could be linked to financial incentives and penalties (refer to section 7.3.2). It should be noted that developing performance measures and standards is in itself a vast research area and is therefore, outside the scope of this research.

All in all, Section 2 of the proposed framework is useful in developing an overall, comprehensive ‘picture’ on SC with the agreement of all project parties for a specific construction project.

9.3.3 Section 3: SC Implementation Process

During the grounded theory analysis it emerged that, within the case studies, the SC implementation process occurred as a linear process comprising of four phases, which are inter-linked by specific outputs of each phase. These four phases of the implementation process were referred to as the conceptual phase, idea development/negotiation phase, physical construction phase and hand over/operation phase. The actions to be carried out during each of these phases are presented under Section 3 of the proposed framework.

The conceptual phase includes activities from the project inception to the development of output specification. Accordingly, the activities during this phase should aim at; (i) establishing and prioritising client’s requirements in terms of SC and (ii) communicating these requirements to potential bidders. The inclusion of SC requirements within the output specifications is key to communicating clients’ SC priorities to the other project parties. The findings revealed that there is a need to embed SC objectives/processes with the objectives/processes of the construction project itself at the very outset to ensure the successful implementation of SC (refer to section 8.3.2.2). It is highlighted that SC considerations should not be viewed as an 'extra' set of objectives or criteria that need to be addressed in addition to fulfilling the construction project objectives.

The second stage of the implementation process is called the idea development stage. The activities during this stage should focus upon; (i) selection of a project team that is facilitating or supportive towards SC, (ii) reaching agreement between project parties on the SC objectives to be addressed and (iii) agreeing upon the extent to which these SC issues will be addressed and setting performance measurement targets (refer to section 7.3.2). The success of this phase is greatly dependent upon the input from the other project parties (i.e. bottom-up idea generation). In order to facilitate this bottom-up idea generation process, it is important to give attention to factors such as, the level to which sustainability aspects are embedded in the organisational culture and policies, the attitudes towards risk, knowledge, creativity and past experience of project parties (refer to section 8.3) in selecting a project team that is supportive and facilitating towards implementing SC.

The third phase is the physical construction phase. Activities during this stage should address; (i) developing and implementing programmes and methodologies to address the SC objectives, (ii) gaining commitment and involvement of other stakeholders (e.g. suppliers, sub-contractors, local community) and (iii) monitoring, reporting and improving performance levels in relation to addressing SC (refer to section 7.3.3). The addressing of SC issues during this stage is fairly well developed. However, the issue here is that these activities alone only address SC at the most basic levels (i.e. product/ component level and project level). In order to address SC in-depth, embedding SC within the project process as discussed in the first two phases, is crucial. Contractor's attitude and motivation towards SC and organisational culture play a crucial role in the level of attention given to addressing SC during this stage.

The final and the fourth phase of the process is the hand over/operational stage. During this phase, consideration should be given to fulfilling the activities in relation to the following; i.e. (i) providing training and improving engagement of building users to ensure the sustainable operation of the facility, (ii) continuously improving the sustainable performance levels of the completed facility and (iii) internal and external dissemination of knowledge and experience gained in relation to SC implementation process. The client representatives were keen to highlight the importance of appointing a dedicated sustainability manager at this stage in order to monitor the sustainability performance of the facility. A key factor at this stage is provision of training for the users of the facilities. The case studies revealed a range of initiatives that were undertaken to increase awareness amongst the users, particularly the hospital staff. These activities included; using ‘house-keeping’ to push energy reduction agenda (e.g. turning off computers), arranging energy awareness weeks and top management training (e.g. participation in programmes such as, ‘energy gyms’), etc. Dissemination of knowledge and experience on the process of uptake and implementation of SC is also important at this stage.

9.3.4 Section 4: Influence Factors

The effectiveness of the process of uptake and implementation of SC is determined by a cohort of intervening conditions (or influence factors). These influence factors could act as either enablers or barriers to the implementation process depending upon the realities of each project’s context. The actions discussed in section 3 of this framework above (see section 9.3.3) are influenced by two main types of influence factors. These are; internal factors and external factors. The internal factors could be further divided into three main categories. i.e.; (i) cultural factors, (ii) managerial/organisational factors and (ii) resource factors. These factors were identified through the analysis of case study interviews and have in turn been validated using the findings from the advisory document analysis, as well as the existing literature (refer to section 8.4).

The internal factors for example, are within the control of the project parties and therefore, could be managed through effective management interventions (refer to section 7.3). The project management should establish the internal factors for the context of each construction project. This will give the project management the opportunity to take necessary pro-active measures to mitigate any negative impacts on the SC implementation process and utilise to the maximum the potential opportunities presented. As opposed to the internal factors, the management of external factors is not within the control of the project parties and therefore, require higher levels of interventions (i.e. at construction industry level, business sector level and/or national level). These external factors have the ability to influence not only the actions within the SC implementation process, but also the internal factors. Hence, the necessary precautions must be put in place by the project management to manage the effect of these external factors on the SC implementation activities.

9.3.5 The Need for Feedback

The need for two distinct feedback loops has been emphasised within the framework (refer to Figure 9.1). Firstly, there is a need for internal feedback within the organisations forming the construction project parties. This will help the project parties to learn from their experiences from the process of uptake and implementation of SC. This feedback could be both formal as well as informal in nature.

Secondly, there is also a need for feedback from the project level to the macro level. This will ensure that the development of policies and other advisory documents are informed by the project level experiences and needs. The main discrepancy between the advisory documents' and project stakeholders' views was around the underlying focus placed on the main elements of SC. Whilst a high level of attention was placed on the environmental element within the advisory documents, there was a tendency at the project level to focus upon the issues that are capable of bringing in tangible, 'quick-wins' in terms of cost savings. As was discovered through the advisory document analysis in chapter 5, there was relatively less focus placed within the analysed documents on the economic element of SC. Emphasising the business case for SC has been identified in many instances as a significant driver for the uptake of SC (For example, BERR, 2009; UK Green Building Council, 2009; Kibert, 2008). This is especially important to promote SC practices within the context of the current economic downturn (refer to section 9.3.1). The investors/clients/occupiers often need to attribute a 'value' for SC in order for them to justify their investment/development/occupation in such facilities. This 'value' is more often than not expected to be in the form of 'financial value' (UK Green Building Council, 2009). The lack of hard evidence to prove the business case of SC in UK (especially when compared to countries such as, USA and Australia) is an important factor that needs to be addressed within the industry. The second feedback loop of the proposed framework could for instance, inform the strategic level of this need to highlight the business benefits of addressing the environmental and social aims of SC within the advisory documents.

9.3.6 Use of the Proposed Framework

The developed framework could be used to further the project stakeholders' understanding of the concept of SC and the requirements for its successful implementation across the life cycle phases of a construction project. It is particularly useful to be used by clients and contractors, who play key roles in the SC implementation decision process. The developed framework is non-technical in nature. This could benefit those stakeholders that come from non-technical backgrounds (e.g. some of the FM and Trust respondents), who found some of the existing technical guidance available on various SC aspects difficult to comprehend.

The proposed framework is particularly useful for the project level management to take proactive actions necessary to manage the success of the SC implementation process. This is facilitated within the framework by the identification of sets of activities that need to be fulfilled within the different phases of the implementation process and presenting the requirements for cultural, organisational/managerial and resource facilitation within each phase.

Whilst it is hoped that the above uses of the proposed framework will drive forward the construction project stakeholders to uptake the framework, its use in practice may be limited by a number of factors. Firstly, the findings in relation to the implementation process of SC have been developed using three case studies carried out in PFI healthcare projects. Although, the actions as well as the external and internal factors identified within the developed the framework were found to be common at a generic level across the case studies, their applicability within construction projects in other sectors or in projects using other types of procurement approaches has not been extensively verified. Some of the interviews conducted to validate the framework however, established the comprehensive nature and applicability of the contents of the framework for use at the construction project level (see section 9.4).

Activities within the framework such as setting SC objectives, requires the project team members to work together in an inclusive and collaborative manner. Therefore, the use of the framework may also be limited by the poor levels of integration of project parties within construction project environments.

Interventions are necessary at national and industry levels to manage some of the barriers in implementing SC at project level. The framework provides a means of guiding some of these interventions. In particular, the need for more cohesiveness and coordination in developing policies, legislations and other guidance, the need for training and education programmes and promotion of best practices is highlighted.

9.4 VALIDATION OF THE PROPOSED FRAMEWORK

The proposed framework was 'validated' using qualitative interviews during the final stage of the research. Herein, the term 'validation' is not used in the positivist sense; i.e. to refer to 'nothing less than the truth' known through 'language referring to a stable social reality' (Seale, 1999). Rather the term is used to encapsulate some of the criteria put forward by Corbin and Strauss (2008) to evaluate the 'quality' of research findings derived using the principles of grounded theory. These criteria are;

- *'Fit'* (i.e. ensuring that the findings 'resonate' with the experience of the professionals for whom they are intended).
- *'Applicability'* (i.e. establishing the usefulness of findings).
- *'Logic'* (i.e. ensuring that there is a logical flow of ideas, making sure that there are no significant gaps in logic).
- *'Depth'* (i.e. ensuring that there is sufficient substance within the findings).

Four semi-structured interviews were carried out with two members of academia and two industry practitioners to ensure that the proposed framework shown in Figure 9.1 satisfied the above criteria. The interviews consisted of open ended questions addressing the following aspects;

i. Level of coverage in terms of the main sections constituting the framework (i.e. *'Depth')*
ii. Level of coverage in terms of the contents within each of the constituent sections of the framework (i.e. *'Depth)*
iii. The flow/logic/clarity within the framework (i.e. *'Logic'* and *'Fit')*
iv. Overall usefulness of the framework (i.e. *'Applicability'* and *'Fit')*

The findings of these interviews are summarised in Table 9.1 below.

Table 9.1: Summary of validation interviews

Criteria	**Int. 1 (Academia)**	**Int.2 (Academia)**	**Int. 3 (Industry)**	**Int. 4 (Industry)**
(1) Level of coverage (or completeness) in terms of the overall contents (main sections)	Very high	Very high	Very high	Very high
(2) Level of coverage (level of completeness) in terms of the logic	Very high	Very high	Very high	Very high
(3) The issues covered under individual sections:				
- Section 1- Context	High	Very high	Very high	Very high
- Section 2 - What is SC?	Very high	Very high	High	Very high
- Section 3 - Actions	Very high	High	Moderate	High
- Section 4 - Influence factors	High	High	High	High
(4) Level of understanding of the proposed framework	Very high	Very high	High	High
(5) Further comments/ suggestions on areas that need to be improved/included/ deleted			Inclusion of performance measures within Section 2B	
(6) Would you recommend the framework for use by construction project stakeholders?	Yes	Yes	Not sure	Yes

The interviewees agreed that there is a very high level of coverage in terms of the constituent sections of the developed framework. There was further agreement amongst interviewees that there was a high level of coverage in terms of the contents provided within each section. However, one industry practitioner mentioned that the framework could be further improved through the incorporation of performance measures within section 2B, which would in turn improve its applicability in practice. The interviewees also felt that the flow and the logic of the framework were easy to understand and clear, indicating a high level of logic. Overall, the interviewees felt the framework presented a useful tool for providing greater understanding and awareness on SC issues and guiding actions for implementing SC within construction project environments. Given below are some of the comments from the interviewees;

> *'It looks very comprehensive, because it goes into details in each section' – Int. 1*

> *'I'm sure it will be useful to the construction industry to consider SC, because now it's becoming more and more of a requirement... I think it will be useful to the construction industry to understand more, what SC is about' – Int. 2*

9.5 SUMMARY

This chapter addressed the second part of the research aim presented in section 1.2, by developing a framework for the uptake and implementation of SC within a construction project environment. The developed framework addresses the two key problem areas of understanding SC and implementing SC that were uncovered through this research. The proposed framework comprise of four main sections addressing, (i) the contextual considerations, (ii) understanding the phenomenon of SC (through the characteristics and objectives of SC) (iii) actions for implementing SC and (iv) influence factors. The contents, logic/flow and structure of the developed framework were validated using qualitative interviews with members of the academic community and industry practitioners.

The developed framework provides a starting point for broadening the project stakeholders' awareness and understanding of SC and actions needed for its practical implementation at project level. It is hoped that the developed framework will provide a useful tool for taking implementation of SC at project level beyond the mere achievement of mandatory legislative targets. The proposed framework is particularly useful for the project level management to take proactive actions necessary to manage the success of the SC implementation process. The contents within the sections 3 and 4 of the framework could be further developed and generalised by using case studies from other sectors and different types of procurement. Overall, this chapter fulfilled the sixth and final objective of this research.

CHAPTER 10: CONCLUSIONS AND RECOMMENDATIONS

10.1 INTRODUCTION

This chapter summarises the key research findings in relation to the aim and objectives of the research. A summary of the research process adopted to accomplish the same is provided at the beginning of the chapter. The conclusions emanating from the research findings are then presented. Recommendations for academic community as well as industry practitioners are given at the end of the chapter. The possible areas for further research are also presented within this chapter.

10.2 RESEARCH PROCESS ADOPTED – A SUMMARY

The aim of this research was to understand the interpretation of SC and to develop a framework that can assist in its effective uptake and implementation within construction project environments. Six objectives were set to achieve this overall aim. These were;

i. To review the concept of SD and its impact and application within the construction industry (i.e. SC).

ii. To develop a conceptual framework to illustrate the concept of SC and its implementation within a construction project environment.

iii. To analyse and report on how the concept of SC is set out in government policies and other advisory documents.

iv. To ascertain and report on the perceptions of construction project stakeholders regarding the concept of SC.

v. To analyse and detail the actions and influence factors in implementing SC within a construction project environment.

vi. To refine and validate the framework for uptake and implementation of SC in light of the findings from objectives (i) to (v) above.

The research process adopted to realise the aforementioned aim and objectives consisted of four key stages:

The first stage of the research process comprised of a critical review of available literature relevant to the main focus areas of the research. The literature review established a background understanding of SD and explored its implications to the construction industry. A conceptual framework was developed to address the gaps in research identified through the literature review process. Overall, the first stage addressed objectives 1 and 2 and research question RQ1 of the research. During the second stage of the research, a qualitative document analysis was carried out to identify how SC has been interpreted in 18 advisory documents developed for the industry. This addressed objective 3 and research questions RQ2 and RQ3 of this research. The third stage employed a case study approach, together with grounded theory analysis, to establish (a) the project stakeholders' perceptions on SC, (b) how SC is implemented at construction project level and (c) any influence factors affecting the said implementation process. Three case studies were chosen for this stage of the study. Semi-structured interviews were conducted with project parties representing the client, contractor, design and FM organisations. Accordingly, this stage fulfilled objectives 4 and 5 and research questions RQ4, RQ5 and RQ6 of the research. The fourth and final stage of the research process covered the development of a framework for the uptake and implementation of SC at construction project level. The framework was refined and validated by qualitative interviews carried out with two members of the academic community, as well as two industry professionals.

10.3 CONCLUSIONS OF THE RESEARCH

The main conclusions of the research can be presented as follows:

10.3.1 The concept of sustainable development and its impact and application within the construction industry

There is no uniform understanding of SD within literature. The concept continuously keeps on developing theoretically and methodologically. Given the current context, it seems unlikely that a coherent, universal conceptual approach to SD will emerge in the near future. However, while this conceptual development takes place the principles of SD continues to be implemented at various levels. One such application is within the context of the construction industry. The 'ground level' experiences gained in such applications in turn fuel the conceptual development. This was one of the main inferences forming the base of this research.

The activities of the construction industry result in significant environmental, social and economic impacts. The adoption of SD in the construction industry is therefore, crucial to attain the overarching goals of SD. Herein, SC is the most suitable terminology to describe the application of SD principles within the construction industry activities. As opposed to other terminologies that are sometimes used interchangeably in literature (e.g. green construction), the term SC incorporates the following characteristics that better encapsulates the principles of SD within the context of the construction industry. These characteristics are;

- Addresses issues throughout the complete life-cycle of a construction
- Focuses not just upon the environment, but also the economic and social aspects of construction, thereby addressing both hard and soft issues.
- Meets the needs of all present stakeholders, whilst having the ability to be flexible to address the changing needs of stakeholders throughout the life cycle.
- Requires the application of not just technological solutions, but also non-technological, process directed measures (such as, changes to the traditional institutional structures, knowledge, information, methods and lines of communication) as well as changes to the traditional values and attitudes of stakeholders.

10.3.2 The advisory documents' interpretation of sustainable construction

There is a variety of advisory documents available on SC for the project parties. The most widely cited reasons for producing these documents were to 'increase awareness and understanding on SC' amongst project stakeholders and to provide them 'guidance' for addressing SC. Despite these stated purposes for producing documents, not all documents endeavoured to provide an outright definition or description of SC for their intended users. This lack of a proper definition/description of the concept of SC, upon which the objectives or actions for implementing SC are to be founded upon, in turn appear to have an effect on the uptake (i.e. understanding) of SC by stakeholders at project level.

There is a lack of common understanding on the characteristics and objectives of SC, across the analysed documents. There are also discrepancies between how the analysed advisory documents characterised SC and how these were in turn translated into objectives to base practice upon. In general, the according to the documents', SC could be characterised as, incorporating issues in relation to the three environmental, social and economic elements, in a holistic manner, taking into consideration the local contextual factors, throughout the whole life cycle of construction. Despite this, there is a clear bias towards the environmental issues within the analysed documents. Hence, the study raises the question whether an actual transformation has been made from what is referred to as 'green' construction to truly sustainable construction at the strategic level. The current legislative environment, as well as the fiscal tools (i.e. taxes and levies) that are in place, covers a wider, more comprehensive range of environmental objectives compared to social or economic objectives.

According to their coverage across the documents, the highest level of attention was on the issues of carbon and energy, waste, pollution, biodiversity, water, materials and whole life value. The objectives of SC (particularly, those in relation to the environmental element) cover a range of spatial scales from project component (i.e. micro) level to global (i.e. macro) level. Therefore, there is a need for the project level decision makers to expand their 'horizons of attentions' in decision making, beyond the traditional boundaries of construction projects in order to address SC in a holistic, comprehensive manner.

10.3.3 The project stakeholders' perceptions of sustainable construction

There is wide appreciation amongst project parties that SC is an important issue that need to be addressed. However, the project parties involved in the process of implementing SC at project level have varying levels of understanding on the concept of SC. These views on SC range from more superficial outlooks, such as regarding SC as a by-product of achieving mandatory legislative requirements, to more well-rounded and comprehensive stances. The emphasis placed on different SC objectives also varies between different stakeholder groups. This variation of perceptions could be attributed to several factors such as, the prevailing legislative environment, backgrounds and past experiences of project parties, their awareness on and attitudes towards wider issues of SD, as well as the policies and cultures of their respective organisations.

Reducing energy consumption, reducing energy costs and ensuring end user satisfaction were the most prominent SC objectives for construction project stakeholders. Overall, there is a high level of emphasis placed on the economic element of SC by the project parties. Financial benefits, user satisfaction, meeting legislative targets and reputation gains are key drivers for considering SC at project level.

The perceptions of project parties on SC keeps on developing with experiences gained at project level. The culture within the project team (e.g. high level of integration between project parties, effective communication, and non-adversarial, partnering culture within the team) and the sustainability policies of their respective organisations are pertinent factors in shaping project parties' view on SC. These factors were especially relevant in improving the understanding and knowledge of those project team members who did not come into the project with prior experience or knowledge on SC.

10.3.4 Implementing SC at construction project level

Four distinct phases could be identified as important in relation to the implementation of SC within construction project environments. There is a need for overall management of the SC implementation process, to ensure the process' smooth flow and transition from one phase to another. There is also a need for overall management to consider the needs of the SC implementation process and to align/integrate those needs with the generic activities of the construction project delivery process itself.

Timely management interventions and control is necessary during each phase of the implementation process to manage the effect of the influence factors and ensure the success of the SC implementation process. Each phase of the SC implementation process is affected by two types of influence factors; internal factors and external factors. In particular, a pro-active approach to cultural, organisational/managerial and resource facilitation is required to manage the effect of the internal factors, which are within the control of the construction project stakeholders. National, sector and industry level interventions should be taken to manage the effect of external factors, which are outside the control of the project parties.

The exact order or structure of the activities within each phase of the SC implementation process, as well as the exact nature of influence factors affecting those activities, differ based upon the realities and complexities of each construction project. Dissemination of knowledge and experiences gained through media, industry events or conferences are important in improving knowledge and awareness on SC, which could be used in future projects.

10.3.5 Developing, refining and validating the framework

The research developed a holistic framework addressing the uptake and implementation of SC, in response to the identified deficiencies in the conceptual precision of SC (provided within the advisory documents, as well as held by the project stakeholders) and the lack of a holistic framework inter-relating the SC requirements in policies and other guidance with on the ground realities.

From the analysis of advisory documents it was apparent that no single document provided a comprehensive picture on SC encompassing all issues. There were discrepancies between documents on the meaning of certain terminology and the sub-elements/indicators and objectives identified differed between documents as well. Whilst, there was an expressed understanding that SC should incorporate a joined up approach when considering the environmental, social and economic issues, there was a clear emphasis on the environmental element; i.e. green issues.

With regards to the project stakeholder perceptions on SC, these were found to be generally focused on a few key issues that have been the main focus within the government agenda. Furthermore, given the context of the case studies, there were some instances where certain project team members came into the project without clear knowledge or prior experience on SC. These stakeholders often displayed a very superficial understanding of SC and were faced with difficulties in understanding some SC related guidance.

Setting project level goals for SC for each phase of the construction life-cycle, which are in line with the policies and advisory documents, will enable key parties involved in implementing SC at different life cycle stages, to develop a uniform understanding on issues to be addressed. This will therefore, help integrate what is agreed at strategic level (and in turn laid out in policies and guidance) and what is being achieved at project level, when it comes to implementing SC. An important aspect to take into consideration here is that implementing SC must not be separated from the achievement of the objectives of a construction project. Rather SC practices must be incorporated within the framework for attainment of the project objectives and should be part and parcel of it.

The developed framework addresses the aforementioned issues through four main sections. One of the main attributes of the proposed framework is that it avoids being too rigid or prescriptive in its application. Through the stated characteristics of SC and the identification of contextual considerations, the framework acknowledges that the objectives, activities and influence factors of SC within construction projects differ, based upon the context of each project. Therefore, it allows the project parties to adapt the framework, taking into consideration the specifics of each project.

The framework also highlights the need for feedback, not just at the project level, but also from project level to the policy development level. The latter could help bridge the gap between content within policies and other guidance documents and on the ground realities. The developed framework is comprehensive in the issues covered and has the potential of being a useful tool at project level implementation of SC.

10.4 RECOMMENDATIONS AND FUTURE RESEARCH

Considering the above findings of this research, the following recommendations could be made to the government and other industry bodies, industry practitioners and members of the academia.

10.4.1 Recommendations for government and other industry bodies developing advisory documents on SC:

- There is a need to streamline the development of advisory documents on SC. Particular attention should be paid towards improving the comparability between different advisory documents.
- Attempts should be made at developing a single source for project level stakeholders to easily access the various documents, depending upon their different requirements and technical knowledge.
- Within the documents, further attention should be given to providing more conceptual precision on SC, especially for those project level stakeholders who do not have specific educational backgrounds or experience in addressing

sustainability issues.

- There is a need to promote a more holistic approach to SC at national level, which should in turn be reflected within the advisory documents. This requires giving equal consideration to environmental, social and economic elements.
- Awareness and access should be improved on new knowledge and innovations. This could help in alleviating the perceived high risk of certain SC considerations held by some project parties.
- Best practice examples, from not just within UK, but also from other countries should be promoted.

10.4.2 Recommendations for project stakeholders:

- There is a need to consider SC as an integral part of the construction process itself, rather than something superfluous or extra that has been necessitated through mandatory legislations and regulations.
- Accordingly, construction clients should lay out the SC requirements at the very outset of a construction project with the expected and/or desired levels of attainment of each requirement clearly stated. The knowledge and skills, past performance in terms of SC and organisational policies on SC should be considered as important criteria in selecting project parties.
- The project level implementation of SC should align with the national policies and guidance on SC and the sector policies and guidance. However, the blind application of the above at project level is not recommended. Instead, consideration should be given to the specific requirements of each project, which may be determined by the user requirements and local context of each project.
- The individual organisations forming parties of a construction project should develop their own policies on SC reflecting the aforementioned policies and guidance. The employees should be properly made aware of these policies and be required to adhere to them through their day to day activities.
- A partnering culture should be promoted within project teams. This will facilitate better communication and integration between project parties overcoming problems faced due to lack of trust, communication and

involvement of parties in the uptake and implementation of SC.

- KM practices should be promoted so that SC knowledge of project parties could be shared.
- Formal feedback processes need to be put in place so that lessons learned in implementing SC in one project could be used in new projects being undertaken.

10.4.3 Recommendations for future research for academics:

- This study identified a comprehensive list of environmental, social and economic sub-elements/indicators and objectives under each of these sub-elements. In section 9.3.2.2 the importance of setting performance measures and standards for each of these objectives to guide actions was highlighted. This presents an interesting and important area for further research in developing a comprehensive a list of performance measures and standards to address each of the identified objectives of SC.
- The case studies used in this research were all selected from the healthcare sector (refer to section 4.8.2 for rationale behind the selection of these cases). Therefore, including case studies from other sectors could assist in generalising the contents within sections 3 and 4 (i.e. process of implementation and influence factors) of the developed framework.
- Similarly, as the case studies were selected from PFI projects, replicating the methodology of this study in construction projects using other methods of procurement could be useful in providing greater insight into the procurement method related factors affecting the uptake and implementation of SC.
- The intention behind the developed framework was to provide a useful tool for project parties to improve how SC is addressed at project level. Therefore, developing this framework as a user friendly IT tool could further improve its ease of use and appeal for project level stakeholders.

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APPENDIX 1

A Summary of International Events/Conferences on SD

Year/Place	Event/Conference	Description
1967	Environmental Defence Fund (EDF)	EDF was formed following the legal victory by a small Long Island conservation group to ban the spraying of DDT on Long Island's marshes. EDF is now focused on solving the most critical environmental problems facing the planet in relation to; climate, oceans, ecosystems and health.
1972, Stockholm	UN Conference on the Human Environment	The outcomes of the conference included; ▪ A framework for environmental action, ▪ Recommendations for action at the international level, ▪ Identification and control of pollution of broad international significance, ▪ Educational, informational, social and cultural aspects of environmental issues ▪ Development of an action plan consisting of 03 component areas to deliver the recommendations. These areas included; the global environmental assessment programme (Earthwatch), the environmental management activities and the supporting measures. ▪ Development of the Declaration of the United Nations Conference on the Human Environment –this was the result of identifying the need for a common outlook and for common principles to inspire and guide the peoples of the world in the preservation and enhancement of the human environment.
1972	Publication of the Club of Rome's report 'The Limits to Growth'	The report presented some challenging scenarios for global sustainability, based on a system dynamics computer model to simulate the interactions of five global economic subsystems, namely; population, food production, industrial production, pollution and consumption of non-renewable natural resources.
1976, Vancouver	Habitat, the UN Conference on Human Settlements	Became the first global meeting to link the environment and human settlement.
1977, Nairobi	United Nations Conference on Desertification (UNCOD)	Adopted a Plan of Action to Combat Desertification (PACD).
1980	World Conservation Strategy released by IUCN	The strategy defined development as 'the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human needs and improve the quality of human life'. Called for international action towards; tropical forests and dry lands, a global programme for the protection of genetic resource areas, regional strategies for international river basins and seas, and SD. The action 'Towards Sustainable Development' identified the main agents of habitat destruction as poverty, population pressure, social inequity and the terms of trade. It calls for a new International Development Strategy with the aims of minimising inequities, achieving a more dynamic and stable world economy, stimulating economic growth and countering the worst impacts of poverty.
1980	Independent Commission on International Development Issues publishes 'North:	The report asked for a re-assessment of the notion of development, calling for new economic relationships between North and South. The Brandt Commission set out a comprehensive strategy for food, aid, environment, trade, finance and monetary reform – as well as global negotiations

Year/Place	Event/Conference	Description
	South - A Programme for Survival (Brandt Report)'	to implement those objectives.
1982	Establishment of the World Resources Institute	World Resources Institute was established in the USA. It begins publishing biennial resource assessments in 1986.
1983	Formation of World Commission on Environment and Development (WCED)	Chaired by Norwegian Prime Minister Gro Harlem Brundtland, the commission worked for 03 years to produce a report on social, economic, cultural, and environmental issues.
1986, Ottawa	IUCN Conference on Environment and Development	Meeting participants defined SD as the emerging paradigm derived from two closely related paradigms of conservation, namely; 1) one reacting against the laissez-faire economic theory, which considers living resources as externalities and free goods and 2) one based on the concept of resource stewardship
1987	Our Common Future (Brundtland Report)	The report of the WCED or the Brundtland Commission, inter-relating the social, economic, cultural and environmental issues and global solutions. It popularises the term, SD.
1988	Intergovernmental Panel on Climate Change (IPCC) is established	The IPCC was formed with 03 working groups to assess the most up-to-date scientific, technical and socio-economic research relating to climate change.
1992, Rio de Janeiro	United Nations Conference on Environment and Development (UNCED)	Was attended by 172 Governments -108 represented by heads of State or Government. The participants adopted 03 major agreements to guide future approaches to development: i.e. Agenda 21 (a global plan of action to promote SD); the Rio Declaration on Environment and Development (a series of principles defining the rights and responsibilities of States); and the Statement of Forest Principles (a set of principles to underpin the sustainable management of forests worldwide). In addition, two legally binding instruments were opened for signature at the Summit. These were; the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity. Moreover, negotiations began on the Convention to Combat Desertification, which was opened for signature in October 1994 and entered into force in December 1996.
1995, Berlin	COP 1	Parties agreed that the commitments in the UNFCCC were inadequate for meeting the Convention's objective. In a decision known as the Berlin Mandate they agreed to establish a process to negotiate strengthened commitments for developed countries.
1995, Copenhagen	World Summit for Social Development	For the first time the international community expressed a clear commitment to eradicating absolute poverty. Governments reached a new consensus on the need to put people at the centre of development. The Social Summit pledged to make the eradication of poverty, the goal of full employment and the fostering of social integration, the overriding objectives of development.
1996, Geneva	COP 2	A decision on guidelines for the national communications to be prepared by developing countries was adopted. Quantified Emissions Limitation and Reduction Objectives (QELROs) for different Parties was also discussed at the conference.
1997, Kyoto	COP 3	The Kyoto Protocol was adopted by consensus. The Protocol contained legally binding emission targets for developed countries (i.e. Annex I) for the 06 major greenhouse gases, which are to be reached by the period 2008-2012. Issues for future international consideration include developing rules for emissions trading, and methodological work related to the

Year/Place	Event/Conference	Description
		Kyoto Protocol, co-operation with the IPCC and development of observational networks of the climate system.
1998, Buenos Aires	COP 4	Adopted the Buenos Aires Plan of Action, focusing on strengthening the financial mechanism, the development and transfer of technologies and maintaining the momentum in relation to the Kyoto Protocol.
1999, Bonn	COP 5	The focus was placed on the adoption of the guidelines for the preparation of national communications by the Annex I countries, capacity building, transfer of technology and flexible mechanisms.
2000, Hague	COP 6	Consensus was reached on the Bonn Agreements. Work was also completed on a number of detailed decisions based on the Bonn Agreements, including capacity-building for developing countries and countries with economies in transition. Decisions on several issues, notably the mechanisms for Land Use, Land-Use Change and Forestry (LULUCF) and compliance, remained outstanding.
2001, Marrakech/ Morocco	COP 7	Parties agreed on a package deal, with key features including rules for ensuring compliance with commitments, consideration of LULUCF principles in reporting of such data and limited banking of units generated by sinks under the Clean Development Mechanism (CDM) (i.e. the extent to which CO_2 absorbed by carbon sinks can be counted towards the Kyoto targets). The meeting also adopted the Marrakech Ministerial Declaration as an input into the WSSD in Johannesburg.
2002, Johannesburg	World Summit on Sustainable Development (WSSD)	10 years after the Rio Declaration, the follow-up conference WSSD, was convened in Johannesburg to renew the global commitment to SD. The conference agreed on the Johannesburg Plan of Implementation (JPOI) and further tasked the Commission on Sustainable Development (instituted in 1993 by the UNCED) to follow-up on the implementation of SD.
2002, Delhi	COP 8	The Delhi Ministerial Declaration on Climate Change and Sustainable Development reiterated the need to build on the outcomes of the World Summit
2003, Milan	COP 9	Adopted decisions focusing on the institutions and procedures of the Kyoto Protocol and on the implementation of the UNFCCC. The formal decisions adopted by the Conference intend to strengthen the institutional framework of both the Convention and the Kyoto Protocol. New emission reporting guidelines based on the good-practice guidance provided by the IPCC were adopted to provide a sound and reliable foundation for reporting on changes in carbon concentrations resulting from land-use changes and forestry. Another major advance was the agreement on the modalities and scope for carbon absorbing forest-management projects in the Clean Development Mechanism (CDM), completing the package adopted in Marrakesh. Furthermore, 02 funds (i.e. the Special Climate Change Fund and the Least Developed Countries Fund) were developed to support technology transfer, adaptation projects and other activities.
2004, Buenos Aires	COP 10	The main aims of COP 10 were to complete the unfinished business from the Marrakesh Accords and to reassess the building blocks of the process and to discuss the framing of a new dialogue on the future of climate change policy. Numerous decisions and conclusions were adopted on issues relating to: development and transfer of technologies; land use, land use change and forestry; the UNFCCC's financial mechanism; Annex I national communications; capacity building; adaptation and response measures; and UNFCCC

Year/Place	Event/Conference	Description
		Article 6 (education, training and public awareness) examining the issues of adaptation and mitigation, the needs of least developed countries (LDCs), and future strategies to address climate change.
2005, Montreal	COP 11	COP 11 addressed issues such as capacity building, development and transfer of technologies, the adverse effects of climate change on developing and least developed countries, and several financial and budget-related issues, including guidelines to the Global Environment Facility (GEF), which serves as the Convention's financial mechanism. The COP also agreed on a process for considering future action beyond 2012 under the UNFCCC.
2006, Nairobi	COP 12	A wide range of decisions were adopted designed to mitigate climate change and help countries adapt to the effects. There was agreement on the activities for the next few years under the 'Nairobi work programme on Impacts, Vulnerability and Adaptation', as well as on the management of the Adaptation Fund under the Kyoto Protocol. The 'Nairobi Framework' was developed, to provide additional support to developing countries to successfully develop projects for the CDM. Parties in Nairobi also adopted rules of procedure for the Kyoto Protocol's Compliance Committee, making it fully operational.
2007, Bali	COP 13	The Bali Road Map was adopted as a 02 year process towards a strengthened international climate change agreement. The Bali Road Map includes the Bali Action Plan, the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP) negotiations, the launch of the Adaptation Fund, as well as decisions on technology transfer and on reducing emissions from deforestation.
2008, Poznan	COP 14	COP 14 launched the Adaptation Fund under the Kyoto Protocol, to be filled by a 2% levy on projects under the CDM. Parties agreed that the Adaptation Fund Board should have legal capacity to grant direct access to developing countries. Further progress was made on a number of issues of particular importance to developing countries, including finance, technology and disaster management. An intensified negotiating schedule for 2009 was also endorsed by parties.
2009, Pittsburgh	G20 Pittsburgh Summit	G20 nations' leaders called for phasing out of fossil fuel subsidies, and measures that will lead to sustainable consumption, while providing targeted support for the poorest people. The conference also focused on launching a framework laying out the policies to generate strong, sustainable and balanced global growth, taking new steps to increase access to food, fuel and finance among the world's poorest while clamping down on illicit outflows, steps to reduce the development gap, and maintaining openness and moving towards greener, more sustainable growth.
2009, Copenhagen	COP 15	The Copenhagen Climate Change Conference raised climate change policy to the highest political level, with close to 115 world leaders attending the high-level segment. It produced the Copenhagen Accord, which was supported by a majority of countries. This included agreement on the long-term goal of limiting the maximum global average temperature increase to no more than 2 degrees Celsius above pre-industrial levels, subject to a review in 2015. A number of developing countries agreed to communicate their efforts to limit GHG emissions every two years. On long-term finance, developed countries agreed to support a goal of mobilising US$100 billion a year

Year/Place	Event/Conference	Description
		by 2020 to address the needs of developing countries.
2010, Cancun	COP 16	COP 16 produced the Cancun Agreements. Among the highlights, parties agreed to: commit to a maximum temperature rise of 2 degrees Celsius above pre-industrial levels; make fully operational by 2012 a technology mechanism to boost the development and spread of new climate-friendly technologies; establish a Green Climate Fund to provide financing for action in developing countries via thematic funding windows. They also agreed on a new Cancun Adaptation Framework, which included setting up an Adaptation Committee to promote strong, cohesive action on adaptation.
2011, Durban	COP 17	Parties decided to adopt a universal climate agreement by 2015, with work beginning under a new group called the Ad Hoc working Group on the Durban Platform for Enhanced Action (ADP). Parties also agreed a second commitment period of the Kyoto Protocol, from 1 January 2013. A significantly advanced framework for the reporting of emission reductions for both developed and developing countries was also agreed upon, taking into consideration the principle of common but differentiated responsibilities.
2012, Rio de Janeiro	United Nations Conference on Sustainable Development - Rio+20	Marked the 20th anniversary of the 1992 UNCED in Rio de Janeiro, and the 10th anniversary of the 2002 WSSDin Johannesburg. The United Nations Conference on Sustainable Development (Rio+20) was an action-oriented conference, where all stakeholders, including Major Groups, the UN System/IGOs, and Member States were invited to make commitments focusing on delivering concrete results for SD on a voluntary basis. By the end of the Conference, over 700 voluntary commitments were announced and compiled into an online registry managed by the Rio+20 Secretariat, initiating a new bottom-up approach towards the advancement of SD.
2012, Doha,	COP 18	AT COP 18, governments set out a timetable to adopt a universal climate agreement by 2015, to come into effect in 2020. Governments emphasised the need to increase their ambition to cut GHGs and to help vulnerable countries to adapt. COP 18 also saw the launch of a second commitment period under the Kyoto Protocol, from 1 January 2013 to 31 December 2020, with the adoption of the Doha Amendment to the Kyoto Protocol.

(see also: http://www.un.org/en/development/devagenda/sustainable.shtml; http://unfccc.int/documentation/decisions/items/2964.php; http://unfccc.int/meetings/items/6240.php; http://www.iisd.org/rio+5/timeline/sdtimeline.htm; http://www.iisd.org/pdf/2012/sd_timeline_2012.pdf)

APPENDIX 2

Case Study Interview Guide

Purpose of the interviews:

The purposes of the interviews are two-fold: i.e. (i) To obtain insight into the understanding of SC amongst project level stakeholders and (ii) To understand the process of implementing SC (including the influence factors that affect this process) within a construction project environment.

Target respondents:

- Client (i.e. NHS Trust) representative
- Contractor organisation representative
- Design team member
- FM team member

Date:...

Respondent details:
Name of respondent:..
Position:..
Organisation:...
Background and years of experience:...

Project details:
Name of project:..
Location:...
Cost (approx):..
Current stage:..

Section 1

Purpose: To understand the perception of project parties on sustainable construction [i.e. Objective 04]

1. Do you have any prior experience or knowledge in addressing sustainability/ sustainable development in construction projects?
2. Do you think it is an important issue that needs to be addressed? (Can you please explain your reasoning)
3. In your view what does sustainable development in construction mean? (What are its main features or characteristics or principles or objectives?)

Section 2

Purpose: To understand the impact of advisory documents on project parties in uptake and implementation of sustainable construction

4. Do you refer to any particular documents (guidelines/policies) in adopting sustainable construction practices?
5. If Yes, what are they? If No, why not?
6. Do you find these documents useful?
7. Are the documents easy to understand and clear?(coherence, clarity)
8. Are the documents current and reflect the present circumstances when it comes to sustainability? (currency) (core content)
9. Do you have any issues with the documents?
10. Are there any other documents, that you are aware of but do not use?

Section 3

Purpose: To understand how sustainable construction is implemented at project level [i.e. Objective 05]

11. According to your understanding, what were the main reasons for considering SD /SC in this project?

12. What were the main goals/objectives set to be achieved in terms of SD in this project? (What were the main SC issues addressed?)
13. Were there any particular reasons for selecting those specific SC goals/objectives for implementation in this project? (criteria for selection of SC issues)
14. Could you please describe your role in selecting and implementing the aforementioned SC objectives in this project? (e.g. Idea generation, idea development, providing consultation, monitoring implementation)
15. Could you please describe the role of other stakeholders of this project in selecting and implementing the aforementioned SC objectives in this project? (e.g. Idea generation, idea development, providing consultation, monitoring implementation)
16. What were the actions taken to address those objectives in different phases? (initial stage, tendering stage, construction stage, operation stage)

Section 4

Purpose: To understand the influence factors in implementing sustainable construction at project level [i.e. Objective 05]

17. How would you describe the main drivers or enablers you came across in implementing sustainable construction? (during different phases)
18. Did you face any practical difficulties or challenges in implementing sustainable construction aspects in this project?
19. How did you manage to overcome those difficulties?

Would you be willing to be contacted for further input/ comments later on for the purposes of this research?

Please state any other contact details:

Address:
Tel:
Email:

Thank you for your co-operation.
Sachie Gunatilake

APPENDIX 3

Interview Guide for Refining and Validating the Proposed Framework for Uptake and Implementation of SC

Purpose of the interviews:

The interview seeks to refine the proposed framework for the uptake and implementation of SC within construction project environments.

***Date*:.......................................**

Respondent details:

- Name:
  ....………………………………………………….………
- Background: ☐Academia ☐ Industry
- Position / Area of expertise:
  …………………………………………….…………..
- Organisation:
  ………………………………………………………….………………

Evaluation of the proposed framework:

1. What is your opinion on the level of coverage (level of completeness) in terms of the overall contents (main sections) of the proposed framework?

2. What is your opinion on the level of coverage (level of completeness) in terms of the logic (i.e. flow/ sequence within the framework and how it mirrors what should be done) used within the proposed framework?

3. What is your opinion on the issues covered under Section 1: Context within the proposed framework?

4. What is your opinion on the issues covered under Section 2: What is SC? within the proposed framework?

5. What is your opinion on the issues covered under Section 3: Actions /Strategies for implementing SC within the proposed framework?

6. What is your opinion on the issues covered under Section 4: Influence factors within the proposed framework?

7. What is your opinion on the level of understanding of the proposed framework?

8. Do you have further comments/suggestions regarding any areas that need to be improved/included/deleted within the proposed framework?

9. Would you recommend the framework for use by construction project stakeholders in addressing the issues of uptake and implementation of SC within construction project environments? (Herein, *'Uptake'* refers to the *understanding and comprehension of SC issues by project parties,* whereas, *'implementation'* refers *to practical measures that are required in addressing those issues.)*

Investigation of further issues in uptake and implementation of SD within construction project environments:

10. In your opinion what are the practical difficulties or challenges in the uptake and implementation of SC?

11. Are there any other further comments/ suggestions?

APPENDIX 4

A Summary of Existing Emissions Reporting Mechanisms in the UK

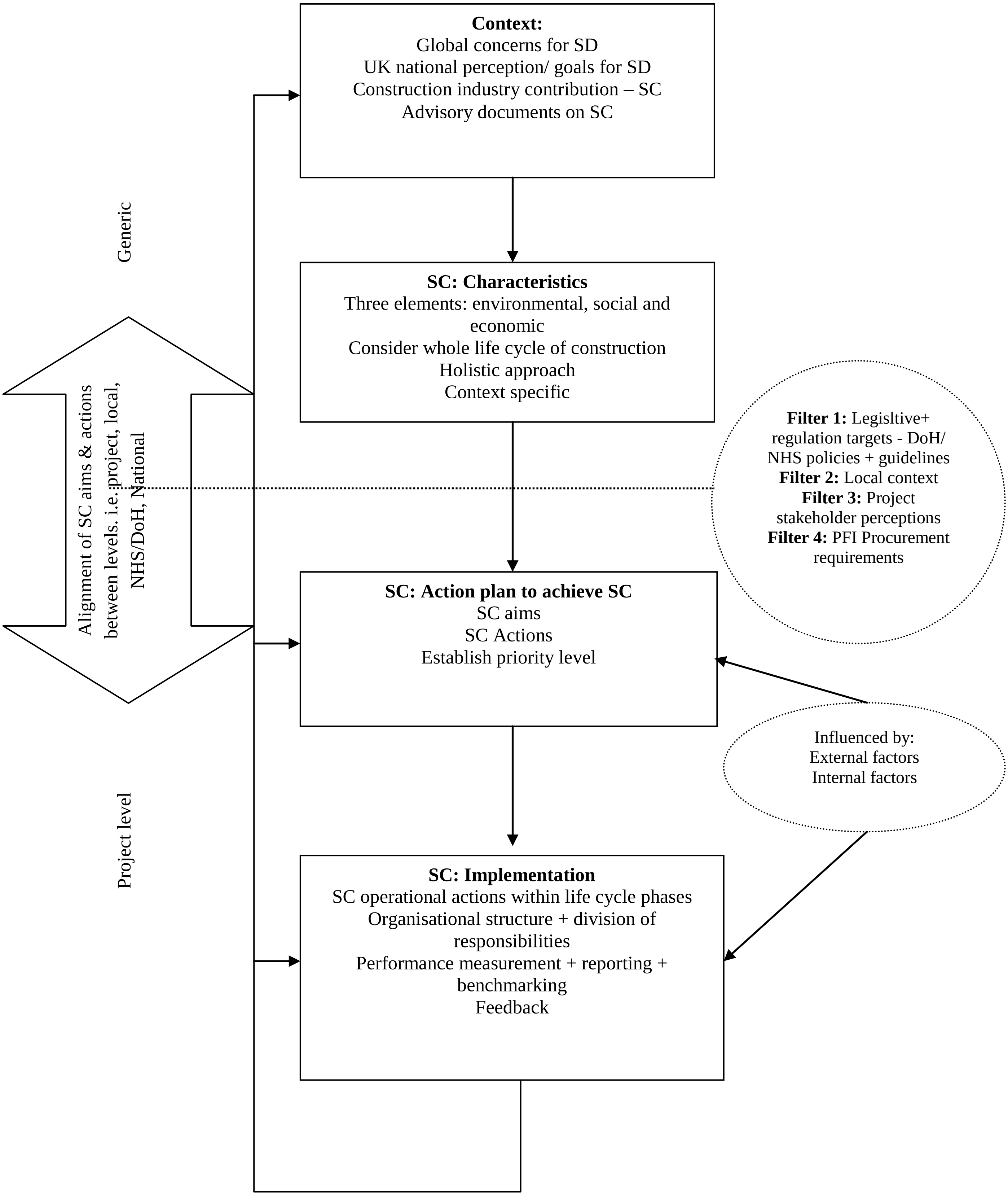
There are currently several requirements on organisations in the UK to collect data and report on their emissions. Although these various schemes require that the organisations covered measure and report on certain parts of their emissions footprints, reporting is not the main aim of any of these schemes but rather a means to the achievement of emissions reductions (DEFRA, 2010). The Table below gives a summary of the three main emissions reporting requirements in UK.

Reporting Requirement	Description
EU Emissions Trading System (EU ETS)	EU ETS functions on the 'cap and trade' principle, covering around 45% of the EU's GHG emissions. The system operates in the 27 EU countries and the three EEA-EFTA states and Croatia. It sets a limit or a cap (which is gradually reduced over time) on the total amounts of certain GHGs that can be emitted. It also allows companies to receive or buy emissions allowances and trade these with one another as required. EU ETS also acts a driver of investments in clean technologies and low carbon solutions in developing countries by allowing companies to buy international credits.
CRC Energy Efficiency Scheme (CRC)	This is a mandatory energy efficiency scheme aimed at the large scale companies in both the public and the private sectors (these companies are responsible for 10% of the UK's total GHG emissions). Qualifying companies for the scheme are selected based upon the electricity usage. For example, for Phase 2 of the scheme, organisations will qualify if they consumed over 6,000 megawatt-hours of qualifying electricity, during the year, measured through settled half-hourly meters. The scheme targets energy supplies not already covered by Climate Change Agreements (CCAs) and the EU Emissions Trading System.
Climate Change Agreements (CCAs)	CCAs are a series of voluntary agreements that allow eligible energy-intensive businesses meeting energy efficiency or carbon saving targets to receive up to a 65% discount from the Climate Change Levy. The discount for electricity will further increase to 90% from April 2013. The scheme is currently (until March 2013) administered by the DECC and will then be taken over by the Environment Agency from 1 April 2013 to 31 March 2023.

(Sources: DEFRA, 2010; European Commission, 2012)

APPENDIX 5

Development of the Framework for Uptake and Implementation of SC: Draft Version



APPENDIX 6

Achievements and Conference Publications during the PhD

Achievements during the course of the PhD:

1. **Best student paper award** – American Society of Civil Engineers' 6th International Engineering and Construction Conference, held in Cairo, Egypt, 28 – 30 June 2010

2. **Best poster** presentation at the Annual Graduate Research Conference of the School of Built and Natural Environment, University of Central Lancashire, May 2012.

Papers published in refereed conference proceedings:

1. Gunatilake, S. and Liyanage, C., 2011. A qualitative content analysis approach to analysis of advisory documents on sustainable construction. *In*: *Proceedings of 10th International Postgraduate Research Conference*, 14-15 September 2011, University of Salford, United Kingdom.

2. Gunatilake, S. and Liyanage, C., 2010. Sustainable construction: a conceptual framework for transforming policy into project level practice. *In*: Mossallam, A. S., El-Demirdash, M. A., El-Zahaby, K. M., Bathala, C. T., and Zaki, M. A., eds. *Proceedings of the American Society of Civil Engineers' 6th International Engineering and Construction Conference*, 28-30 June 2010, Cairo, Egypt.

3. Gunatilake, S. and Liyanage, C., 2010. Harmonising sustainable construction policy with practice at project level: a research proposition. *In*: Egbu, C., ed. *Proceedings of 26th Annual Conference of the Association of Researchers in Construction Management (ARCOM),* 6-8 September 2010, Leeds Metropolitan University, Leeds, United Kingdom.

4. Gunatilake, S. and Liyanage, C., 2010. Implications of the concept of sustainable development to the construction industry. *In*: Barret, P., Amaratunga, D., Haigh, R., Keraminiyage, K., and Pathirage, C., eds. *Proceedings of the CIB*

2010 World Congress, 10-13 May 2010, Salford Quays, United Kingdom.

5. Gunatilake, S. and Liyanage, C., 2010. Investigating the adaptability of relational contracting (RC) practices - the Sri Lankan context. *In*: Barret, P., Amaratunga, D., Haigh, R., Keraminiyage, K., and Pathirage, C., eds. *Proceedings of the CIB 2010 world congress*, 10-13 May 2010, Salford Quays, United Kingdom.

6. Yatanwala, S., Gunatilake, S., Jayasena, S. and Liyanage, C., 2009. Use of PFI as a tool for delivering transport infrastructure in developing countries: the Sri Lankan context. *In*: *Proceedings of the 13th Pacific Association of Quantity Surveyors Congress*, 17-18 August 2009, Kuala Lumpur, Malaysia.