The Management of Climate Change Mitigation Objectives in the Supply Chains of Public and Private Organisations in the UK

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The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

The management of greenhouse gas emissions (GHGEs) in the supply chains of public and private organisations is increasingly recognised as an avenue through which to pursue climate change mitigation goals. This presents opportunities and challenges for focal organisations who lead and control supply chains. The literature and practice of environmental supply chain management (ESCM) is well developed, but there remains the scope for theoretical advancements.

This research aims to deepen understanding of the current state of efforts to manage GHGEs in supply chains, including the drivers, barriers and activities involved and how they interact; exploring the policy and legislative possibilities is an additional aim. Using qualitative methods, an exploratory interview survey of 11 experts from academia, think tanks, business support and consultancy organisations was conducted, followed by interviews with 20 organisations in the public and private sectors.

It is found that private sector organisations, driven by factors such as competitive advantage, reputation and risk management are leading current efforts. A wide range of ESCM techniques are utilised and in some instances focal organisations are found to be attempting to increase the capabilities of their supply chains to manage GHGEs. A paradox is found in terms of public sector supply chains, through their high potential contribution towards supply chain GHGE management, yet constrained actions.

Using these results, the research constructs an 'Emission Reduction INtervention Options' (ERINO) supply chain approach, outlining a range of interventions to enhance management efforts, as well as a 'Focal Organisations Supply Chain emission Activity/Outcome' (FOSCAO) matrix, highlighting the relationships between GHGE management activities and outcomes. Finally, a 'Supply CHain Emission ManagEment' (SCHEME) overview framework is constructed.

It is concluded that current action is reliant on characteristics and capabilities not present within all organisations, meaning wider engagement may require interventions by government or other actors.

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List of Abbreviations

AIM: Alternative Investment Market

BIS: Department for Business, Innovation and Skills

BITC: Business in the Community

BS: British Standard

BSI: British Standards Institute

CCC: Committee on Climate Change

CDM: Clean Development Mechanism

CDP: Carbon Disclosure Project

CEMARS: Carbon Emissions Management and Reduction Scheme

CIPS: Chartered Institute of Purchasing and Supply

CO_2: Carbon Dioxide

CR: Corporate Responsibility

CRC: Carbon Reduction Commitment

CSR: Corporate Social Responsibility

DECC: Department of Energy and Climate Change

Defra: Department for Environment, Food and Rural Affairs

DEMATEL: Decision Making Trail and Evaluation Laboratory

EMS: Environmental Management System

ERINO SC Approach: 'Emission Reduction INtervention Options' Supply Chain Approach

ESCD: Environmental Supply Chain Dynamics

ESCM: Environmental Supply Chain Management

EU: European Union

EU-ETS: European Union Emissions Trading Scheme

FOSCAO Matrix: 'Focal Organisation Supply Chain emission Activity/Outcome' Matrix

FTSE: Financial Times and the London Stock Exchange

GHG Protocol: Greenhouse Gas Protocol

GHGEs: Greenhouse Gas Emissions

GRI: Global Reporting Initiative

GSCM: Green Supply Chain Management

HEFCE: Higher Education Funding Council for England

HMG: Her Majesty's Government

IOA: Input-Output Analysis

IPCC: Intergovernmental Panel on Climate Change

ISO: International Organisation for Standardization

IT: Information Technology

JI: Joint Implementation

KPI: Key Performance Indicator

LA: Local Authority

LCA: Life Cycle Assessment

MNE/C: Multi-National Enterprise/Company

NEEFT: The National Environmental Education & Training Foundation

NEPIs: New Economic Policy Instruments

NGOs: Non-Governmental Organisation

Ofwat: Water Services Regulation Authority

PAS: Publically Available Specifications

PR: Public Relations

R&D: Research and Design

SC: Supply Chain

SCHEME Framework: ‘Supply CHain Emission ManagEment’ Framework

SCM: Supply Chain Management

SME: Small and Medium sized Enterprise

SSCM: Sustainable Supply Chain Management

UK: United Kingdom

UNFCCC: United Nations Framework Convention on Climate Change

US: United States (of America)

VP: Vice President

WBCSD: World Business Council for Sustainable Development

WRI: World Resources Institute

Chapter 1. Introduction

1.1 The Environmental Movement and Changing Role of Business

Increased recognition and concern of environmental degradation can be traced back to acts such as images of the Earth taken by Apollo 17, illustrating its enclosed and isolated nature and works such as Rachel Carson's 'Silent Spring', which described the adverse impacts of pesticides on the natural environment. These led to an increased environmental awareness among individuals and the introduction of environmental regulations across developed nations through the second half of the 20th century (Manheim 2009; Harrison 2001). This occurred hand in hand with international summits, such as the Rio Earth Summit in 1992, which sought to raise awareness and coordinate global action to tackle these issues.

Large corporations spent much of the 20th century denying their role in the unsustainable practises causing widespread environmental damage; increasingly over the last 20 years however, businesses and other large organisations have started to recognise that they have a role to play in tackling these environmental and wider sustainability issues (Kolk and Pinkse 2008a).

Climate change, as the archetypal environmental problem of current times poses severe risks and challenges to populations globally (Barnett 2003), and increasing consideration of climate change as an environmental problem, and indeed other sustainability and ethical issues, in general discourses and academia, has focused attention (Barkemeyer et al. 2010; Doulton and Brown 2009). Mitigation, one of two complimentary routes to reduce the risks posed by climate change, involves the management and reduction of greenhouse gas emissions (GHGEs) (Füssel 2007; Yohe and Strzepek 2007).

The increasing role and value of brands and reputation for contemporary organisational strategy, as well as an evolving debate within academia, embodied through work that highlights the benefits available from reduced environmental impact (Porter and Kramer 2006), has raised the environment up the agendas of management boards. The increased importance and efficacy of corporate responsibility (CR) has seen organisations attempting to ensure that their activities and

conduct exceeds that as required by law. As environmental problems, and more specifically anthropogenic climate change, have increased in severity, CR is now seen to include the environmental impacts, including those occurring in supply chains (SCs) (Kovács 2008).

Alongside this, SCs themselves have altered radically over recent decades, becoming longer and more internationalised, as organisations and businesses have increasingly focused on their core competencies and outsourced many components of the products and services they produce; this has altered how organisations attempt to manage their SCs, as its strategic importance has increased (Preuss 2005). The SCs of consumer goods makers, manufacturers and high tech firms can contain 40-60% of their GHGE footprint, whilst for retailers the figure can be over 80% (Brickman and Ungerman 2008; Oracle 2008). Such high instances of GHGEs within the SC pose a CR and potential future regulatory risk; however less than a quarter of top executives surveyed by Brickman and Ungerman (2008) were found to have acted in their SCs, even though three quarters noted it as a priority.

The management of SCs, both for more orthodox operational objectives and more recently for environmental and wider sustainability goals is well-established in the academic literature (Gold, Seuring and Beske 2010). However, there is little empirical or theoretical literature concerning the management of SC GHGEs (for examples, see Chaabane, Ramudhin and Paquet 2012; Hsu et al. 2011; Lee 2011; Côté et al. 2008), as literature concerning sustainable 'supply chain management' (SCM) has generally focused upon more general environmental management efforts (Carter and Easton 2011; Seuring and Müller 2008).

The United Kingdom (UK) is seen as a leader in terms of climate change policy, with the passing of the Climate Change Act in 2008, however there is no legislation or regulation directed at SC emissions (Defra 2011). There is nevertheless evidence that organisations are managing and reducing their SC emissions in the absence of legislation, through the use of purchasing power and other strategies, through programs such as 'Carbon Disclosure Project (CDP) Supply Chain' (CDP 2011; CDP 2010a). Which organisations are leading such efforts, how and why, are all important questions.

The importance of SCs to organisations' prosperity and success is un-doubtable with the expansion of CR to include activities occurring upstream in the SC. In order for the possible negative impacts of such activities to be minimised, and for the opportunities presented to be seized upon, it is critical that greater understanding is gained. Knowledge is required on the factors driving this process, the aspects that act as barriers, as well as the strategies being used by those organisations that have moved early and begun to manage and reduce SC GHGEs.

This thesis seeks to contribute to ESCM literature by identifying current leading organisations in the UK with regards to SC GHGE management and the strategies they are using, including the factors that are driving or hindering engagement. The fulfilment of these aims will allow the formation of a knowledge base from which further research into this important topic can be launched.

1.2 Corporate Responsibility

With increasing concerns and demands from stakeholders regarding issues around sustainability, including the environment, many organisations now dedicate time and resources towards CR. CR, also labelled corporate social responsibility (CSR), sees organisations responsibilities as extending beyond those of wealth and job creation (Kovács 2008; Carroll 1999; Cannon 1994), as their operations and actions increasingly expose organisations to reputational risks.

Ideas concerning the responsibilities of business towards society were being articulated as early as the 1930s, however Bowen's 1953 book 'Social Responsibilities of the Businessman' is widely considered the first genuine contribution (Carroll 1979). Some contended that the only social responsibility of business was towards the owners or shareholders and to make and maximise profits for them (Friedman 1970). Increasing social activism in the 1960s however, followed by the institutionalisation of consumer and environmental protection in the USA in the 1970s, established the concept in academic and business discourses (Carroll 1991).

Central to the evolution of the concept of CSR was the acceptance that a wider range of societal actors had both legitimacy and power in relation to businesses, including employees and customers; this meant that business leaders now had to balance the

competing demands of these groups with more traditional concerns such as shareholders' interests (Carroll 1991; McGuire 1963).

Carroll (1991; 1979) made several core contributions, including highlighting four central aspects of business responsibility, those being the economic, legal, ethical and discretionary (changed later to philanthropic); these aspects of CSR were later constructed as a pyramid, with economic responsibilities forming the base, upon which rested legal, ethical and discretionary activities. Under this conception, businesses were seen to have a responsibility to produce profits within legal frameworks, whilst also submitting to widely held societal expectations of ethical behaviour and attempting to be 'good' corporate citizens.

This conception was later built upon, incorporating ideas of 'performance' (introducing the term 'corporate social performance'), with alternate layers of CSR actions identified; these included the need for social legitimacy (at the institutional level), public responsibility (at the organisational level) and managerial discretion (at the individual level) (Carroll 1999; Wood 1991).

As such, stakeholders are intimately linked to CR through ideas that organisations receive a 'license to operate' from the societies within which they exist (Hasnas 1998). Empirical research on CR gathered momentum in the 1980s with stakeholder theories, business ethics theories and corporate citizenship forming the focus of efforts (Carroll 1999). It is increasingly recognised, by both scholars and organisations themselves, that greater social and environmental responsibility can improve an organisations performance, and produce positive benefits for both shareholders and wider stakeholders (Porter and Kramer 2006; Porter and van der Linde 1995); although empirical research that fails to find such links does exist (Aupperle, Carroll and Hatfield 1985).

Now considered an established criteria upon which organisations are judged by their stakeholders (Lewis 2003), CR increasingly relies upon the effective communication of efforts and programmes. Several organisations now exist that provide frameworks within which organisations are able to report their social and environmental performance, such as the CDP and the Global Reporting Initiative (GRI).

1.3 Business Engagement with Climate Change Mitigation Objectives: From Opposition to Opportunity

The rise and significance of CR efforts by organisations and businesses can be seen in conjunction with a changing relationship between business and the environment. Throughout the early 1990s, businesses climate change strategies were concerned with denying and challenging the science behind GHGEs links to climate change (Kolk, Levy and Pinkse 2008). However, as regulations at both the national (the UK's Climate Change Act 2008) and international (Kyoto Protocol) level have been enacted and the consensus around climate change has strengthened, increasing numbers of businesses and scholars see business at the centre of the challenge to mitigate GHGEs (Gouldson and Sullivan 2013; Downie and Stubbs 2011; Voss and Clegg 2010; Jeswani, Wehrmeyer and Mulugetta 2008); indeed, some highlight that businesses have a central role in reducing the carbon footprint of products, through strategies such as product choice editing by eliminating high GHGE products and running marketing campaigns to encourage consumer take up of low GHGE products (Bocken and Allwood 2012). Although a shift is seen to have occurred, it is still true that not all businesses or organisations are engaging with climate change mitigation objectives and that opinion is divided with regards to businesses role within the 'climate challenge' (Ihlen 2009).

This shift has meant that many businesses and organisations at the forefront of corporate action on climate change no longer query the costs involved, but ask what opportunities are presented. Financial markets keen to understand climate risks within businesses have started to ask for information on GHGE levels and the strategies undertaken to manage and reduce them (Reid and Toffel 2009); in some instances, financial markets have also started to reward businesses for their actions (Cogan 2006). The refinement of economic models and their assumptions, increasing consensus politically and scientifically, as well as advances in the technologies available to mitigate GHGEs also claim some responsibility for this shift (Dunn 2002).

As businesses and organisations have begun to engage with climate change issues, and sought appropriate responses, the flexibility within the regulatory regime has allowed a plurality of GHGE reduction activities and strategies to arise, providing much managerial discretion (Kolk and Pinkse 2005; Dunn 2002).

1.3.1 The Current State of Business Engagement with Climate Change Mitigation Objectives

As indicated above, business engagement with climate change mitigation objectives, in both more practical and strategic terms, has increased over recent years, with an associated body of academic literature being created to reflect and attempt to explain these changes (Lee 2012; Weinhofer and Hoffman 2010; Kolk, Levy and Pinkse 2008; Hoffman 2005).

A range of activities are identified, including emission reduction commitments, product development, process and supply improvements and entry into new markets and other business development efforts (Sprengel and Busch 2010; Weinhofer and Hoffman 2010; Jeswani, Wehrmeyer and Mulugetta 2008; Boiral 2006; Hoffman 2005; Kolk and Pinkse 2005; Schultz and Williamson 2005; Dunn 2002). These activities, although not exhaustive, can be considered in relation to objectives such as GHGE assessment and quantification, reporting and disclosure through schemes such as the CDP and participation in offsetting or trading mechanisms, or GHGE reductions (Knox-Hayes and Levy 2011; Lovell and MacKenzie 2011; Reid and Toffel 2009; Kolk, Levy and Pinkse 2008).

A range of driving factors have been highlighted as responsible for businesses shifting stance towards climate change mitigation, including competitive pressures, fluctuating energy prices, market shifts and stakeholder demands (Sullivan 2010; Jeswani, Wehrmeyer and Mulugetta 2008; Kolk and Pinkse 2008a; Okereke 2007); Appendix A contains a more thorough list of driving factors. Not mutually exclusive, these drivers can be seen to be active within specific organisational contexts depending upon the location, sector and area of operation or historical experiences faced by businesses (Kolk, Levy and Pinkse 2008; Okereke 2007). Although a range of factors can be identified explaining why businesses and organisations would engage with climate change mitigation objectives, they also face challenges and barriers (also noted within Appendix A). These include aspects such as uncertainty, high costs, lack of technological development, low levels of awareness and little regulatory or government pressure (Lee 2012; Sullivan 2010; Jeswani, Wehrmeyer and Mulugetta 2008; Pinkse 2007).

It is important to recognise however, that although climate change mitigation policies are active in certain areas of business and industry, such as the European Union Emission Trading Scheme (EU-ETS), that many of the actions being undertaken by business in relation to climate change mitigation occur in the absence of direct regulation. This is often explained through 'early mover advantage' and 'win-win' theories. 'Early mover advantage' theories posit that these voluntary actions present benefits, including competitive advantage (Pinkse 2007; Hoffman 2005; Dunn 2002; Nehrt 1996; Porter and van der Linde 1995). Similarly, ideas concerning 'win-win' outcomes in relation to more general engagement with sustainability and environmental actions by businesses also highlight the competitive advantage and wider benefits of such actions (Kolk and Pinkse 2008b; Lash and Wellington 2007; Porter and Reinhardt 2007; Boiral 2006; Drake, Purvis and Hunt 2004). Ideas concerning the possibility of 'win-win' outcomes however are balanced with those that assert that 'trade-offs' exist, and that in a majority of cases improvements in environmental performance may result in reduced economic benefits for organisations (Hahn et al. 2010).

Investors are considered to play a special role in relation to climate change mitigation objectives in this regard, encouraging businesses and organisations to measure and disclose their GHGEs, so as to allow the associated risks and opportunities to be priced into investment decisions (Reid and Toffel 2009; Kolk, Levy and Pinkse 2008). This is considered by some as a type of informal governance (Hutter and Jones 2006; Gunningham and Grabosky 1998; Ayres and Braithwaite 1992).

It is clear that a range of actions are available to businesses and organisations wishing to engage with climate change mitigation objectives. However, this presents organisations with choices and decisions with regards to this engagement, such as between GHGE reductions versus offsetting or trading (Weinhofer and Hoffman 2010), product and process improvements versus trading, and the internal or external focus; actions in the SC would be an example of an external focus (Kolk and Pinkse 2005). Further, the amount of resources employed towards these objectives in relation to other organisational imperatives, such as marketing or product/service delivery, is a further decision that must be made (Lee 2012).

The actions and decisions made by businesses and organisations are seen to be impacted by a range of factors, including the political and national jurisdiction or location, the perceived risks and opportunities (Weinhofer and Hoffman 2010; Kolk and Pinkse 2007; Kolk and Pinkse 2005; Kolk and Levy 2004; Dunn 2002), industry type and company size (Lee 2012; Weinhofer and Hoffman 2010), the type of corporate governance (Galbreath 2010), and the historical strategies pursued by an organisation (Voss and Clegg 2010). A further significant factor considered here are the type of stakeholders and their specific demands, such as investors and their requests for disclosure and reporting (Boiral, Henri and Talbot 2012; Sprengel and Busch 2010).

Although initial efforts in relation to organisational engagement with climate change mitigation objectives focus on measurement and assessment, followed by internal efficiency improvements or offsetting and trading (Lash and Wellington 2007; Hoffman 2006), the total sum of GHGEs involved in the production of a product or service, (i.e. both direct and indirect emissions), are now also increasingly considered important for the fulfilment of both mitigation and wider CR goals. As a result, those GHGEs that reside in the SC are increasingly being considered (Lee 2012). This has led to supplier selection based on GHGE performance being touted as an important aspect of supplier appraisal in the future (Enkvist, Nauclér and Oppenheim 2008).

Discourses exist, as demonstrated above, that provide evidence that businesses and organisations are engaging with climate change mitigation objectives. However, those GHGEs embodied within SCs form a relatively new and burgeoning area of organisational action. As will be examined now, these embodied or indirect GHGEs are receiving greater attention, both in respect to an area of business and organisational action, but also in terms of methodologies and tools.

1.4 Greenhouse Gas Emission Accounting, Associated Tools and Actors

As businesses and organisations have increasingly engaged with the environmental agenda, and climate change in particular, the tools and frameworks within which this has been occurring, is an important contextual consideration.

1.4.1 Greenhouse Gas Protocol

As the most widely used tool for GHGE accounting, by both governments and businesses, the Greenhouse Gas Protocol (GHG Protocol), is a partnership between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The GHG Protocol serves as a basis for many standards and programs globally (GHG Protocol 2012a).

The GHG Protocol splits GHGEs into three different 'scopes'. Scopes One and Two cover the GHGEs that occur within the traditional boundaries of organisations, concerning their direct operations; they include all direct GHGEs, in the case of Scope One, such as gas burnt for the heating of water, and indirect GHGEs, in the case of Scope Two, from the purchase of electricity, heat or steam.

Scope Three GHGEs are all remaining indirect GHGEs, not including those included in Scope Two. These GHGEs occur both upstream and downstream in the value chain (GHG Protocol 2012b). The GHG Protocol has developed methodologies and standards that can be used by organisations to measure their Scope Three GHGEs, including the 'GHG Protocol Corporate Value Chain (Scope Three)' and 'Product Life Cycle Standards'. The corporate value chain (Scope Three) standard is described as the first tool that organisations can use to assess and quantify their value chain GHGEs. This framework is also noted as supporting strategies to "partner with suppliers, customers and other companies in the value chain to achieve GHG reductions" (GHG Protocol 2011a p.12). The product life cycle standard is used to highlight the full life-cycle GHGEs of a product or service, and is able to highlight which actions would result in the greatest GHGE reductions (GHG Protocol 2011b).

1.4.1.1 Users of the Greenhouse Gas Protocol

Several significant non-governmental organisations (NGOs) involved in organisations engagement with GHGEs use the GHG Protocol standards, including the CDP and GRI (GRI 2013; CDP 2010b). Both these initiatives allow organisations to report their environmental impact, generally, in the case of the GRI, and specifically with regards to carbon and water, in the case of the CDP. Many large corporations and public sector organisations report their GHGEs through these schemes, and they include aspects

that relate to both direct and indirect environmental impacts, including those of GHGEs.

Following WBSCD/WRI reporting guidelines, the CDP was established in 2000 by a group of institutional investors who were concerned about climate change risks impact on, and implications for, businesses and organisations (CDP 2010a; Kolk, Levy and Pinkse 2008). As voluntary scheme, the CDP aims to report information on a wide range of issues and risks, including the measurement of emissions, the preparations taking place in an organisation, technological investments and trading and offsetting, and constitutes the largest database of organisational GHGEs.

Similarly, the GRI is a not-for-profit organisation that seeks to advance sustainability reporting by organisations and businesses. It seeks to make sustainability reporting comparable to, and as wide spread, as financial reporting (GRI 2013).

1.5 The Rational for Looking at Supply Chain/Scope Three Greenhouse Gas Emissions

As noted above, interest in the GHGEs that are embodied within SCs constitutes an area of research and investigation that is young and developing. This focus however has several prime causes. Firstly, as noted above, in the continued absence of a global treaty, the measurement and management of GHGEs through the production process, i.e. through the SC, may be able to offer a short term, or bridging solution, and would be able to identify where current efforts should be aimed, as 'hotspots' or large instances of GHGEs would be able to be identified (Busch 2010). The argument for the management of SC GHGEs in relation to the lack of global agreement is increased as it is highlighted that not only does this identify fuel consumption that needs reducing, but that it localises GHGEs, ascertains why they are being generated, and which sectors are responsible, making the task of assigning responsibility easier (Bastianoni, Pulselli and Tiezzi 2004).

Although sector and industry differences exist, it is highlighted that Scope Three GHGEs, or those GHGEs that reside in the SCs of a business or organisation, can constitute up to and above 75% of the total GHGEs associated with a product or service, although in service companies this may be as low as 30% (although this lower figure still represents a third of all emissions) (Huang, Weber and Matthews 2009; CDP

2008). However, engagement with Scope Three/SC GHGEs is generally poorly understood (Huang, Weber and Matthews 2009). Understanding the full extent of the GHGEs for a product or service is important with regards to risk and the potential that regulation will be administered at some point in the future; without this understanding, a business or organisation is unable to fully appreciate the overall risk associated with their GHGEs (Downie and Stubbs 2011; Matthews, Hendrickson and Weber 2008).

Further arguments for the management of SC GHGEs stem from issues concerning how GHGEs should be accounted for, introducing issues of equity and fairness; specifically, whether GHGEs should be measured through the production or consumption process, and who should be held responsible. Taking a production based approach allows territories to achieve high standards of living associated with high GHGEs, but for those emissions to be outsourced to other producing territories (Munksgaard and Pedersen 2001), and may lead to less efficient reductions strategies (Mózner 2013). It is because of these accounting difficulties that consumer responsibility was suggested (Munksgaard and Pedersen 2001; Proops, Faber and Wagenhals 1993), leading to concepts such as 'carbon footprinting', with similarity to the preceding concept of the ecological footprinting proposed by Wackernagel and Rees (1996). These approaches focussed on environmental management of the product, which lead to ideas concerning product stewardship (Roome 1992). From a focus on the product, as a method of managing environmental impact, to a focus on those actors best able to manage a products environmental impact, leads logically to those organisations or businesses that lead and control the production process. By attributing GHGEs to the organisation that leads a SC, SC accounting can get around these issues and difficulties, and policy and regulation can target these organisations to affect a larger proportion of GHGEs.

The arguments for engagement, measurement and management of Scope Three or SC GHGEs do not just concern policy. For businesses to identify the most cost effective abatement opportunities, an understanding of the full GHGEs of a product or process is required, and that just focusing on the internal or Scope One and Two dimensions of an organisations GHGEs can lead to the misallocation of capital and effort (Sanchez,

Matthews and Weber 2010; Huang, Weber and Matthews 2009; Matthews, Hendrickson and Weber 2008; Kolk and Pinkse 2005). Achieving the most cost effective abatement is important, even if these opportunities reside within actors external to the organisation that leads the SC (Lenzen and Murray 2009). Indeed, engagement with SC GHGEs is proposed to hold many benefits to organisations, including reduced GHGEs, better brand image and improved competitiveness (Butner, Geuder and Hittner 2008), in turn making it an important issue not just for governments and society, but businesses and organisations themselves.

1.6 Environmental Regulation and Climate Change

It is essential to establish the different types of policy that are available when dealing with environmental problems that afflict society. Mickwitz (2003 p.419) offers a practical categorisation and typology of policy instruments:

- Command and control – measures used to modify options.
- Economic – altering the benefits and costs associated with certain actions.
- Information/Education – alters priorities and the relative significance of issues.
- Support and capacity building – providing actors with help in relation to policy objectives.

1.6.1.1 Command and Control Measures

Command and control measures include the stipulated use of specific technologies or approaches and the instigation of detailed performance standards (OECD 2009). Criticised for their lack of flexibility and impact on innovation, such interventions also fail to motivate actors to go beyond the specified level of environmental protection or action (Jaffe and Stavins 2003).

Also included within this category are arbitrary regulations such as building codes, which can be used to increase energy efficiency and other factors that impact on energy use and GHGEs (UNEP 2009). The use of 'portfolio standards' within the UK energy market, requiring energy providers to generate a certain minimum amount of power from renewable sources can also be considered to be included within this category (UNEP 2009).

1.6.1.2 Economic Policy Instruments

A suit of measures based on economic mechanisms also exists, including taxes and emission trading (Bailey 2007; Jordan, Wurzel and Zito 2005; Tews, Busch and Jörgens 2003). These alter the benefits and costs associated with specific actions (Ekins 1999), and are seen as central to climate policy (Stern 2008), due to their cost effectiveness and flexibility (Labatt and White 2011). Carbon or GHGE taxation is noted as environmentally effective, but is unable to guarantee a specific level of reduction in emissions, could impact lower income communities disproportionately and as such be unpopular (Gupta et al. 2007).

This literature has focused upon the effectiveness of taxation and trading approaches (Meehl, Stocker and Collins 2007) and their advantages over other methods (Murray, Newell and Pizer 2009; Chameides and Oppenheimer 2007). Supply chain impacts specifically, have been modelled under carbon taxes (Davis, Peters and Caldeira 2011) and emission trading (Chaabane, Ramudhin and Paquet 2012; Abdallah, Diabat and Simchi-Levi 2010; Diabat and Simchi-Levi 2010; Bojarski et al. 2009).

Subsidies are also highlighted in relation to climate mitigation, for example for renewable energy or other abatement schemes, and represent a more traditional economic approach to government intervention (Jacobson and Delucchi 2009).

Such mechanisms operate through the 'prioritisation of the self', pushing actors to comply with regulations for their own well-being, by changing the costs and benefits associated with specific actions (Ekins 1999).

An increasing prevalence of approaches based on neo-liberalism is advanced by some scholars, due to the expense and potentially negative impacts upon innovation of traditional command and control style regulations (Taylor et al. 2012). A suit of measures based on economic mechanisms, labelled new economic policy instruments (NEPIs), can be identified (Bailey 2007; Jordan, Wurzel and Zito 2005; Tews, Busch and Jörgens 2003). Including schemes such as taxes, charge schemes and trading schemes, these mechanisms allow the actors under regulation to choose compliance methods.

1.6.1.3 Information based Policy Instruments

Information based schemes operate through the provision of information and are designed to change the decisions made by organisations or their stakeholders; such

measures have been shown to be able to correct negative environmental externalities (Kennedy, Laplante and Maxwell 1994). They include methods such as the use of eco-labels or mandatory reporting schemes (Taylor et al. 2012).

Organisations that are included in reporting schemes face the potential spectre of loss of business, boycotts and damage to their reputation (Mackenzie 2010). Information based schemes can also work in a more positive way, by providing information to key decision-makers, through the mandated use of environmental management systems (EMS) or one-off 'energy audits' to identify inefficiencies and ways to reduce energy consumption (Taylor et al. 2012; UNEP 2009). Empirical research has demonstrated that firms that are 'named and shamed' with regards to poor environmental practice, suffer falls in their share value, indicating the existence of the enforcement mechanism (Hamilton 1995).

1.6.1.4 Support and Capacity Building

A further category of policy and regulation for use with regards to environmental problems is that of the provision of supporting mechanisms and capacity building (Gouldson et al. 2008). These include the generation of research and knowledge, demonstration projects, knowledge diffusion, networking building and joint problem solving. Technological support, including R&D and clean technology deployment have been emphasised in relation to enhancing climate mitigation efforts (OECD 2009).

1.6.1.5 Voluntary Agreements and other Mechanisms

The use of voluntary approaches, where businesses or other organisational actors reach agreements with government concerning their environmental performance is also seen to be relevant in relation to climate mitigation. Such agreements often include specific targets and can involve incentives for the organisations submitting to the voluntary agreements (Gupta et al. 2007). Businesses often agree to such measures in order to avoid more arbitrary regulations being imposed, with examples including the motor industry agreeing emission reduction targets with the EU (EA 2013).

1.6.2 The Declining Power of Government – The Rise of Governance?

The rise in environmental policy and regulation since the 1950's has coincided with a growth in softer more flexible regulatory measures and arrangements (Kern et al.

2001; Weale 1992). This in part can be attributed to a relative decline in the power of governments, due to technological and economic changes (Ronit and Schneider 1999); the autonomy and effectiveness of government has been blunted by the internationalisation of markets and communication networks, which is seen by some to have blurred where the state should and should not act (Knill and Lehmkuhl 2002).

In addition to these changes, governments, including that in the UK, are increasingly outsourcing the provision of public services, labelled New Public Management (Bevir, Rhodes and Weller 2003). Taken together, these changes have meant that a new kind of regulation has emerged (O'Rourke 2003).

1.6.2.1 From Government to Governance

The use of a new suit of regulatory and policy instruments, highlighted above, have led some scholars to advance arguments asserting that the meaning of government has changed. Including the increased use of economic and information based policies, it is noted that these instruments can emanate from non-governmental actors (Bevir and Rhodes 2003). This is seen to raise the need for governance beyond the state (Ronit and Schneider 1999). Such actors are seen to include organisations from the economic sector (profit driven organisations), as well as civil society, such as NGOs or professional bodies (Hutter 2006). This is an important addition to the state led conceptions of regulation advanced above, as it broadens the sources from which regulation and policy can originate, including those organisations or business that lead or control supply chains.

1.6.3 Kyoto Protocol, Intergovernmental Panel on Climate Change Policy Recommendations and Other Key Actors

As noted above, a range of policy responses are available to tackle climate change mitigation objectives, including command and control style regulations, taxes, tradable permits, information-based instruments and voluntary approaches (IPCC 2007a); these can be targeted at key sectors such as energy, transport, industry and agriculture and across varying scales, including sub-nationally, nationally and supra-nationally (IPCC 2007b).

The options highlighted above where utilised in the only internationally agreed mechanisms for the management of GHGEs enacted to date, the Kyoto Protocol.

Through the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol came into force in 2005. This international agreement committed 37 industrialised nations into GHGE reductions, over the period 2008-2020. Three mechanisms were established to aid these commitments, including emission trading, the clean development mechanism (CDM) and joint implementation (JI) (UNFCCC 2013).

The measures established through the Kyoto Protocol sought to utilise market forces, through the allocation and subsequent trading of GHGE permits or credits. This was seen as advantageous, as it allowed the most cost effective GHGE reduction methods or projects to be identified and undertaken (UNFCCC 2013). It is important to recognise the limited effects of the above noted recommendations and mechanisms, as at the time of writing, GHGEs continue to increase and the problem of anthropogenic climate change remains unsolved. Indeed, it is highlighted that for successful action, efforts may be required on many parallel front (Socolow et al. 2004).

1.6.3.1 United Kingdom Policy and Regulatory Context

A range of bodies and institutions operate within the UK in relation to climate change policy objectives. These include the Department of Energy and Climate Change (DECC), the Department for Environment, Food and Rural Affairs (Defra) and the Committee on Climate Change (CCC). DECC holds responsibility for energy policy and climate change, and leads on climate mitigation policy (DECC 2012). Defra, although not leading, controls several policy areas related to climate mitigation goals, including agriculture, land management, forestry, waste, water treatment and several other areas (Defra 2013a). Finally, the CCC, established under the Climate Change Act, provides independent advice to government on its carbon budgets, including their levels and the likelihood of current efforts to meet targets (CCC 2013).

Legislation is identified by some authors (e.g. Green, McMeekin and Irwin 1994) as a key driver for instigating pro-environmental behaviour in businesses. There is currently no legislation aimed at supply chain GHGEs; however the Climate Change Act does require the government to introduce mandatory GHGE reporting. A consultation was launched outlining several options, including the addition of Scope Three GHGEs, which include SC GHGEs (Defra 2011). However, Scope Three GHGEs were excluded

from the new requirements (Defra 2013b). This legislation is expected to impact large UK listed companies, excluding those that are privately owned, or those that trade on the Alternative Investment Market (AIM); those companies expected to be impacted range from mining, financial and insurance, as well as manufacturing firms (Hatchwell and Richens 2012).

1.7 Problem Statement and Motivations behind the Study

As set out above, climate change and the role that large organisations and businesses can play in its management and mitigation has received increasing attention in both academic and more mainstream agendas. At the same time, the SCs of these organisations and businesses have lengthened, whilst also containing risks for which SC leading businesses and organisations are now being held responsible.

As these phenomena collide, the management of GHGEs in organisations' SCs is increasingly recognised as an area that organisations and businesses must engage with in order to pursue climate change mitigation, CR goals and more general strategic objectives (Brickman and Ungerman 2008; Carter 2004; Carter and Jenning 2002). It is clear that these phenomena will change the way that organisations and businesses "run their supply chains" (Butner, Geuder and Hittner 2008 p.1). A further challenge will involve the location of these GHGEs, as they lie beyond the traditional boundaries of organisations (CDP 2009; HM Government 2009; Butner, Geuder and Hittner 2008). Schemes such as 'CDP Supply Chain' highlight that a group of leading businesses and public sector organisations recognise this emerging agenda and area of environmental management.

However, current academic knowledge is lacking in terms of its engagement with SC GHGE management. As will be demonstrated, environmental supply chain management (ESCM) literature is broad and diverse, yet has failed to adequately provide overarching theories able to holistically explain current or future practice (Carter and Easton 2011; Seuring and Müller 2008), whilst those scholars concerned with business and organisational engagement with climate change, although identifying the SC as an area of action, have failed to investigate in any depth. Those studies that have investigated the management of SC GHGEs, have been industry specific, or relied upon modelling, rather than providing a broader overview of this

current phenomenon (Chaabane, Ramudhin and Paquet 2012; Hsu et al. 2011; Lee 2011; Ramudhin et al. 2008).

In addition, the role of the state in managing the economy and society has been seen to be changing. As international businesses and organisations have increased in strength and influence, the nation state has seen a decline (Jordan, Wurzel and Zito 2005; Rhodes 1996). However, it is highlighted that "business policy appears to be at the core of the environmental debate and central to the problems and solutions" (Lamming and Hampson 1996 p.45).

These factors lead to a need for an exploration of the current phenomenon of SC GHGE management by those businesses and organisations that lead and control SCs, called 'SC leading' or 'focal' organisations (Seuring and Müller 2008). The reasons for their engagement and the methods they are using within this area require greater focus, whilst the barriers they are experiencing, if they are to be overcome, must be exposed. In addition, if climate change mitigation goals are to be tackled and achieved, governments and wider societal actors require a wide array of measures and methods that are able to manage and reduce GHGEs, including through SCs, which potentially holds several advantages.

1.8 Aim and Scope of the Research

As such, this research will explore the current phenomenon of SC GHGE management by businesses and organisations with the aim of identifying why and how this is occurring as well as what methods are available to governments and other societal actors to enhance such efforts.

1.8.1 Significance of the Study

This research will contribute in several ways, by:

1. Providing an overview of the current phenomenon of SC GHGE management in terms of why and how it is occurring, offering fresh insights and knowledge to the literature of ESCM, corporate climate change strategies and policy and regulation.

2. Identify key activities involved in SC GHGE management, allowing practitioners greater understanding, examples of best practice and provide methods for them to achieve their aims in relation to SC GHGE management.
3. Illustrate a range of interventions available to governments and other societal actors, wishing to enhance and further efforts by businesses and organisations to manage their SC GHGEs.

1.9 Thesis Overview

The thesis will continue as follows. Literature in relation to theories and existing academic knowledge regarding ESCM will be presented in Chapter 2. The rise of SCM will be charted as well as its extension into the management of environmental impacts. The drivers, barriers and methods involved in ESCM will be covered, as well as the prevailing frameworks of sustainable and environmental SCM. In addition, the existing research regarding the management of SC GHGEs will be highlighted.

The research methodology and methods used will be covered in Chapter 3. This will explain the thesis' epistemological approach as well as presenting the research questions and aims used to guide the study. The methods used to identify and collect appropriate empirical data will be noted, alongside ethical considerations.

The initial scoping study will be presented in Chapter 4. This will highlight significant actors involved in SC GHGE management, as well as identifying initial options for the enhancement of SC GHGE management, in the form of policy options.

The main results phase of the thesis will be presented in Chapter 5. This will cover why public and private sector organisations reported they were engaging with SC GHGE management, as well as the activities utilised, the factors taken into account when choosing which aspects of the SC to work with as well as the identification of variables considered to impact upon the SC GHGE management strategy undertaken.

Framework and theory building and its outcome will be presented in Chapter 6. An intervention theory, called the 'Emission Reduction INtervention Options' (ERINO) SC approach, will outline the development of options designed to enhance and increase levels of GHGE management in organisations, whilst a matrix, called the 'Focal Organisation Supply Chain emission Activity/Outcome' FOSCAO matrix, will highlight

the relationship between activities to manage SC GHGEs and the objectives and outcomes reported. In addition to these two contributions, an overview framework of SC GHGE management will be developed, aiming to synthesise the results of the research as a whole. This chapter will also aim to consider the meaning and implications of the findings in terms of their practical and theoretical significance, whilst attempting to move the thesis towards its conclusions.

The conclusions will be presented in Chapter 7. This chapter will consider the limitations of the research, what new questions are raised as well as what possible avenues exist to answer them, in the form of future research possibilities. The key contributions of the research to existing bodies of knowledge will also be covered here.

Chapter 2. Environmental Supply Chain Management and Suppliers

This chapter will cover literature that explores and outlines actions taken within and around the supply chain (SC) in order to manage and reduce the impact they inflict on the environment. The theoretical underpinnings of this work will be covered, including conceptions of the SC, how supply chain management (SCM) expanded to consider environmental impacts, as well as how wider theories and paradigms have affected this discipline. Those factors seen to be driving ESCM efforts, as well as those acting as barriers, will be highlighted, as well as the activities undertaken by organisations, including in relation to supplier management and development. Finally, the management of greenhouse gas emissions (GHGEs) within the SC will be covered, noting that although potentially important to climate change mitigation goals, that SC GHGEs are currently understudied, in part due to their contemporary nature.

2.1 Supply Chains

In order to deal with SCs in this project, and cover the necessary literature, it is essential to start by examining what a SC is. Lambert, Stock and Ellram (1998) offer a simple definition, noting that a SC is "the alignment of firms that bring products or services to market". A deeper description is offered by Chopra and Meindl (2001 p.3):

> A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves.

Both definitions hold value, and allow the projects focus to be clearly established. However, they take differing focuses and depths, with the second definition providing a more customer, or demand perspective. Both agree that the SC is a collection of businesses or business units aligned in order to provide a product or service to a customer.

2.1.1 The Rise and Meaning of Supply Chain Management

The SCM literature is central to the conceptual founding's of the project; as a term, it was first coined in 1982 by Oliver and Webber (Cambra-Fierro and Polo-Redondo 2009). The rise of SCM and its associated literature resulted from several phenomenon' occurring in the 1970s and 1980s. Firstly, changes to the general

business environment including increasing competitive pressures and specialisation, (Lummus and Vokurka 1999); and secondly, the success of new industrial approaches in Japan, namely by Toyota (Cox 1999). The changes in the general business environment, such as increased competition, due to opening markets and greater trade liberalisation, greater fragmentation of previously integrated businesses and associated specialisation, meant businesses increasingly recognised that they could no longer remain competitive in isolation, and that their success depended on the success of other businesses within the networks that supplied them (Lummus and Vokurka 1999).

Cox (1999) views SCM roots as a response to these changes, as scholars and business people alike searched for effective competitive strategies; the Japanese automotive industry of the 1970s and 1980s was often highlighted as an example of effective business and supply management. Toyota's lean thinking approach to supply management can be argued to be the start of SCM research and practices, and that SCM is an attempt to replicate such successes. Other early examples of SCM, as noted by Lummus and Vokurka (1999) include efforts within the United States (US) textiles and grocery industry to reduce the amount of time it took for products to make it through the SC (Kurt Salmon Associates Inc. 1993), mainly by increasing information flows between the businesses involved and using the information to better predict demand patterns and ensure that products were in the right place at the right time. Other businesses credited with early adoption of SCM initiatives include HP, Whirlpool and Wal-Mart (Lummus and Vokurka 1999).

2.1.2 Supply Chain Management Defined

Although the term SCM has been used for some 30 years, its precise meaning has been much debated. At its conception, SCM was used to describe several bodies of work, including the internal SC of businesses, dyadic business relationships, of vertical SCs including 'suppliers suppliers' and 'customers customers', as well as the management of a network of interconnected businesses involved in the provision of products and services to end customers (Harland 1996).

SCM is often conceived as managing everything from the extraction of raw materials, to assembly and sale to the end customer in a seamless process, with those companies

able to lead and effectively control their SC achieving success and competitive advantage (Monczka and Morgan 1997; Ellram and Cooper 1993). Attempts to construct theories of SCM have struggled due to its breadth; for example work by Chen and Paulraj (2004), who successfully identify core constructs of SCM consider aspects ranging from the role of top management and environmental uncertainty, through logistics and supply network structures, to the role and risks of supplier performance.

It is highlighted that SCs can be managed for many different priorities, including price, speed, quality and flexibility (Ketchen and Hult 2007). Consequently, SCM can be described as the tools and management techniques needed to increase the efficiency and operational effectiveness of a SC according to specific priorities (Cox 1999). This is seen to include:

- Striving for perfection in the delivery of value for customers, concentrating solely on those actions that create value,
- The elimination of waste in all process, internally and externally,
- The development of win-win relationships with suppliers,
- Collaborative supplier relationships,
- Reducing the total number of suppliers,
- The building of a network of suppliers within which trust and common understanding can be achieved whilst also allowing the sharing of learning about waste reduction and operational efficiency.

The overall goal of all these actions is to maximise performance and SCM thinking said that to do that it is necessary to tackle and enhance the whole SC. It is not just 'supplier partnerships' or 'logistics' (Lummus and Vokurka 1999).

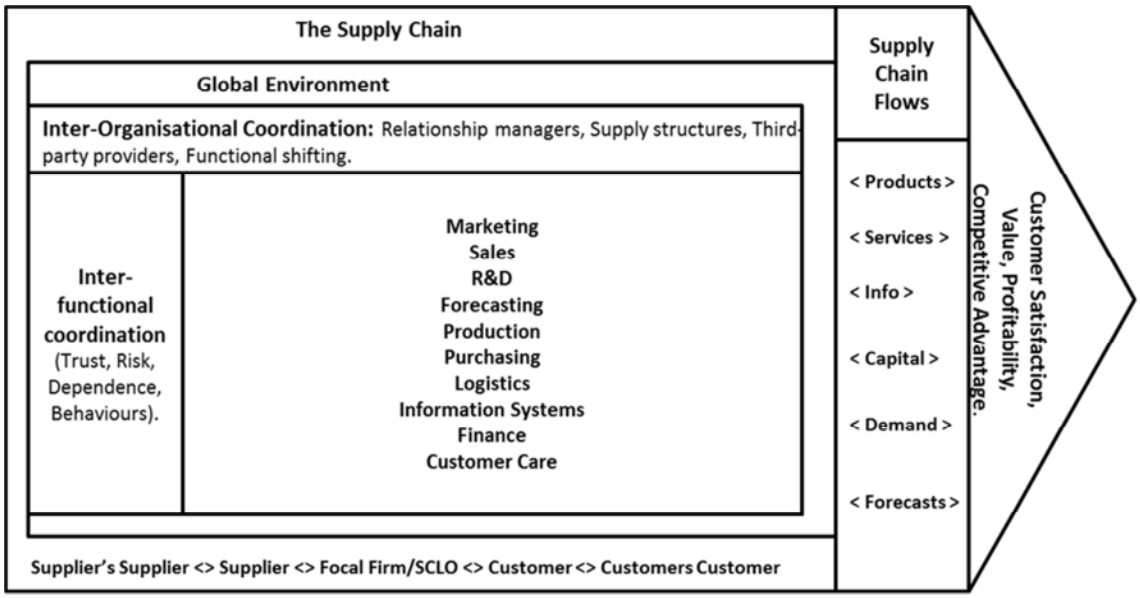
Handfield and Nichols (1999 p.2) integrate a definition of the SC into SCM, noting:

> The supply chain encompasses all activities associated with the flow and transformation of goods from raw materials stage (extraction), through to the end user, as well as the associated information flows. Material and information flow both up and down the supply chain. Supply chain management (SCM) is the integration of these activities through improved supply chain relationships to achieve sustainable competitive advantage.

Many typical business functions are involved in SCM, across varying geographical scales and across many firms; in attempting to define SCM, Mentzer et al. (2001)

developed a model of SCM to serve as an illustration and guide with regards to the planning, organisation and processes that must be considered in order for SCM to prove successful and to demonstrate its inter-functional nature. Figure 2-1 is able to highlight the breadth of SCM including, the many internal functions involved, from marketing to finance, as well as the importance of the outputs and contribution that SCM can make to an organisation, including customer satisfaction, value and profitability.

Figure 2-1: Model of aspects and processes involved in supply chain management (Mentzer et al., 2001 p.19).



The definition of SCM and its place within business or management thinking is important, as the understanding and the arrangements undertaken in this area by businesses have implications for industrial efficiency and competitiveness (Hobbs 1996). As this project is concerned with how organisations are managing the GHGEs embodied within their SCs, SCM thinking and science has influenced how modern production processes, and the SCs they are part of, are constructed. Equally, as this thinking has influenced the current shape of the world today, it may have a place in understanding how organisations approach, measure and manage their SCs to reduce GHGEs. As a consequence it is important to take forward the notions that SCM is a broad and potential all-encompassing view of management, involving many aspects of business and organisational management more generally.

2.2 Environmental Supply Chain Management

In conjunction with the rise of environmental concern in society, as well as increasing awareness of the importance of environmental issues within business, the management of SCs in an environmentally sympathetic manner has received an increasing and significant amount of attention, both in academia and in practice (Luthra et al. 2011; Simpson 2010). With regards to a definition of green or environmental SCM, Srivastava (2007 p.53-54) states that it can be considered as:

> [I]ntegrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life.

Much work has been conducted on SCM and its integration with concepts and objectives of sustainability. Several names have been used for this integration, including sustainable supply chain management (SSCM), which integrated the demands of sustainable development, namely social, environmental and economic goals (Carter and Rogers 2008; Seuring and Müller 2008; Linton, Klassen and Jayaraman 2007) and it's extension to public procurement (Walker and Brammer 2009). Terms such as environmental (Walker, Di Sisto and McBain 2008; Kim 2007) or green SC management (Srivastava 2007) (ESCM and GSCM respectively) have also been coined, and reduce the scope of such actions to those objectives designed to limit the impact of SC operation on the natural environment, rather than the social and economic elements also encompassed in SSCM.

One issue with such literature is its wide ranging focus, for examples from logistics (e.g. Carter and Rogers 2008) to aspects of product design (e.g. Baumann, Boons and Bragd 2002). Several authors have endeavoured to review the literature, each developing their own classifications in an attempt to encompass what is a substantial and ill-defined body of work (Gold, Seuring and Beske 2010; Seuring and Müller 2008; Seuring and Müller 2007; Srivastava 2007). Handfield, Sroufe and Walton (2005) classify the literature depending upon topic, covering areas such as environmental risk management, environmental purchasing or product and process design. Srivastava (2007) categorise on problem context, covering green design versus green operation, with the latter including green manufacturing and remanufacturing, reverse logistics

and waste management. Both these reviews demonstrate the breadth of literature and its wide focus.

Other areas linked to ESCM include environmental purchasing (Zsidisin and Siferd 2001) and environmental performance as an operations directive with SC issues subordinate (De Burgos and Lorente 2001). Walker, Di Sisto and McBain (2008), through an interview survey of seven public and private organisations note that environmental SC initiatives can range from reducing packaging and waste, to vendor environmental assessments, to eco-friendly product design. Such efforts provide benefits, including reduced costs, improved organisational performance and enhanced reputation.

ESCM has further advantages, like SCM before it; typical examples include the reducing or elimination of material used in manufacturing, the auditing and establishment of environmental compliance and practise of suppliers and the joint development of new environmentally friendly materials and process (NEEFT 2001). Such efforts are also able to manage the risks that arise from poor environmental performance, and so form part of the risks management and strategic activities of businesses (Linton, Klassen and Jayaraman 2007; Preuss 2005). Ultimately however, ESCM or GSCM aims to control and reduce the environmental impacts that result from the SCs that businesses construct and use to provide products and service to their customers.

There are less direct, wider benefits, beyond improved environmental performance in the SC, such as improved competitive advantage, increased ability to adopt advanced technologies and techniques, and provide more optimal outcomes; similarly to some theories put forward within SCM, these however are seen to rely upon close working relationships between SC members (Bai and Sarkis 2010; Bojarski et al. 2009; Seuring and Müller 2008; Florida 1996).

As a result of the above mentioned factors, a further environmental advantage of ESCM, as noted by Green, Morton and New (1996) is that green initiatives are not grounded in altruism; rather they are based on market principles and strategic issues, meaning that an increased awareness and consideration for the environment, and in this case GHGEs, is based on a business case.

2.2.1 Sustainable Procurement in the Public Sector

SSCM or ESCM in the public sector is addressed separately by some authors within the literature; denoted as 'procurement', sustainable procurement in the public sector follows the principles of sustainable development, incorporating its social, economic and environmental dimensions, including the management and reduction of GHGEs. This places the government in dual roles within the economy, as both a regulator and a participant or buyer (McCrudden 2004). Taxpayer's money is used in order to purchase the goods and services required for the public sector to fulfil its obligations. UK public sector spending is substantial, measuring some £691.67 billion in 2010/11 (Rogers, Sedghi and Tetlow 2011) meaning the scale of this spending, if coordinated accordingly, can be used to pursue wider government policy goals (Preuss 2011; Walker and Brammer 2009), such as social policy objectives (Erridge 2007), or for enhancing innovation (Uyarra and Flanagan 2009).

A lack of academic attention to public sector sustainable or environmental procurement means few publications are available (Preuss 2009; Walker and Preuss 2008). Research that has engaged with this area has focused on the development of tools for aiding the process (Walker and Brammer 2009; Li and Geiser 2005; Coggburn 2004), or for purchasing from specific industries or sectors such as timber (Bull et al. 2001), Information Technology (IT) (Matthews and Axelrod 2004) or from small and medium-sized enterprises (SMEs) (Walker and Preuss 2008).

Key conceptual differences exist between procurement in the public and privates sectors, including size, leverage over suppliers, procedures and as mentioned above, the dual role of government (New, Green and Morton 2002; Heinritz et al. 1991). Procurement within the public sector is often on a greater scale as compared with the private sector, which leads to greater leverage over the SC (Preuss 2011); this means that public sector organisations should have greater power, especially when combined with the government's ability to set commercial terms. Further, the high degree of procedural compliance required by suppliers should enable additional objectives, such as those aligned to sustainable development, to be integrated with ease. However, a number of barriers exist, which creates a paradox, where this power fails to translate into an increased ability to integrate sustainability objectives into public procurement (Walker and Brammer 2009; Walker and Preuss 2008; New, Green and Morton 2002).

Although many barriers are identified, actions by public sector organisations in relation to sustainable procurement are recognised in the literature (Preuss 2009). For instance, the supplying of information to suppliers and encouraging the adoption of EMS is highlighted within the context of local government (Thomson and Jackson 2007).

Within the UK, several factors have been identified that restrict the public sectors ability to procure sustainability, and specifically integrate environmental criteria and objectives in to the procurement process. Through a survey of 106 procurement officers by Walker and Brammer (2009), analysis showed that the public sector was focussing upon social and economic aspects of sustainability to a greater degree than those concerned with the environment. A high degree of variability was also discovered across the sector, due to specific contextual constraints such as supplier willingness and availability, familiarity with policies, and specific organisational pressures and incentives. This indicated that policy, emanating from the top of government, for the public sector to embrace and instigate sustainable development through the procurement function was being moderated by factors within specific public sector organisations, possibly a symptom of the highly devolved nature of the public sector in the UK. This assertion is reinforced through the identification of a lack of common procurement formats throughout the public sector and fragmented expenditure (Walker and Preuss 2008; Preuss 2007).

The public sector is also identified as being poor at enforcing non-monetary criteria (New, Green and Morton 2002), lacking adequate project management skills and awareness, holding a perception that ‘sustainability’ increased costs and having a bureaucratic culture that focussed on policy, rather than delivery (Morgan 2008; National Audit Office 2005). A failure to use whole life costing as well as a general lack of skills were also found to be factors hindering such efforts and were deemed priorities for action by Sir Neville Simms, tasked to investigate procurement in 2006 (Sustainable Procurement Task Force 2006). Increased transparency, alterations to organisational culture and increased support for procurement staff, have all been identified as actions that would support sustainable procurement efforts within the public sector (Preuss 2009; Walker and Preuss 2008).

This research demonstrates that although the scale and prospective ability to coordinate public procurement towards sustainable or environmental goals is high, that in practise many barriers and challenges exist that reduce its potential. This area of the literature is thin and could be further developed specifically with regards to why environmental aspects of government policy are not being pursued to such a degree, and how sustainable public procurement approaches compare to those in the private sector.

2.3 Drivers and Barriers

2.3.1 Drivers

Companies are beginning to recognise how greater social and environmental responsibility can improve firm performance (Zadek 2004; Porter and van der Linde 1995). The factors that drive and push SC leading organisations to enact ESCM initiatives and practices are important to understand, as these factors allow the motivations to be understood, and consequently illuminates potential levers available to those actors wishing to enhance such efforts.

Many drivers are investigated in research concerning ESCM, and why focal organisations strive to achieve environmental performance beyond that as required by regulation; these are seen to include:

- Institutional influences (Hoffman 1999; Jennings and Zandbergen 1995),
- Stakeholder pressures (Sharma and Henriques 2005; Buysse and Verbeke 2003),
- Managerial interpretations (Sharma 2000),
- Managerial attitudes (Cordano and Frieze 2000),
- Managerial and organisational values (Bansal 2003; Bansal and Roth 2000),
- Leadership (Egri and Herman 2000),
- Organisational capabilities (Aragón-Correa and Sharma 2003; Christmann 2000; Sharma and Vredenburg 1998; Russo and Fouts 1997; Hart 1995) and,
- Organisational identity (Sharma 2000).

Those factors responsible for driving focal organisations to engage and manage issues within their SC, beyond that as required by law, can be broadly split into two

categories: stakeholder pressure, focused on issues that can impact the reputation and brand image of an organisation, such as workers' rights or poor environmental management within a supplier; and traditional SCM objectives to enhance efficiency and insulate the organisation from supply variability in terms of both price and security of supply. Proactive focal organisations go beyond basic requirements, often for financial reasons, until they achieve a competitive advantage-seeking stage (Porter and Kramer 2006; Rasmussen 2005; Porter and van der Linde 1995).

Recognition and development of an organisational requirement to manage its impact on the environment has developed largely in response to increasing levels of government regulation and campaigning of environmental issues by non-financial stakeholders such as government, third sector organisations and the media (Bansal 2005; Hoffman 1999; Aragón-Correa 1998). Friedman (1970) and Egri and Pinfield (1996), however take an alternative perspective, that the choice of environmental strategy adopted by a SC leader has more to do with the needs of the firm's financial stakeholders; this demonstrates the plurality of driving factors identified and the potential disagreement within the discipline as to the relative primacy of the many driving factors identified.

Green, Morton and New (1996) note that these pressures can be seen as a firms 'selection environment', or those factors external to the firm which influence chosen products or processes. Both Walker, Di Sisto and McBain (2008) and NEEFT (2001) separate such factors between those that come from within an organisation and those originating externally. Walker, Di Sisto and McBain (2008) conducted an exploratory study of seven private and public organisations investigating the drivers they felt had pushed them to undertake ESCM initiatives; Table 2-1 presents a non-exhaustive list of identified driving factors highlighted within the literature.

A study by Croom et al. (2009) notes similar factors, established through several case studies. The most significant factors found were regulation, cost savings, reputation or as a differentiator, marketing strategy and corporate culture (see Table 2-1). There is general agreement regarding these drivers, with Croom et al. (2009) noting the primacy of regulatory drivers, Kovács (2008) focussing on stakeholders and Florida (1996) and Green, McMeekin and Irwin (1994) highlighting the role of consumers.

Consequently, the literature in this area is in broad agreement to the reasons why organisations engage with ESCM, but disagree when questioned over their relative primacy and importance.

Table 2-1: Non-exhaustive collection of driving factors identified within the environmental supply chain management literature.

Internal Drivers	External Drivers
Pressure to reduce costs (Walker, Di Sisto and McBain 2008; NEEFT 2001)	Regulation (Walker, Di Sisto and McBain 2008; NEEFT 2001)
Risk Management Function (Walker, Di Sisto and McBain 2008; NEEFT 2001)	Customer Demand (Walker, Di Sisto and McBain 2008)
Owners/ Founders Values (Bingham et al. 2011; Walker, Di Sisto and McBain 2008)	Competitive Pressures (Walker, Di Sisto and McBain 2008)/ Market Forces (Seuring and Müller 2008)/ as a differentiator (Croom et al. 2009)
Enhanced Product Quality (NEEFT 2001)	Society (i.e. public pressure, pressure from campaign groups) (Kovács 2008; Walker, Di Sisto and McBain 2008)
	Suppliers (Walker, Di Sisto and McBain 2008)
	Brand Image (Kovács 2008; NEEFT 2001)
	Technological Developments (Florida 1996)

The drivers that are responsible for focal organisations engaging with ESCM are also highlighted as being able to pass through these businesses and organisations to other businesses within the SC, noted through work on Environmental Supply Chain Dynamics (ESCD) (Hill 1997; Green, Morton and New 1996). The factors that control or facilitate ESCD are mostly external (Gunningham 2009), such as stakeholder pressure (Ciliberti, Pontrandolfo and Scozzi 2008), regulation (Lee 2008) and technological developments (Florida 1996). Seuring and Müller (2008) provide a categorisation of the pressures that can flow through the SC, aiding in their assessment and evaluation; the categories identified include:

- Legal & regulatory,
- Response to stakeholders,
- Competitive advantage,
- Customer demand,
- Reputation loss,
- Environmental and social pressures groups (NGOs).

The ability of these pressures to move through focal organisations and impact the SC has implications. Focal organisations, as noted previously in this chapter, are now seen to rely upon their SCs for their competitive performance. That such pressure can pass down through the SC means that the methods used by focal organisations and their reasons for engaging in ESCM can be affected, and that this in turn will impact on those firms that populate the SC.

2.3.2 Corporate Responsibility in the Supply Chain

A somewhat separate and well defined body of literature sees ESCM efforts as part of organisations CSR or CR efforts, and is connected to several drivers above, such as society and brand image. Central to CR as a driver, is that these organisations are attempting to ensure that their activities and conduct exceeds that as required by law (Kovács 2008; Pedersen and Andersen 2006; Welford and Frost 2006).

CR objectives are managed in SCs through a number of mechanisms and initiatives, including supplier codes of conduct; although heavily criticised (Pedersen and Andersen 2006), increasingly research is highlighting methods that are proving effective at monitoring and enforcing such codes, including (Andersen and Skjoett-Larsen 2009; Pedersen and Andersen 2006):

- Direct sanctions (where non-compliance in detected),
- Ensuring goal convergence, through longer term contracts,
- Trust, pursued through long-term relationships,
- Third-party monitoring and verification.

A well-defined set of literature concerning CR issues within the SC centres on labour standards, where early efforts concentrated non-governmental sources of regulation to control activities upstream in the SC (Weil and Mallo 2007). This literature has

concerned itself with ethical procurement initiatives, which have experienced mixed success (Roberts 2003), and represents a widening of areas where firms were felt to have to act responsibly (Kovács 2008; Welford and Frost 2006).

Although literature in this area offers a precedent, it is concerned with more social aspects of SCM, but does demonstrate how practises occurring up stream in the SC have impacted SC leading organisations and led them to engage and increase control over their SC for CR purposes; actions taken in order to limit social liabilities or risk in the SC differ to those enacted in order to enhance environmental management in that they are unlikely to reduce costs or increase efficiency. Ideas regarding the spread of CR beyond the traditional boundaries of organisations, and specifically in SCs, are well addressed by Kovács (2008), who attributes such shifts to increasing recognition by organisations of the importance of stakeholders, a prominent driver of ESCM efforts.

2.3.3 Barriers and Challenges to Environmental Supply Chain Management

Literature concerning the barriers faced by organisations implementing ESCM initiatives is relatively sparse when compared to that on the driving and motivating forces (Walker, Di Sisto and McBain 2008). Table 2-2 and Table 2-3 highlight key barriers and challenges presented in the literature.

Table 2-2: Key internal barriers and challenges identified within the literature for environmental supply chain management.

Barrier (Internal)	Source
Cost Concerns of Programme	(Luthra et al. 2011; Wycherley 1999)
Cost Primacy Over the Environment	(Min and Galle 2001)
Lack of Training or Poor Human Resources	(Hsu and Hu 2008; Bowen et al. 2001)
Lack of Internal Measurement Infrastructure	(Hervani, Helms and Sarkis 2005)
Information Dissemination and Communication	(Zhu and Cote 2004; Lamming and Hampson 1996)
Lack of Commitment or Interest	(Handfield, Sroufe and Walton 2005; Ravi and Shankar 2005)

Table 2-3: Key external barriers and challenges identified within the literature for environmental supply chain management.

Barrier (External)	Source
Regulation (inhibiting innovation)	(Zhu and Sarkis 2006; Porter and van der Linde 1995)
Supplier Unwilling to Share Information	(Wycherley 1999)
Supplier Reluctance to Participate	(Luthra et al. 2011; Srivastava 2007)
Inconsistent Science and Opinion	(Lamming and Hampson 1996)
Slow Advances in Environmental Technology	(Lamming and Hampson 1996)
Low Customer Demand	(Lamming and Hampson 1996)

2.4 Methods and Activities for Environmental Supply Chain Management

The management of environmental issues in the SC is achieved either through the establishment of certain requirements that must be fulfilled by the SC, by capacity building through the extension of the collaborative paradigm of competition to include environmental issues or by altering the manufacturing process internally or in the SC (Vachon and Klassen 2006; Preuss 2005).

Seuring and Müller (2008) note that focal organisations will have to lead these initiatives as they rule or govern the SC, provide direct contact to customers and design the product or service offered. Specific techniques for the management of environmental issues through a SC include:

- Eco-efficiency initiatives (Donnelly et al. 2006), often through extended Total Quality Management efforts (Lamming and Hampson 1996).
- Eco-design and materials choices (Donnelly et al. 2006).
- Life Cycle Assessment and product stewardship, i.e. 'cradle to grave' thinking and design (Lamming and Hampson 1996), including product life extension, end-of-life considerations and recovery processes (Linton, Klassen and Jayaraman 2007). This approach is required to reduce impacts across the entire SC (Chaabane, Ramudhin and Paquet 2012).

Further initiatives identified through the literature aligned more with management, rather than process and design as above, include:

- Supplier enabling (i.e. capacity building) (Ciliberti, Pontrandolfo and Scozzi 2008) including collaboration and relationship building, increasing understanding and joint working practises (Lamming and Hampson 1996).
- Supplier requirements, including codes of conduct (Preuss 2010; Ciliberti, Pontrandolfo and Scozzi 2008).
- Evaluation, auditing (Ciliberti, Pontrandolfo and Scozzi 2008), and supplier/vendor questionnaires (Lamming and Hampson 1996).
- Involvement of procurement staff or SC managers with internal environmental initiatives and/or making them responsible for environmental impacts up and/or down the SC (Preuss 2005), also linked to the central role of focal organisations in this process (Seuring and Müller 2008).
- Supplier forums – discuss/report progress, annual benchmarking, outline future strategies (Keating et al. 2008).
- CSR management systems and standards – e.g. SA8000, ISO14001 (Ciliberti, Pontrandolfo and Scozzi 2008).

Several studies have outlined various methods for the successful implementation of ESCM or SSCM strategies. Keating et al. (2008) establish a six phase strategy: (1) SSCM framework development; (2) data gathering on current supplier performance; (3) data gathering and screening of new suppliers; (4) ensure compliance across all business units; (5) supplier management and influencing; and (6) enhance reporting of SC impacts in future sustainability reports.

Handfield, Sroufe and Walton (2005) offer a similar approach, involving the (1) defining of the strategic and environmental importance of the commodity; (2) the conducting of research on potential solutions; (3) the development of a strategy; and (4) and the monitoring of results.

A survey of purchasing professionals indicated that the development of a standard checklist, establishing an audit team including third party members, maintaining

records on progress and violations of policy, regular assessment of environmental issues and the development of action plans and continuous monitoring of progress as all being essential for the implementation of SSCM (Min and Galle 2001). Bowen et al. (2001) take a similar stance and emphasise the need for internal commitment and the development of internal capabilities. The benefits of these approaches go beyond a reduced environmental impact. Cost savings can be shared between the supplier and the focal organisation, also known as 'gain share' (Bowen et al. 2001), whilst also aiding in efforts to add value and avoid risks (Lamming and Hampson 1996); indeed, many of these decisions can be seen as risk management, balancing action and inaction (Cousins, Lamming and Bowen 2004).

When ESCM is conducted through a cooperative relational approach, the spread of best practice, technology and processes is also noted as a positive spill-over (Vachon and Klassen 2008; Hall 2000; Green, Morton and New 1996; Lamming and Hampson 1996). Preuss (2005) notes the enhanced business relations that can result, also aiding inter-organisational learning.

Certain capabilities and commitments are noted as required for ESCM or SSCM. Walton, Handfield and Melnyk (1998) note the need for upper management commitment. The development of internal capabilities, especially for product based approaches, is emphasised by Bowen et al. (2001), whilst trust is seen as central in more cooperative and relation led approaches (Narasimhan, Mahapatra and Arlbjørn 2008). Vachon and Mao (2008) note that 'strong' SCs, or those with a high number and quality of suppliers, correlate with successful environmental initiatives. The ability of a focal organisation to ensure that these measures go beyond the first tier of suppliers and continue to percolate up/down the SC is a widely reported difficulty inherent in SCM (Green, Morton and New 1996).

In close relation to the overarching theme however, Hughes (2001) notes the increasing role for 'big capital' in managing global SCs. In later research Hughes (2005) highlights three basic approaches employed by large multi-national companies (MNCs) to manage sustainability in their SCs:

- ‘Arm’s length’ approach (audits by third parties in line with relationships characterised by contractual relationships);
- Coordinated approach (trust and collaboration – self-regulating and same tasks passed on to suppliers, i.e. second and third tier engaged);
- Developmental approach (working together, engaging with suppliers from the inception).

In conclusion, the literature regarding the strategies used to manage sustainability in the SC notes product based approaches, contractual methods based on targets and criteria, and a more collaborative developmental approach that aims to build capacity in a SC through a longer term outlook.

2.4.1 Supplier Management

Specific efforts mentioned within the ESCM literature that deal with the management of suppliers is a critical issue to the management of GHGEs within suppliers and the SC; indeed, research indicates that supplier selection and engagement not only impacts on the success of supplier relations, but is also linked to the success of the buying organisation (Kannan and Boie 2003).

Supplier selection is a critical aspect of SCM, however, it can be conducted depending upon a range of factors, including price, quality and if any technical support is offered for example (Swift 1995). Supplier selection processes are noted as having altered radically over recent decades, involving greater scrutiny, including increased specifications and guidelines, greater use of telecommunications and increased technical capabilities (Weber, Current and Benton 1991). Other factors noted as being considered when choosing suppliers include whether any additional services are supplied with a product, the geographical location of suppliers, their financial position and resilience, their labour relations record, or likelihood of compliance with organisational policies and laws (Dickson 1966).

Supplier engagement, once the selection process has been completed, can range from board engagement, such as setting expectations, to deeper levels of development, such as supplier partnering. Supplier development has become to be seen as a method through which businesses and organisations can improve their own performance

(Krause 1997). These can range from limited to extensive efforts, including the training of supplier personnel or investing in the supplier.

A common supplier management technique is found to be supplier questionnaires, used to collect information on aspects such as legal and regulatory compliance, whether suppliers have EMS and policies and more general performance measures (Green, Morton and New 1998; Hill 1997; Lamming and Hampson 1996). Other methods used include:

- The imposition of certain requirements (Hill 1997),
- The assessment of supplier performance for use in a focal organisations owns accreditations (Baylis, Connell and Flynn 1998; Krause 1997),
- The coaching of suppliers, including training aid (CIPS 1998),
- Partnering approaches (Holt 2004),
- The de-selection of suppliers who fail to comply with specific environmental requests (Baylis, Connell and Flynn 1998).

Research in this area also notes, with regards to the use of questionnaires, that a collaborative and close working relationship may produce positive spills-overs through the demonstration of best practice for example (Holt 2004). Indeed, a close collaborative approach, achieved through mentoring, coaching or supplier educational schemes is seen as critical to the ability of ESCM initiatives to filter up and down through SCs spreading best practice (Holt 2004). Indeed, simple dialogue with suppliers has been shown to allow solutions to common problems to be found (King 1996).

In order for close, collaborative relationships to achieve these aims, free flows of information, close teamwork, and attention to detail at the start of the relationship are all highlighted as important requirements (Holt 2004). It is also noted that large third party organisations can facilitating these requirements, by bringing suppliers and focal organisations together and establishing frameworks within which they are able to establish effective commercial relationships (Gascoigne 2002). Supplier partnership development has been found to rely upon top management commitment, and on the philosophical approach undertaken towards purchasing within an organisation, i.e.

whether it is just a way of procuring products or services, or whether it is seen as a potentially collaborative relationship with reciprocal benefits (Stuart 1993).

Although efforts to increase the management and development of suppliers can be seen to have increased both in practise, and in terms of academic research, a number of difficulties and barriers are also identified. These include its cost and complexity, a lack of supplier commitment, inadequate supplier resources or capabilities, low levels of trust and insufficient levels of inducements to suppliers (Handfield et al. 2006).

2.4.2 Factors, Competencies and Elements for Success in Environmental Management

Academic literature concerning those factors and capabilities organisations and businesses require for successful environmental management focuses on smaller businesses, such as those found within SCs. As this project is interested in larger focal organisations, only inferences can be drawn from the literature concerning capabilities for smaller organisations. To supplement this lack of information, literature concerning more general competencies for competitive advantage and business success will also be considered. Competencies or capabilities can be considered as the knowledge and skills required by businesses and organisations to achieve their goals, whether that is enhanced environmental management efforts or improved business performance in terms of competitive advantage (King, Fowler and Zeithaml 2001).

A range of factors and competencies are noted as required for successful environmental management in SMEs. By looking at manufacturing firms, and by considering the dynamic capabilities literature, which highlights the need for rapid alterations and a flexible approach to the competencies or skills of businesses, Hofmann, Theyel and Wood (2012) note the successful adaption of technology, inter-firm relations and innovation as three key capabilities. In addition, by considering a wider range of SMEs, Lee and Klassen (2008) highlight the effects of supportive buyer-supplier relations, resource acquisition and more general capability development. That inter-firm or buyer-supplier relations were identified by both sets of scholars indicates a key role for collaboration and joint-working with partner organisations in enhancing environmental management efforts. However, as this research was based on smaller

businesses, which may lack such competencies, and hence obtain them from partners, its applicability to the context of SC GHGE management may be limited.

By considering more general capabilities and factors for success, a wider range of capabilities and factors can be found. A study of 17 textile manufacturers and hospitals identified industry specific factors; these included knowledge of international logistics, technology and knowledge for differentiation on price and quality, the development of internal talent, and the development and maintenance of efficiencies for the textiles industry (King, Fowler and Zeithaml 2001). Hospitals required flexibility, high levels of internal communication (through relevant information technology), the attraction of top management talent and staff training for effective communication (King, Fowler and Zeithaml 2001). The ability to embed those capabilities is also highlighted here, as a capability that is not fully integrated into an organisation's structures is unable to be fully utilised (King, Fowler and Zeithaml 2001). It should be no surprise that these different organisations required different competencies and capabilities; however the role of internal communication and staff training and the development of talent may be those factors most relevant to large focal organisations.

The role of effective collaboration and inter-firm relations is also highlight by Lorenzoni and Lipparini (1999) in their consideration of the factors necessary for growth and innovation in the packaging machinery industry. The role of communication and knowledge transfer, both between partner organisations and within larger organisations and businesses is highlighted in other research in the literature, as well as the positive effects of improved team working and training (Lokshin, Gils and Bauer 2009; Wang, Tong and Koh 2004; Adam and Lamont 2003).

In summary, the above noted literature indicates that communication (internally and externally) as well as collaboration allows required knowledge and skills to be obtained by organisations, that can then be employed towards their goals, whether they be improved business performance or enhanced environmental management, and that these efforts can be improved through training, the recruitment of skilled employees and better team working.

2.4.3 Outcomes

There is much discussion within the literature regarding the outcomes of the strategies and mechanisms used by focal organisations in order to manage environmental issues in their SCs. Indeed, throughout section 2.4 the positive spill-overs and potential 'gain share' opportunities are noted (Vachon and Klassen 2008; Bowen et al. 2001; Hall 2000; Green, Morton and New 1996; Lamming and Hampson 1996).

The use of codes and policies in particular is much critiqued, as they "by their nature, tend to be relatively static, whereas the issues present in SCs and in wider societies can change relatively quickly, leading to gaps and ambiguities in their implications" (Brammer and Walker 2011 p.38). Criticisms concerning the role that codes of conduct can play in ensuring minimum levels of performance in SCs are highlighted by other research, which notes that they rely upon a precondition of active commitment and can be vague and poorly managed (Preuss 2010; Pedersen and Andersen 2006). It is highlighted that this raises agency problems, resulting in non-compliance; these issues are exacerbated when SCs are international.

A recent body of academic research generates support for the theory that the customer-supplier or supplier-supplier relationship may generate a range of positive environmental outcomes (Rao and Holt 2005; Zhu and Sarkis 2004; Klassen and Vachon 2003). Communicating goals of sustainability or environmental performance through the supply relationship has resulted in, for example, collaborative waste reduction, environmentally sound innovation, cost-effective and environmentally beneficial solutions to production problems, and more rapid development and uptake of environmental technologies.

2.5 Environmental Supply Chain Management Theory

Although hailed as a major shift in business thinking, many scholars have noted the lack of theory and grounding for SCM thinking (Carter and Easton 2011; Halldorsson, Mikkola and Skjott-Larson 2007; Chen and Paulraj 2004; Cox 1999; Hobbs 1996). No one theory has been established that covers environmental or sustainable SCM fully (Seuring and Müller 2008; Halldorsson, Mikkola and Skjott-Larson 2007). Various theories have been applied to SCM, including the natural resource-based view, transaction cost approaches, the network perspective, game theory, social capital

theory, and strategic choice, each offering contributions via different perspectives (Ketchen and Hult 2007; Skjott-Larson 1999; Hobbs 1996). ESCM research followed a similar path as more general research into social and environmental issues, going from a 'stand-alone' stance, through social responsibility conceptions, before finally recognising environmental management and sustainability as highly interrelated concepts, covering topics from supplier management to design (Carter and Jenning 2002).

Efforts to provide a grand theory of SCM have not been successful. Halldorsson, Mikkola and Skjott-Larson (2007) attempted to combine principle agent theory (i.e. aligning incentives between agent and a principle), transaction cost analysis and network theory (that it is not just down to the focal organisations 'business-to-business' relationships, but that their suppliers relationships with their suppliers is important). This attempt investigated how to structure a SC as well as how best to manage one. This effort concluded that no one theory is suitable and that even with complimentary theories, difficulties are encountered, such as the range of problems and objectives inherent within the operation of a SC.

Within SCM, transaction cost approaches were used by Hobbs (1996) and are able to provide an explanation for the existence and structure of businesses and for the character of vertical integration in a SC. Hobbs (1996), using these concepts, highlights the need for rapid data transfers, co-operation and team work among SC members in order to reduce costs in the SC and hence increase efficiency and profits. Although these assertions are useful for considering how focal organisations should manage their suppliers and the GHGEs they embody, other concepts such as power and value are also advanced as useful, and have often been overlooked in favour of concepts such as trust, equity and openness (Cox 1999).

Cox (1999) asserts that in order to understand how a SC operates and how a business is successful through its management of the SC, it is essential to understand the physical resources required to deliver the service or product; understanding the exchange relationships and what it is about the resources within the SC that allow a business to obtain value from them, is also highlighted. Central however, is that a business must have power over the resource within the SC, implying power over

suppliers. Hill (1997) and Green, Morton and New (1996) introduce the 'Green Supply' paradigm, asserting that at each stage of the SC, information and pressures are transferred. Such pressures can assert influence over SC members, both above and below.

Preuss (2005) also highlights the transfer of information and pressure through the SC, noting its potentially strategic importance, and also how it allows buying firms to influence their suppliers, through mechanisms such as minimum standards, the stipulation of specific accreditation or environmental policies. These concepts that see SCs as conduits of pressures, as well as capital, information and goods or services, are felt to be controlled by 'focal' organisations (Seuring and Müller 2008).

Focal firms can be considered as those that rule or govern the SC, providing the direct link with the customer, as well as designing the product or service offered (Seuring and Müller 2008). Along with this concept, El-Ansary and Stern (1972), Imrie and Morris (1992) and Price (1995) note the term 'channel power'; much like the focal firm, channel power describes the ability of one firm (a Channel Leader) to control the actions of another in the SC. The identification of such organisations is significant, as power and influence over many other businesses is centred upon them. With this power, such firms are able to influence the environmental performance of SC members and hence the SC as a whole.

There is a sizable portion of literature noting that SCs can be used to disseminate and spread management best practice, technologies and processes, with larger firms often the originator (Vachon and Klassen 2008; Hall 2000; Green, Morton and New 1996; Lamming and Hampson 1996). This phenomenon is considered to work through closer relationships between firms in the SC, and increased levels of cooperation and joint venture, (Seuring and Müller 2008; Preuss 2005), in contrast to theories concerned with power, control and influence.

Hill (1997 p.1259) notes that "[e]nvironmental pressure can thus be conceptualised as moving along the SC through two constituent elements: through customers, those who purchase the products of the firm and through suppliers...". Hall (2000 p.456) calls this

phenomenon, where practice and information diffuse through a SC to reduce environmental impacts, Environmental Supply Chain Dynamics (ESCD).

Hall (2000) also theorises on the ability of SC leading or focal organisations to pressure SC members. ESCD are proposed by Hall (2000) as being formed by both environmental pressures and SC pressures; although it is highlighted that environmental pressure can be weak, when combined with SC pressures, they can exert considerable influence on a supply base.

The sum of these concepts for focal organisations is that information exchange, similarly highlighted by Hobbs (1996) in SCM, is central to the initiation of ESCD. Whilst for suppliers, adaptability is seen as crucial in allowing them to change to work effectively with their customer firms (Hall 2000). Hall (2000 p.469) further notes that policy makers should understand that "legislation is not the only mechanism generating changes", and that such non-regulatory pressures have potential to enact changes in the SC. It is also noted however that current government regulation favours voluntary controls and the use of markets, and that ESCD are currently limited, being most effective when instigated by legislation (Hill 1997).

These theories highlight that focal firms or organisations have power over their SC, either through co-operation and collaborative strategies, or through power and value appropriation. By combining these SC pressures, or methods of control, with environmental pressures, the SC can become a conduit for the pursuit of environmental performance enhancement in firms that are external and separate from focal organisations, i.e. those within the SC. This is significant to the themes within this project, especially as the methods used by focal organisations to influence and control the GHGEs of SC members has been highlighted as a core concern in terms of risk and reputation.

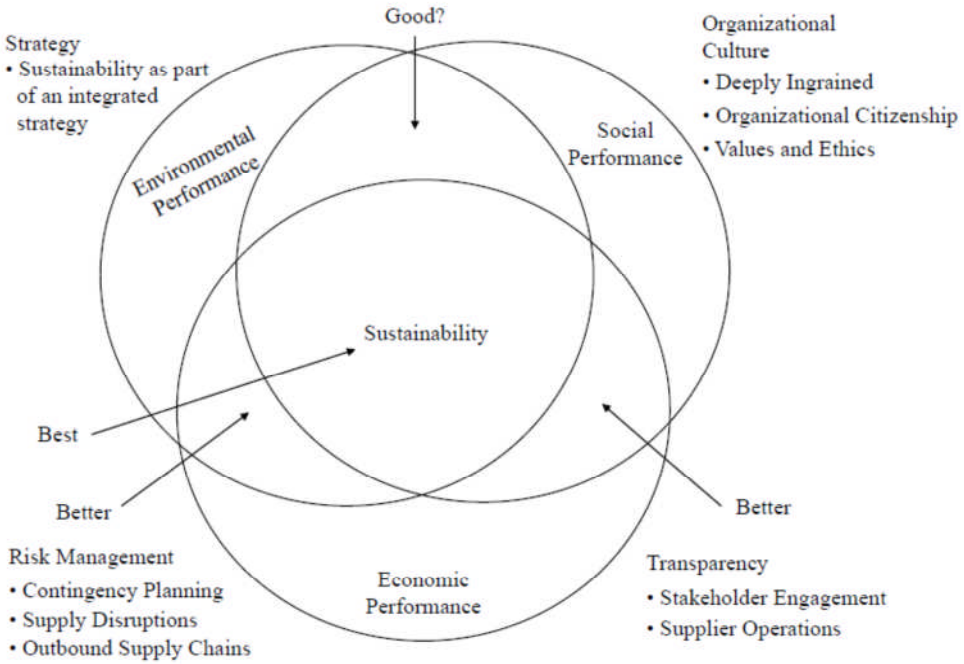
2.5.1 Environmental/Sustainable Supply Chain Management Frameworks

Although efforts to advance overarching theories of ESCM have provided troublesome, several attempts have been made to develop frameworks. An early attempt is provided by Sarkis (2003), who developed a strategic decision framework. This was aimed primarily at practitioners as a decision support tool, rather than aiming at providing an overarching theory or understanding and as such only took into account

those variables or factors felt relevant for improving SC performance in relation to environmental goals. In this way, although no doubt a contribution, it has limited use with regards to a wider understanding when considering factors such as drivers and a greater diversity of outcomes.

Carter and Rogers (2008) developed a framework of SSCM by conducting a large scale literature review. Through the literature review, the authors were able to integrate conceptions of sustainability, including its environmental, social and economic dimensions, with that of the SC. The framework developed, illustrated in Figure 2-2, builds upon the triple bottom line of sustainability and integrates critical supporting elements, such as risk management, transparency, strategy and organisational culture. Although simple and novel, its usefulness in predicting or providing more in-depth insights into SC GHGE management efforts is questionable and its relevance to this more specific area of ESCM is reduced due to its inclusion of wider sustainability elements.

Figure 2-2: Sustainable supply chain management framework (Cater and Rogers, 2008 p.369).

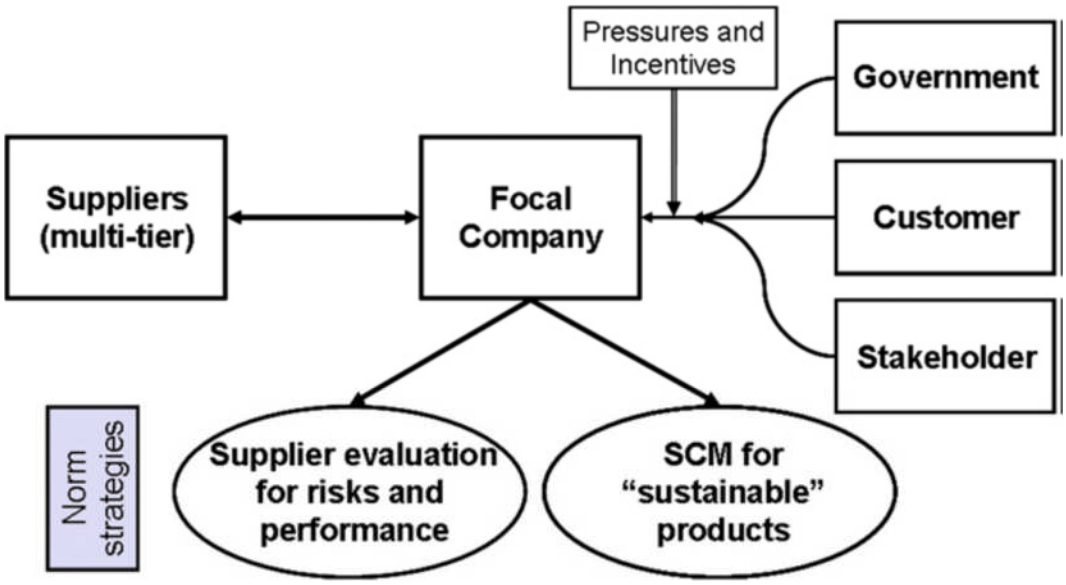


Finally, Seuring and Müller (2008), following similar methods to Carter and Rogers (2008), that being an extensive literature review, also develop a framework of SSCM.

This framework, illustrated in Figure 2-3, focuses upon 'triggers' of SSCM and following conceptions noted above, concerning the propensity of supply chain leading or focal organisations to pass pressure onto suppliers and the SC, includes these as an explicit visual element (not included in either of the preceding frameworks described). The pressures and incentives noted within the framework range from reputation loss to regulation and policy, which, as is shown, result in strategies that either aim to manage suppliers or the products life-cycle.

All of the above noted frameworks, with special focus upon those provided by Seuring and Müller (2008) and Carter and Rogers (2008), provide fertile ground upon which future research in this regard can build, taking into account their wider focus upon sustainability rather than ESCM and their methods, namely the use of literature reviews and conceptual theory building.

Figure 2-3: Seuring and Müller (2008 p. 1703) sustainable supply chain management framework.



2.5.2 Supply Chains and Conceptions of Competition: Paradigm Shifts and Links to Business Strategy

In conjunction with the rise of SCM thinking and science, a shift in general business thinking was occurring, concerning how to conceive of businesses competition. Ideas of individual business units competing against each other were diminishing, being replaced by concepts of SC versus SC competition, requiring businesses to collaborate and ensure joint success as SCs or networks (Ketchen and Hult 2007).

Early thinking highlighted that in order to optimise processes and general management, firms must look beyond the boundaries of their own operations (Walton, Handfield and Melnyk 1998). That organisations will have to start to examine GHGEs beyond the boundaries of their own operations, raises new questions and demands of management processes and strategic decision making.

Lummus and Vokurka (1999), Monczka and Morgan (1997) and Ellram and Cooper (1993) all posit that in order for a business to be successful, it must have control and influence over its SC, and that the SC needs to be run as a single entity. With this conception, SCM moved from an operational imperative, towards a strategic concern. Indeed, Michael Porter (1980) also recognised the importance of suppliers to overall business success and the role that collaboration in the SC can play, towards achieving sustained competitive advantage; however, management thinking overall has generally underestimated the importance of buyer-seller relationships (Cox 1999).

Cox (1999) notes how management thinking in the 1990s concentrated on 'core competencies', and that this was similar to Toyota's achievement in harnessing its SC for success, as the key questions it asked were whether to make or buy. These choices depend on decisions around what resources to own and control and which ones to buy in; i.e. which resources create the most value. Leading from the description by Cox (1999), it is now common to hear that competition has been superseded and that collaboration is central to business in the 21st century, and is seen to form a new collaborative paradigm in business. This focus on 'core' competencies coincided with an increasing internationalisation of business and higher levels of vertical disintegration, leading to ideas and realisations that businesses are no longer competing individually, but as partners within supply networks (Chen and Paulraj 2004; Spekman, Jr and Myhr 1998).

In conjunction with the growing collaborative paradigm, it was increasingly felt that SCM had to be aligned with the overall business strategy of firms (Lummus and Vokurka 1999), as SCM was able to encourage the management of processes across business departments. With its rise in both business thinking and academia, SCM was seen to "represent one of the most significant paradigm shifts of modern business management" (Lambert and Cooper 2000 p.65). The rise of SCM as a concept and

practise and the reasons for its emergence have shaped the way that businesses organise and operate their SCs today, which has consequences for the management and reduction of GHGEs within them. Equally, as SCs and their operation and management were seen as critical to overall business performance, as the importance of sustainability issues has increased in salience, so SCM is now critical to the management of environmental and social issues for businesses within the SC.

Some research has highlighted that the most significant drivers found for ESCM concern market and competitive forces (Seuring and Müller 2008). Both these factors combined, offer opportunities with regard to GHGE management within the SC, disseminating technology and best practice, whilst basing it on market principle and a 'business case'. Further, these changes were felt by some to lead to wider benefits (Ciliberti, Pontrandolfo and Scozzi 2008 p.1579):

> The economic, social and environmental benefits achieved when adopting socially responsible behaviours go beyond the boundaries of a single firm and involve wider communities.

2.6 The Management and Reduction of Greenhouse Gas Emissions in the Supply Chains of Organisations and Businesses

The management of SCs, both for more orthodox operational objectives and more recently for environmental and wider sustainability goals is well-established in the academic literature (Carter and Easton 2011; Gold, Seuring and Beske 2010; Seuring and Müller 2008). However, there is little empirical or theoretical literature concerning the management of GHGEs, as literature concerning ESCM has generally covered the management of energy consumption or gaseous emissions to a lesser degree (Lee 2011). All such literatures do however share a common goal, that being, enabling a focal organisation to improve its own environmental performance, and enhance competitiveness, by improving the environmental performance of its suppliers (Lee 2011). Although the above noted work is no doubt useful and relevant for efforts towards the management and reduction of GHGEs in SCs, its lack of specificity in this regard means it is unable to provide anything other than points of inference for the questions posed in this research. Further, it is highlighted that ESCM literature has

failed to engage to a sufficient degree with the full range of strategies available to reduce GHGEs within products (Bocken and Allwood 2012). Specifically, these authors note that too little attention has been paid to efforts to influence consumer behaviour, through marketing or price changes.

There is agreement within the literature, that few efforts to date have attempted to incorporate the management of GHGEs, or indeed energy, into SCM thinking or science (Lee 2011; Tang and Wang 2010; Seuring and Müller 2008). This gap is fundamental to SC GHGE management, as within the narrower field of climate change, rather than sustainable development, little theoretical or empirical evidence is available as to how to manage and reduce GHGEs within SCs. Côté et al. (2008) have investigated the potential of ESCM to reduce GHGEs, however their work focused on SMEs, and as such, lacks contextual comparability with efforts by large focal organisations.

Lee (2011) provides a case study of an attempt to integrate GHGEs into the SCM efforts of Hyundai Motor Company, highlighting the importance of boundary setting and measurement as well as the mapping of GHGEs across a manufacturing SC. The study concedes that the contextual environment and operational specifics of the organisation in question will greatly impact on SC GHGE management efforts and strategies. It fails to note how suppliers were engaged and incorporated into the process, and as it is formed of a single case study has limited scope it terms of its ability to generalise and apply its findings to different industries, national contexts or public sector organisations.

Hsu et al. (2011) investigate how to select suppliers based on a GHGE performance standard using a 'DEcision-MAking Trial and Evaluation Laboratory' (DEMATEL) approach. They investigate influential criteria affecting the performance of suppliers under SCM programmes, and develop 13 criteria to judge against. It is found that training is the most significant variable, and that suppliers who are trained and able to effectively conduct GHGE management, receive the greatest score using this model.

Chaabane, Ramudhin and Paquet (2012) develop a framework to allow trade-off decisions to be made regarding an organisations participation in an trading scheme, including gaseous emissions, as well as solid and liquid wastes. Although novel and

concerned with the management of GHGEs in a SC, this paper takes a waste focussed approach within an industrial setting, whereas many SC GHGEs will be emitted from non-industrial suppliers and processes; this work built upon earlier efforts by Ramudhin et al. (2008) who examined the carbon trading implications for SCs.

Recent research by Du et al. (2013) has investigated how an emission restricted supply chain, modelled under a hypothetical cap-and-trade scheme, would impact on decision making and distributional fairness. It is found that under such circumstances, that the focal organisation, a manufacturing firm within the model, experienced improved profits, whilst increased strictness with regards to GHGE levels decreases the bargaining power of the manufacturer.

Although little work has been conducted within the academic literature, much grey literature exists on SC GHGE management. Capgemini (2008) in a report on 'future supply chains', focuses on physical SC innovation, highlighting in-store logistics, collaborative physical logistics (i.e. shared transport), reverse logistics and demand management fluctuation, all methods well documented in the academic literature concerning general SCM. They do however mention the importance of information sharing, an area central to working with SC partners.

Other grey literature is light on substance and novelty, such as Kane (2008) noting that reduced material flows, result in reduced GHGEs. BSR (2009) offer a more comprehensive, if generic, guide, taking a logistics centred approach specific to carbon, but again fail to highlight supplier engagement strategies and methods concerning design or manufacturing.

The CDP (2011), through their yearly reports, offer a roadmap for their voluntary member organisations to engage with SC GHGE management. Strategic awareness, carbon reduction ambition, reporting capabilities and final implementation are covered, with each area consisting of three levels of competence. Based primarily on the 'reporting' of emissions, the approach has allowed many firms to reduce GHGEs with little or no direct costs. In earlier reports and one of the few contributions regarding strategy, the CDP highlights the different levers available for reducing SC

GHGEs, including the simple reduction of demand, to sustainability criteria for supplier selection and collaborating with suppliers (CDP 2010a).

Even when the grey literature is considered the state of knowledge in this area constitutes a genuine gap in the literature on ESCM and how to manage suppliers for GHGE management reduction goals.

2.6.1 Greenhouse Gas Emission Measurement and Assessment

As the project is concerned with the management and reduction of GHGEs within the SC, it is important to consider how such GHGEs are measured, assessed and accounted for. Often referred to as the 'carbon footprint', many methodologies and standards exist. In order for GHGEs within suppliers, the SC or products to be managed and reduced, it is first imperative that they are estimated and assessed, and that a measurement system is established. A range of standards and methodologies have emerged, designed to aid the measurement and assessment of GHGEs, which can be found in Table 2-4 (Pandey, Agrawal and Pandey 2011; Finkbeiner 2009).

Two main methods are used for measuring and assessing Scope Three GHGEs or those that reside in the SC, namely Input-Output Analysis (IOA) and process analysis (see Huang, Weber and Matthews 2009; Lenzen and Murray 2009; Andrew and Forgie 2008; Lenzen 2008; Peters 2008; Lenzen et al. 2007; Gallego and Lenzen 2005; Suh et al. 2003; Lenzen 2002; Munksgaard and Pedersen 2001); such research has been conducted on SCs, but also on Scope Three GHGEs for specific industries and cities (Hillman and Ramaswami 2010; Downie and Stubbs 2011).

These approaches are best differentiated between their 'bottom-up' (IOA) versus 'top-down' (process analysis) stances (Pandey, Agrawal and Pandey 2011). Process analysis details the production process as well as its inputs, based on the transaction receipts to produce a model of the inputs to a process (Lenzen 2002). Process analysis has the advantage that it accounts for all upstream inputs meaning that no cut off is required (Murray, Wood and Lenzen 2010). Process analysis becomes too complex when applied to large businesses or organisations (Pandey, Agrawal and Pandey 2011). Issues that must be addressed when starting a GHGE assessment include the selection of GHGEs, boundary setting and the collection of GHGE data (Pandey, Agrawal and Pandey 2011).

Table 2-4: Standards and methodologies for the measurement and management of GHGEs.

1.	GHG Protocol by WRI/WBCSD – two standards provided including (1) Product Life Cycle Accounting (LCA) and Reporting Standard, and (2) Corporate Accounting and Reporting Standard: Guidelines for Value Chain (tier III) Accounting and Reporting. Includes general and specific calculation and informs most GHGE accounting guides including ISO 14064 (1&2).
2.	ISO: - 14067 on Carbon Footprinting of Products (Part 1: Quantification, Part 2: Communication). - 14064 (1&2): international standard for boundary determination, quantification and removal. - 14025: standard for conducting LCA. - 50001: energy management systems. - 14045: principles and requirements for eco-efficiency assessments for production systems.
3.	- PAS 2050 (BSI) (now ISO 14067) specifies the requirements for assessing GHG life cycle of products. Co-sponsored by the Carbon Trust and Defra. - PAS 2060 specifies carbon neutrality requirements.
4.	Other examples: - BS EN 16231 Energy Efficiency Benchmarking Methodology. - BS 8903 Principles and Frameworks for Procuring Sustainably. - Carbon Trust Standard. - Korean Product Based Reduction Scheme. - European Commission Project on “carbon footprint measurement toolkit”. - Methodology project of German Ministry of Environment. - Carbon footprinting methodology of New Zealand Ministry of Agriculture and Forestry.
Aggregated and adapted from (BSI 2012; Pandey, Agrawal and Pandey 2011; Finkbeiner 2009)	

2.6.2 Problems with Scope Three/Supply Chain Greenhouse Gas Emission Accounting and Action

Although the arguments for Scope Three/SC GHGE accounting and action are strong, as outlined in section 1.5, problems and difficulties exist. The need for a standardised approach that is able to reflect industry and sector differences has been noted (Busch 2010); further, questions concern where threshold boundaries should lie, or if they should exist at all. A 5% boundary has been proposed (Busch 2010), however this has been attacked, as it is not possible to understand if one section of the SC contributes more or less than 5% without understanding or measuring the whole of the SC GHGEs (Murray, Wiedmann and Dey 2011).

Further arguments within the literature concern the methods used for the measurement and assessment of Scope Three emissions; whether process approaches or IOA are the most advantageous, with scholars in this area disagreeing (see discussion between Busch 2011; Murray, Wiedmann and Dey 2011; Busch 2010). Bottom up approaches such as LCA are felt to be insufficient, and that IOA are able to capture the whole SCs of companies, including those that make or produce more than one product or service (Murray, Wiedmann and Dey 2011). Conversely, IOA is criticised for its low use rates and complexity (Busch 2011; Busch 2010). Ultimately, many scholars call for a hybrid approach, although these are in their infancy (Murray, Wiedmann and Dey 2011).

Throughout these debates the need for industry or sector specific rules is made (Busch 2011; Busch 2010), that wide variations exist in what Scope Three GHGEs are reported and included in assessments, and that there is a need for a clearer methodology to be followed by all (Downie and Stubbs 2011; Busch 2010; Minx et al. 2009). The GHG Protocol is highlighted as the most authoritative attempt and most trusted source of guidance for GHGE assessment (Hoffman and Busch 2008; Kolk, Levy and Pinkse 2008).

A specific aspect of these difficulties tackled within the literature concerns the practical issues and costs of assessing GHGEs within a SC for the purposes of developing per product carbon data for labelling (McKinnon 2009), which can cost up to $30,00 per product (The Economist 2011). Such research concludes that although some standardisation is occurring, and that software support is available, easing the

process, that the procedure has a high cost while the benefits to companies, or consumers, who understand little of the new labels, are questionable at best. Highlighted difficulties, similarly to those noted above, include allocation and boundary setting issues, variability, scalability and cost. McKinnon (2009) finds little plausibility in every consumer product undergoing this process and advises governments and organisations pursuing such product based approaches to reconsider their efforts. That this implication is put forward raises serious and profound questions with regards to this particular aspect of SC GHGE management and assessment.

2.7 Chapter Summary

This chapter has covered the rise of SCM thinking, as well as the integration of sustainability and more specifically environmental goals that led to ESCM. It demonstrated the scope and breadth of literature available regarding ESCM as well as highlighting the theoretical difficulties that the topic has faced, namely that a single theory has been unable to capture the diversity and scale involved in SCM and ESCM efforts.

Several theoretical stances and paradigm shifts were also examined, including 'cooperative' or 'SC versus SC' conceptions of competition. The competing approaches of those that see competition reliant on collaboration and cooperation versus those who emphasise power and control in the SC, through theories such as ESCD, were highlighted. In addition, existing frameworks of SSCM and their relation to ESCM were examined.

The chapter also identified that literature in this area is deficient in several aspects; the lack of work on the management of gaseous emissions within SCs was highlighted as an area that has been signalled as requiring further attention and efforts, as well as that of the topic of public sector sustainable procurement. Both areas embody critical issues, either concerning the potential and arguably untapped power of public procurement to pursue policy goals, as well as the criticality of the management and reduction of GHGEs in order to mitigate the effects of anthropogenic climate change.

Chapter 3. Research Methodology and Methods

This chapter will outline the research methodology, design and methods utilised during the research. It will start by highlighting the research aims and questions that arose out of the literature review, followed by briefly outlining the research methodology followed. The chapter will cover the research design, including the unit of analysis for the project, its qualitative approach and the role of theory in qualitative research. The research methods, namely the use of an interview survey, using semi-structured interviews, will then be described and justified and will include the techniques used for the identification and recruitment of participants. Analysis methods will be highlighted alongside the limitations of the methods and mitigating actions used in their minimisation. Finally, the chapter will introduce and characterise the data that was collected, as well as providing an overview of the analysis stages and their interconnections.

3.1 Research Aims and Questions

The introduction and literature review chapters have demonstrated that organisations are engaging with their SC GHGEs. Anecdotal evidence was presented through organisations such as the CDP, who provide a platform for large organisations to report their SC GHGEs, together with the Carbon Trust, who has worked with several companies to measure and reduce SC GHGEs.

Although evidence was found indicating that organisations were engaging with their SC GHGEs, a review of the literature highlighted that there were few articles that specifically addressed SC GHGE management. A range of literature was found that dealt with more general environmental management in SCs, through ESCM, as well as literature concerning corporate engagement with climate change objectives, noted within the introduction, which identified the SC as an area of concern and action. Although both these sets of literature highlight relevant factors and activities to SC GHGE management, neither deals with it specifically, bar a handful of very specific articles. These included research investigating the integration of GHGE factors into SCM, through a case study of the Hyundai Motor Company (Lee 2011) or the development of supplier selection tools (Hsu et al. 2011). Overall, it was concluded that SC GHGE management was a new and burgeoning area of ESCM, and as such, has not until this point received the academic attention it deserves.

Further, the ESCM literature, although broad and extensive, has made little progress with regards to the creation of an overall theory for the topic, although many narrow theories do exist. Several scholars have made the assertion that within this discipline, theory is following practice (Carter and Easton 2011). In response to these findings from the introduction and literature review chapters, research aims and questions were identified. These were used to guide and focus the project and are described below.

3.1.1 Research Aims

In response to the points made above, with regards to SC GHGE management within the UK, the following research aims are identified:

1. To identify those organisations considered to be leading current efforts in relation to SC GHGE management, so as to scope the phenomenon.
2. To identify and explore the drivers and barriers experienced by these organisations, as well as the methods they use to manage their SC GHGEs.
3. To identify and explore factors that impact and moderate the methods used by these organisations to manage their SC GHGEs, and the relationships that lie behind these.
4. To identify and explore options available to enhance and increase efforts to manage and reduce SC GHGEs, and their implications.

3.1.2 Research Questions

Following from the research aims identified above, a series of research questions have been devised. These include:

1. What factors are driving or hindering organisations engagement with SC GHGE management, and what are the objectives or outcomes?
2. What activities are organisations undertaking to manage their SC GHGEs?
    a. Including the various SCM (Supply Chain Management) and internal measures taken.
    b. If and how focal organisations are targeting their resources towards particular aspects or parts of the SCs, and why?
    c. What factors moderate focal organisation SC GHGE management strategies?

3. Is a deeper understanding able to be gained with regards to:
    a. Relationships between SC GHGE management activities and outcomes?
    b. The conditions under which SC GHGE management could be expanded and used to a greater extent, to achieve climate change mitigation objectives, including policy options and their implications?

These research aims and questions are felt appropriate, as they enable several aspects of SC GHGE management to be uncovered and explored, including:

- Those organisations at the forefront of current, early efforts to be identified and characterised.
    - This will allow the driving factors to be examined, as well as the factors seen to be acting as barriers.
    - The activities they are using to manage their SC GHGEs will also be highlighted alongside the factors that influence which aspects of the SC they choose to work with and the factors that affect the strategies used.
    - By examining SC GHGE management activities, and the factors that moderate focal organisation strategies, the relationships that lie behind may be able to be identified.
- By uncovering these factors, and the contexts within which they operate, it is hoped to identify ways in which to enhance these efforts, either through policy or measures internal to the focal organisations, whilst also contributing to theory within this discipline.
- These outcomes will allow a further area within which climate change mitigation goals can be pursued, whilst also highlighting the implications of current efforts for governments, focal organisations and their SCs.

3.2 Methodology and Research Philosophy

A range of research philosophies exists that affect how research is undertaken, including its epistemological (positivist, realist or interpretist) or ontological (objectivist, subjectivist or pragmatist) approach and the methods used (case study, survey or experiment for example); further discussion of epistemology, ontology,

approaches and methods can be found in Bogdan and Biklin (1998), Creswell (2003) and Saunders, Lewis and Thornhill (2009). As this research deals with an area where little previous knowledge exists and seeks to build new theoretical contributions, a pragmatic realist stance will be taken (Saunders, Lewis and Thornhill 2009).

A pragmatic realist stance originates from philosophies of scientific realism, which see theories as referring to real aspects of the world, be they forces, structures or objectives; it views 'things' as existing independently of our perception of them (Schwandt 2007). Realism can be considered to be a pragmatic approach, in comparison to methods based on positivist or interpretist views, accepting anything that can be seen to allow the researcher to add to knowledge and understanding.

This methodological stance grew in relevance through the work of authors such as Charles Sanders Peirce, William James and John Dewey (Rorty 1979). These thinkers increasingly focused on the conceivable consequences of actions and concepts (James 2008; Peirce 1934), and the need to consider the possibilities of actions, rather than the impacts or meanings of precedents (Dewey 1931). In this sense, it is future and action orientated and seeks to highlight the solutions or answers that might be available to problems or questions.

Pragmatism, as a philosophy, focusses on linking practice and theory; theory, in this regard, is seen to be taken from practice, and then applied back into the practical world in order to find solutions to the problems experienced by society (Morgan 2007). Pragmatic realism sees research as a disciplined attempt to solve and investigate actual human problems (Kivinen and Piiroinen 2004), and can be considered as a 'means-to-an-end'. Questions of interpretation and other ontological queries are seen as potentially obstructive in this process.

A pragmatic realist stance is advocated as a research approach when dealing with business and organisations, as it is allows the research to focus on relevant and practical solutions or explanations (Watson 2011), asserting that only those concepts able to support action should be considered relevant (Kelemen and Rumens 2008). Pragmatic realism is also utilised for research concerning sustainability (Lehtonen

2004), for example in relation to the role of adaptive management when under conditions of environmental uncertainty (Norton 1999).

In summary, pragmatic realism indicates a primary concern for the answering of the research questions, before more assiduous considerations of research philosophies, and is the approach to be taken within this research.

3.3 Research Design

The following section will highlight the research design undertaken to answer the research questions and aims outlined above. The qualitative nature of the research will be explained and justified. The unit of analysis will also be described, as well as the use of interview surveys, through semi-structured interviews. Finally, participant identification and recruitment technique will be covered.

3.3.1 Unit of Analysis: Greenhouse Gas Emission Management Initiatives in the Supply Chains of Organisations and Businesses

Before outlining the research design of the project, it is important to consider the unit of analysis for the research. Due to several reasons, outlined below, focal organisations' SC GHGE management initiatives form the unit of analysis. Specifically, SC GHGE management initiatives will be seen to encompass the efforts of focal organisations to measure and/or manage GHGEs, within the SC. This focus is felt appropriate to deepen understanding of why and how large focal organisations are managing their SC GHGEs.

3.3.1.1 Supply Chain Greenhouse Gas Emission Management as a Stand-alone Environmental Issue

Although climate change mitigation objectives and SC GHGE management more widely, can be considered to be a form of ESCM, many businesses and governments have identified climate change mitigation objectives as a core focus of environmental management efforts. This reality is embodied in legislation and government priorities, such as the 2008 Climate Change Act, through NGO initiatives such as CDP Supply Chain and WRI/WBCSD programmes, and by the activities of focal organisations.

Although arguments exist for the integration of GHGE management and reduction into wider ESCM efforts, when real world examples are approaching this issue as an isolated environmental problem, it is justifiable to approach an investigation of such

initiatives in the same way. Indeed, in attempting to explore and explain factors important to SC GHGE management, it is felt important to approach the issue in the same manner as the organisations under study; if the programmes in question have approached GHGEs as a stand-alone environmental problem, the investigation intends to do the same.

3.3.1.2 Conceptual Precedence

Choosing SC GHGE management initiatives as the unit of analysis has precedence within the ESCM literature. This unit of analysis has been utilised when attempting to explore drivers and barriers, and the activities being undertaken to manage environmental impacts (Walker, Di Sisto and McBain 2008). Further, following 'collaborative' paradigms of competition and SCM (Horvath 2001), which describe increasing SC integration, it is felt important to consider other SC actors beyond the focal organisation, including upstream, such as suppliers, and downstream, such as customers and consumers, and their interactions.

3.3.1.3 Summary

By taking SC GHGE management initiatives as the unit of analysis, multiple aspects of SC GHGE management can be explored and examined, including their internal dynamics. Further, this approach allows the interaction of the focal organisations with the SC to be investigated.

3.3.2 Research Approach

3.3.2.1 Exploratory and Explanatory Approach

Although several theories and sections of the literature were identified as being potentially relevant, attempts to construct a coherent and usable conceptual framework were unsatisfactory. That said, the literature has guided the investigation and has been used to construct aspects of the data collection methods, participant identification and within the analyses. By taking an explorative and explanatory stance, it was felt that the project would be able to document and explore the objects of the study more completely, without constricting the enquiry to specific tenants of existing theories. The context of SC GHGE management in the UK was also considered to be potentially unique, and different from other studies conducted on similar ESCM or corporate issues. Due to these requirements, a qualitative approach was undertaken.

3.3.2.2 Qualitative Approach

Qualitative approaches are appropriate when:

- The issue under study is complex and a broad holistic understanding is required (Leedy and Ormrod 2004; Creswell 2003),
- Few cases exist with many variables, and analysis based on the identification of patterns and categorisations (Creswell 2003),
- The research questions consist of 'how' and 'why' queries (Creswell 2003),
- Initial questions are open ended and exploratory (Tavallaei and Abu Talib 2010; Creswell 2003),
- Where inadequate theory exists to explain the phenomenon (Tavallaei and Abu Talib 2010; Leedy and Ormrod 2004),
- Little is known about the topic (Leedy and Ormrod 2004).

From the literature review and contextual exploration, SC GHGE management and the associated research questions that are raised, fit well with these criteria. SC GHGE management is likely to have many variables. Many drivers and barriers are identified within the literature review and ESCM research is very broad, covering aspects of product design to logistics. As this is a relatively new area of environmental management, little is noted within the literature and relatively few cases are likely to be available for study. The breadth of ESCM research means that although theories exist with regards to specific elements of organisations efforts, there is an absence of an 'overall theory of ESCM'; indeed, within this discipline, practice is felt to be leading theory (Carter and Easton 2011).

As this project seeks to explore and explain SC GHGE management efforts, including its drivers and barriers, management actions and strategies, variables and options for its enhancement, it is felt that a holistic approach is required. Using theory within the initial stages of the project was felt likely to lead to the loss of potentially important information and context. The project seeks a deeper understanding of the phenomenon, including why and how it is occurring, rather than asking 'how much' is occurring, which would suit a quantitative approach (Yin 2009).

3.3.2.3 Qualitative Data

As the project takes a qualitative approach, it was decided that empirical data from both primary and secondary sources would be collected. This would include primary data from participants with internal and external perspectives on SC GHGE management. By obtaining data from multiple perspectives, data triangulation can be pursued, increasing the validity of any results obtained (Guion 2008; Flick 2004; Golafshani 2003).

3.3.2.4 Role of Theory

The relationship between qualitative research and theory is more complicated than that of positivist quantitative approaches, as these more traditional avenues often seek to prove a theory. In contrast, qualitative approaches often aim to generate new theories (Tavallaei and Abu Talib 2010). As such, how existing theories and qualitative research relates is much debated. Three distinct understandings are possible (Anfara and Mertz 2006):

1. That theory relates to the methods chosen and the epistemology underlying the project.
2. Theory has a broader and extensive role, often in providing explanations to the results obtained.
3. Theory has no solid relationship with qualitative research.

Within social science qualitative research, the use of theory in research is further complicated by the existence of multiple theories, with no single theory dominating an area of investigation and theory existing at multiple levels (Tavallaei and Abu Talib 2010). For example, with regards to SC GHGE management, general theories can be applied on a macro level, organisational theories to the organisations undertaking the management, and lower theories dealing with the individuals who are undertaking the work.

Theory can be used as a set of general principles that provide explanations for the empirical results obtained concerning a phenomenon; in this sense, theory points to how the world could be. This use of theory is explanatory (Hammersley 1995). Using theory this way does not however prevent the generation of new theory; rather, new theoretical ideas are tested against both the empirical data and existing theories

(Hammersley 1995). Where persistent findings are uncovered through qualitative research, their persistence requires an explanation, and this can be provided by both new and existing theory (Sutton and Staw 1995). Indeed, using theory as an explanatory tool allows a multi-theoretical approach, which can act as a form of triangulation, potentially allowing greater insights and knowledge gains (Ketchen Jr and Giunipero 2004); the use of multiple theories could be an appropriate approach due to the plethora of explanations available in ESCM research, especially as no single set of explanations has achieved dominance (Carter and Easton 2011).

Indeed, theory, as an outcome of research, is only one option among many. Other outputs can include description (the features of a phenomenon are documented), explanations (an indication of why a phenomenon has these features) and evaluation (value judgements are added concerning the desirability, or not, of the described features) (Hammersley 1995).

3.4 Research Methods

The following section will describe and outline the research methods chosen to answer the research questions. It will be noted that due to difficulties in participant recruitment, the initial aims and methods planned for the research had to be adapted. This included an aim to establish the impact of SC GHGE management efforts on SME suppliers within the SCs of focal organisations.

3.4.1 Initial Research Methods and Aims

Due to the nature of the research area and questions being asked, it was proposed that an inductive multiple case study design be utilised. As noted by (Yin 2009), case studies are a suitable research method when seeking to explore and explain a contemporary real world phenomenon, where the researcher has limited or no control over the phenomenon being studied (see also Voss, Tsikriktsis and Frohlich 2002; Meredith 1998; Ellram 1996). By taking an inductive approach, context can be considered and allows the development of theory from the cases (Eisenhardt 1989).

By conducting multiple case studies, several examples of SC GHGE management initiatives and associated strategies, from different sectors, types of organisation and public or private sector organisations could be explored and explained, allowing the

research questions to be tackled in a broad spectrum of settings, helping to generate theory and increase the validity of the results (Wu and Pagell 2010).

A further benefit of this approach is that it enables the identification of significant factors existing within the different contexts, to help explain the formation of SC GHGE management strategies and the potentially differing impact upon SME suppliers involved. As noted by Kovács (2008), this approach also allows comparisons across and between industries, depending on the cases chosen. The use of a multiple case study approach has precedence within this area of research (see Font et al. 2008).

Both Eisenhardt (1989) and Yin (2009) offer guidance on the number of case studies that are required for a successful doctoral research project that seeks to generate theory. Eisenhardt (1989) notes that seven cases are a minimum requirement, whereas Yin (2009) notes that five to ten should be sufficient. A balance must be struck between obtaining enough data and cases, versus the time and resources available. It was proposed that this project would seek eight case studies.

Although great effort was employed towards the fulfilment of this plan, participants were reluctant for their organisations to form case studies. This reluctance was amplified when requests were made to contact and obtain data from their suppliers. Ultimately, it was felt that as SCs are sources of competitive advantage and crucial to the running of organisations, that the organisations contacted were reluctant for a researcher to have access to this sensitive and important area. As such, the proposed case study method and the aims and objectives concerning the impacts on SME suppliers were dropped in favour of an interview survey with focal organisations. The methods used for this interview survey are described below.

3.4.2 Interview Survey

Although the proposed interview survey would only allow primary data, through the use of semi-structured interviews, to be obtained from single sources within focal and associated organisations, it was felt that sufficient data could be obtained through this method. Consequently an interview survey was undertaken; a broad range of examples of SC GHGE management initiatives from both the public and private sectors were sought. Although unable to provide the depth of data inherent within a case study, the interview survey was still felt sufficient to provide enough data, from more

sources and a greater diversity of examples, to generate theory and capture context specific factors.

Secondary data was collected where available, via the participants interviewed from focal organisations, or through organisations websites, or other sources of grey literature; examples of suitable secondary data included environmental/CSR reports, environmental policy documents, supplier evaluation questionnaires, internal policy documents and external media sources (Font et al. 2008; Walker, Di Sisto and McBain 2008).

Questions regarding data saturation were explored, with contradicting answers given. The number of interviews sufficient for theory generation was reported to be from 10-15 interviews, as the smallest acceptable size (Creswell 2003; Bertaux 1981), up to a requirement of 50 (Morse 1994). Indeed, it is highlighted that due to resource constraints and the lack of readily available participants, that much qualitative research has too few participants; the consequence of this being, a reduction in validity of the results (Strauss and Corbin 1998).

However, due to the qualitative approach, the richness of the data obtained, rather than the amount, is asserted to be the crucial aspect (Carey 1995). This said, literature does note that the type of participants within a sample will impact on what can be considered to be a suitable number (Mason 2010). For example, within a homogenous group of participants 10-15 interviews are felt sufficient, however within a heterogeneous group, more may be needed. Due to the non-probabilistic and purposive sampling strategy undertaken, and the heterogeneous nature of the participants, it was decided to collect data until data saturation became evident; this point, in qualitative research, is when no new data is obtained through the interview process (Green and Thorogood 2009).

3.4.2.1 Research Phases

Due to the relative dearth of knowledge regarding SC GHGE management efforts at the outset of the project, it was decided that several research phases would be required, allowing initial efforts to scope and identify interesting and poignant examples, which subsequent phases could then examine in greater detail. As such, two research phases

were conducted: an initial scoping, exploratory phase and a main exploratory and explanatory phase. These were branded, phase one and phase two.

As the aim of phase one was to provide an overview of current SC GHGE management efforts within the UK, it was felt appropriate to gain a perspective from participants external to organisations undertaking SC GHGE management initiatives (the participant selection strategy is discussed in section 3.4.4). These participants were asked to provide an overview of current SC GHGE management initiatives, the key organisational actors involved, and overarching drivers and barriers, so as to provide a working structure from which to launch the second, main phase of the data collection. The second phase sought an insider perspective, from participants within organisations attempting to measure and manage their SC GHGEs. This phase was followed by framework and theory development efforts.

3.4.3 Semi-structured Interviews

In-depth semi-structured interviews were identified as the most appropriate method for collecting data through the interview survey. This was adopted in line with the exploratory and explanatory nature of the research questions (Creswell 2003). The semi-structured interview method provided a balance between structure, allowing comparability between the data provided by participants, aiding the analysing of the data, whilst also permitting flexibility in the asking and answering of the interview questions. Flexibility was felt to be important due to the potentially unique experiences and contexts of the research participants. This method also permits the use of follow up questions and provides an opportunity for participants to provide extended explanations for their answers.

This method of data collection was felt to have several advantages over alternative methods, such as the use of questionnaires or unstructured interviews (Saunders, Lewis and Thornhill 2009; Creswell 2003). Questionnaires would not have been able to provide the depth of answer required by the project and would have not allowed the participation of the researcher in the data collection process. This participation was important, as it provided the opportunity to ask follow-up questions and seek clarifications where necessary. Unstructured interviews would have failed to provide

the necessary structure to the data collection process, inhibiting the collection of data and its analysis.

Interview schedules were produced for each phase of the research. The interview schedule for phase one was devised using the research questions and the literature, with the aim of providing an exploratory overview to SC GHGE management initiatives. By considering the aims and objectives of the research, and themes, such as relevant actors and the broad drivers and barriers identified within the introductory context and literature review chapter, the set of questions outlined in Table 3-1, were identified.

Open-ended questions formed the majority of the interviews content. An example of the interview schedules used during phase one can be found in Appendix B. In line with the exploratory nature of the research, the interview schedules were subject to change as meaningful and significant information came to light during the data collection process.

Table 3-1: Outline of phase one interview questions.

Questions	Summary of key themes	Intended purpose
1-5	Interviewee introductory questions: • Organisation • Job title • Areas of responsibility • Time in position	For general info (to ensure sufficient expertise/knowledge levels) and to warm up the interviewee.
6	Overview of 'dealing with' SC GHGEs.	To provide overview of SC GHGE management efforts and how to influence them. Also provided further 'warm-up' question.
7-8	Identification of organisations	To identify those

	considered to be leading SC GHGE management efforts and their characteristics.	organisations seen as leading current efforts and therefore likely to form the focus of the second phase of the project. Characteristics to help identify cases.
9-14	Description of current UK policy position in relation to advancement of SC GHGE management efforts/low carbon SCs. Including government's role, the targets of policy, its effectiveness, the balance between regulatory and non-regulatory approaches and any disadvantages to the current approach.	To identify and explore the impact, if any, of current policy and regulatory position of government on SC GHGE management.
15	Actions by government on public sector SCs.	To explore current practice, if any, in public sector organisations and SCs.
16	The identification of key actors with regards to the management of SC GHGEs in the future.	To identify key actors so as to allow greater focussing of research in phase two.
17-21	Policy evolution and options in the future. Including the changing role of government, the targets of future policy (if any) and the role of non-regulatory instruments.	To allow the exploration and assessment of future policy and regulatory options with regards to the advancement of SC GHGE management.
22-23	The role of other actors in SC GHGE management, including the third	To highlight any important roles being played by actors

	sector.	other than the government or businesses.
24	Potential evolution of efforts within public sector SCs, with regards to GHGE management.	To explore and identify the potential strategies likely, or available, to be used within the public sector.

The interview schedules for phase two were heavily influenced by the results of phase one; an outline is presented in Table 3-2. This second phase sought to deepen understanding around a narrower set of topics and themes, focussing on drivers and barriers in public and private focal organisations, the activities they undertook and the factors that they took into account when deciding with which aspects of the SC to engage with and how to approach SC GHGE management. Although heavily influenced by the first phase of the project, literature, including aspects of ESCM, corporate climate change strategies and governance, was also used as an inspiration for the identification of appropriate questions in phase two. A copy of the interview schedules used for this second phase can be found in Appendix C. The questions asked in this second phase were also subject to change as new information came to light through the data collection process.

All interviews, within phase one and two, were recorded where possible. This allowed the researcher to remain focused on the asking of questions and follow-up questions during the interview, rather than taking detailed notes; notes were taken during the interview in addition, however audio recordings provided the primary data. In two instances, A09 and B12, audio recording of the interviews was not possible; where this occurred, notes were taken during the interview, which formed the primary data. The recorded interview data was stored and transcribed. The transcripts were then coded, following the analysis technique to be described below.

Table 3-2: Outline of phase two interview questions.

Q.	Summary of key themes	Intended purpose	Information Source
1-4	Interviewee introductory questions: • Organisation • Job title • Areas of responsibility • Time in position	For general info (to ensure sufficient expertise/knowledge levels) and to warm up the interviewee.	Interviewee.
5-8	Background information on company.	Contextual information.	Interviewee and secondary documentary sources, i.e. publicly available trading information including Sustainability or Financial Reports.
9-12	Supply Chain Decarbonisation Strategy Development and Application: • Self-description of organisation's supply chain decarbonisation/ Scope Three emissions approach. • Driving factors and reasons for engagement with the issue.	Information on the drivers and initiation of the strategy or activities as well as barriers encountered. Whether external (i.e. 3rd sector) organisations were involved.	Interviewee and secondary data sources. Approaches to SC decarbonisation, drivers and barriers, and involvement of external agents answered through CSR, SCM and sustainability reports. CSR and SCM

	• Departments involved with development of approach/strategy. • Involvement of external agents in approach/ delivery. • Obstacles and challenges encountered and how they were overcome?		personnel expected to give more depth than secondary sources.
13-16	Supplier impacts and relations: • How programme applied, whether to all suppliers, or select few. Reasons behind this. • How strategy was introduced to suppliers. • Whether support was offered. • Whether programme altered wider trading relationship with suppliers. • Perceived impact of activities on suppliers.	How programme was applied to suppliers, in order to help establish the differing impacts of alternative approaches. Further, whether suppliers were supported during the program, as well as the focal firms' perceived impact on suppliers.	Data on impacts on suppliers, if support provided and alterations expected to come from SCM personnel as well as secondary documentary sources.
17-18	Programme/Activity Outcome: • Perceived success of the programme.	Outcomes and perceived success of decarbonisation activities.	CSR/higher personnel likely to provide data on success of programmes and

	• Changes or alteration made. • Perceived strengths and weaknesses of programme.		perceived strengths and weaknesses.
19-20	Programme/Activity in the Future: • How they see programme and strategy evolving into the future. • Future of SC decarbonisation more widely.	Future of organisations programmes and well as future more generally.	CSR/higher personnel likely to give data on future strategy development etc.

3.4.4 Participant Selection

In order to obtain valid and useful data, appropriate participants needed to be identified. Central to the role of the research participants, was the knowledge and opinions they could offer of SC GHGE management efforts and the wider context within which they were occurring. A criterion was established for use within each phase of the research. The criteria also served to provide a commonality between the participants within the disparate phases, that allowed the data to be compared and analysed both within and between phases; the differences that emerged from the data are considered the results of the research (Evans, Coon and Ume 2011). The criteria used will be outlined in greater detail in the following sections.

3.4.4.1 Phase One

As this phase sought to provide an overview of SC GHGE management efforts, it was important to identify participants with the correct knowledge and experience. Within this phase, 'experts' were felt to be required, so as to be able to provide an adequate overview, that would then be able to inform both the results and the design and

implementation of phase two. Experts can play an important role in exploratory research, as they are able to shorten the time involved in observations and can be considered to be representatives of other actors (Flick 2009). Further, experts are often highly motivated to take part in research, and able to express their own opinions and provide evaluations. The use of semi-structured interviews increases the validity of using experts in research, as they allow the methods to be repeatable. As specific individuals with the desired context specific knowledge were needed, non-probabilistic purposive sampling was undertaken (Bogner, Littig and Menz 2009).

3.4.4.2 Phase Two

Following phase one, primary data for phase two was also obtained through the use of an interview survey, using semi-structured interviews with key individuals. Phase two, however, sought an internal and more in-depth perspective, following the results obtained from phase one. The interview protocols were developed from the literature and from the results of phase one.

The results of the phase one interview survey indicated, along with likely future policy, that SC GHGE management efforts were developed, or at least administered, from the head of SCs. Subsequently, focal organisations formed the focus of this second stage of the research. A definition of focal organisations was adapted from Seuring and Müller (2008) and used to identify appropriate organisations from which to recruit participants. Focal organisations were defined as those organisations that led or controlled their SC, often designing the product or service being offered and being positioned next to, or one SC stage away from consumers. A diversity of cases was sought in line with efforts noted above, to examine the research questions in a broad spectrum of settings. For example, cases from both the public sector and private sector were identified, involving different industries and different types of SC GHGE management initiatives.

The use of focal organisations had implications for the identification and recruitment of participants, in that these large SC leading organisations had to be identified. Further, it was these companies that were likely to have advertised or publicised their efforts. This also fits with literature concerning how other SC initiatives have started and subsequently operated, and is also how many of the driving forces for such

initiatives flow (see Hall 2000). It was decided to focus on recruiting participants from 'exemplar' organisations, or those organisations considered as being highly active with regards to SC GHGE management efforts.

Focussing on best case examples was felt to offer the best chance of generating robust results, as these organisations were likely to be well established, to have already overcome obstacles and for impacts to have surfaced; this method had precedence in ESCM research (see Wu and Pagell 2010). Only those organisations that had been engaging with SC GHGE management for at least one year were attempted to be identified. Further, participants had to be from consolidated organisations within a mature industry, so as to limit distracting issues, such as economic instability, meaning that a consistent focus on issues had been achieved (Lozano 2009). Where examples were found that included substantial third party involvement, interviews were also sought with individuals within these organisations, as they were felt to have been a significant aspect of the focal organisations engagement with SC GHGE management activities; this occurred in three instances, as will be detailed in section 3.4.5.2.

Due to the second phases focus on focal organisations, individuals who had experience and knowledge of their organisations efforts, with regards to the management of SC GHGEs within these organisations, had to be recruited. These individuals included senior managers in purchasing, sustainable procurement, or environmental management, or more broadly, individuals with decision making power involved in the SC GHGE management initiatives; further, these individuals were felt likely to have had regular contact with partners in the SC and thus were in a good position to determine how relationships in the SC were affected by, or how they affected SC GHGE management efforts (Verwaal and Hesselmans 2004). It was felt that these data collection methods would provide the necessary depth and richness required, whilst also providing a diversity of sources, allowing triangulation.

3.4.5 Participant Identification and Recruitment

This section describes the techniques used for the recruitment of participants for both phase one and phase two. For both phases, organisations from which suitable participants could be recruited were identified initially, as noted above. Once these organisations were identified, specific individuals from within them were identified

and approached. The techniques used in the identification of organisations and the approaching of individuals will be described below.

In both phases, cold approaches formed the primary method of recruitment. Once individuals had participated in the research and provided an interview, they were asked if they knew other suitable individuals; this question was aimed at obtaining participants through snowballing. Although this proved successful on several occasions, cold approaches were used for the recruitment of the majority of participants. Examples of emails sent to participants can be found in Appendix D.

3.4.5.1 Phase One

As phase one sought individuals with an external perspective to SC GHGE management initiatives, it was felt that these individuals would be found within organisations that had an interest in SC GHGE management, but did not undertake the management themselves, i.e. not businesses or public sector organisations (excluding policymakers in government). Organisations were deemed to have an interest if they provided support to focal organisations, such as consultancies or not-for-profit business support or representation organisations, or were involved in policymaking, being policy-makers themselves or lobbying on the issue.

Through academic and grey literature searches, internet searches and co-nomination through snow balling more than 70 individuals or organisations were identified as holding the relevant knowledge and experience to be considered eligible for recruitment in phase one. Depending upon the search method used, a judgement was made upon the participants levels of knowledge and experience based on any biographical information available, including their employment history, current projects and the organisation (its role and activities) where they were currently employed. Broadly, individuals who had written reports or had articles published on topics concerning SC GHGE management, or had at least 3 years' experience within related fields, were felt to hold the necessary knowledge and experience. In addition, the action of participants agreeing to be interviewed, once project description and information on the content of the interview had been provided, indicated a level of knowledge and confidence by the participant, signifying that they would be able to contribute. Once deemed eligible, potential participants were sent an email requesting

their participation, including an information sheet and consent form; Appendix E and Appendix F contain examples of these. Of those approached, 11 agreed to be interviewed and are shown in Table 3-3.

Table 3-3: Phase one participant list.

Interview Code/Number	Participant Job Title	Organisation Type
A01	Senior Policy Advisor	Business Representation Organisation
A02	Head of Corporate Relations	Local Business Support and Representation Organisation
A03	Operations Director	Regional Business Support Organisation
A04	Senior Account Manager	Solution Based NGO
A05	Program Manager	Regional Intelligence Network
A06	Research Fellow	Policy Think Tank
A07	Environmental Campaign Organiser	Regional Business Support Organisation
A08	Corporate Strategy Consultant	Global Management Consultancy
A09	Post-Doctoral Researcher	Academic Institution
A10	Senior Strategy Manager	National Low Carbon Business Support Organisation
A11	Senior Sustainability Manager	Sustainability Think Tank

As actors external to the focal organisations managing their SC GHGEs, these participants were felt to be able to provide an overview perspective, as many of them had experience of providing support and advice to multiple organisations that had engaged with their SC GHGEs. These participants were actors who had encountered

multiple examples of SC GHGE management efforts, rather than in-depth knowledge of specific cases; these participants also had a more general knowledge of organisational motivations and hindrances in relation to environmental management, and to policy and regulation. Due to their general role, they were felt ideal for the purpose of the initial scoping/first phase, which was to provide an overview of the current state of activities, so as to provide further direction and focus to subsequent enquiries.

3.4.5.2 Phase Two

Initial recruitment efforts in phase two involved the identification of individuals from within 'exemplar' focal organisations attempting to manage their SC GHGEs. Only those organisations that had publicised their efforts through various mechanisms were able to be identified, such as through industry/trade body or NGO membership (for example through membership to the CDP or WRI/WBCSD). This method had precedence in other ESCM research (see Font et al. 2008). Further internet searches were conducted to identify organisations through trade magazines or newspaper articles, such as 'BusinessGreen.com', 'GreenWise', 'Logisticsmanager.com' and 'Supply Chain Standard' (see Wu and Pagell 2010, for precedence on this method). Search terms such as 'supply chain/GHGs' or 'supplier carbon/GHGs' were used. Several examples, especially those in the public sector, were also identified through phase one.

Once organisations were identified and selected, individuals within them were sought, either through general requests, or through further searches, either on organisation websites, or through professional social media sites, such as LinkedIn. Individuals who had worked in areas central or related to their organisations activities with regards to SC GHGE management efforts were targeted. Those individuals with at least 2-3 years' experience in areas related to SC GHGE management were deemed suitable; in addition, as in phase one, the action of the participant agreeing to be interviewed, once information on the project and interview questions had been provided, indicated a confidence and likely level of knowledge by the participants, which strengthen assertions that the participant was suitable.

Once individuals within the organisations were identified, they were contacted via email. These emails contained a request to participate in the research and included an information sheet and a consent form (see Appendix E and Appendix F).

77 organisations were identified as attempting to manage their SC GHGEs; however only 55 individuals from this list of organisations could be identified to be contacted; where specific individuals within an organisation could not be identified, a general enquiry was made, however where this was the case the response rate was zero. From the 55 individuals identified, 23 individuals agreed to be interviewed from 20 organisations. An outline of the research participants for phases one and two can be found in Table 3-4. A full outline of the research participants, including the interview date, time and type can be found in Appendix G.

Table 3-4: Phase two participant list.

Interview Code/ Number	Participant Job Title	Organisation Type
B01	(2x Participants) Head of CSR Strategy & Policy for Procurement; Climate Change & Sustainability Officer	Multinational Telecoms Service Provider
B02	Associate Director of Brownfield and Sustainability	British House Building Company
B03	Science & Technology Leader	Multinational Consumer Goods Company
B04	VP of Sustainability	Multinational Pharmaceutical and Consumer Healthcare Goods Company
B05	Executive Director	Regional Social Enterprise
B06	Capability Manager	British Water Utility Company

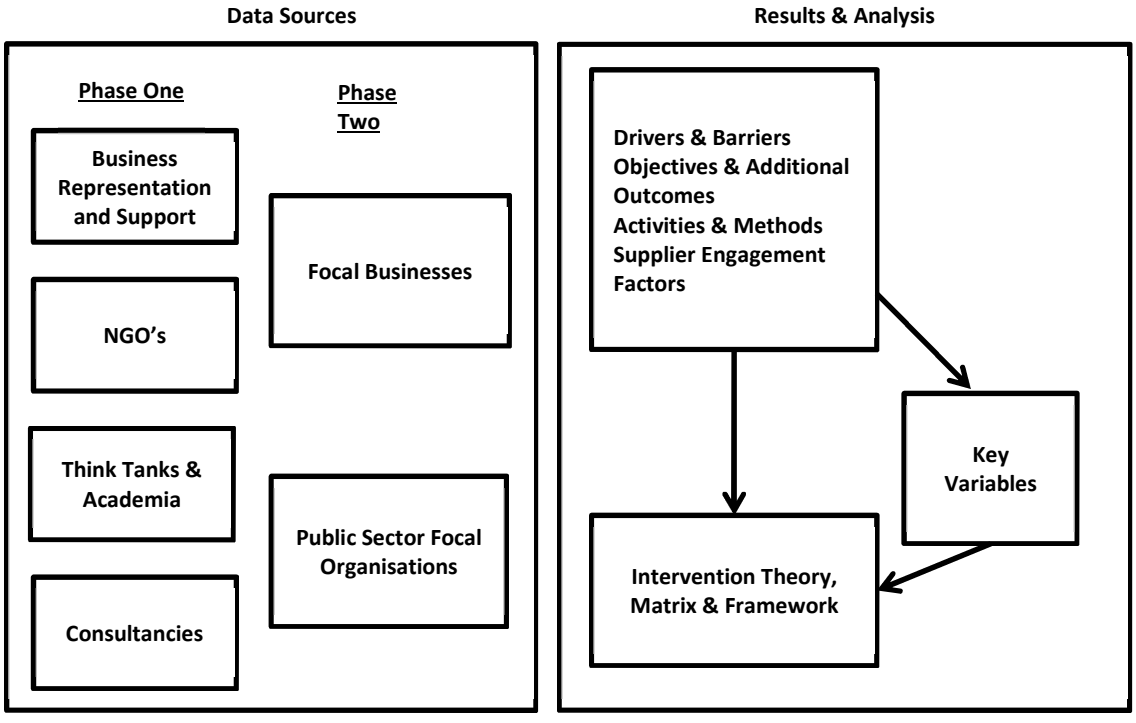
B07	Group Environment Health and Safety manager for the UK subsidiary	Dairy Products Company
B08	Head of Sustainability	Construction, Property & Housing Company
B09	Senior Sustainability Manager	Multinational Construction & Development Company
B10	Regional Manager, North of England	Multidisciplinary Consultancy Company
B11	Head of Supply Chain Carbon Reduction	Multinational Grocery and General Merchandise Retailer
B12	Sustainability Officer	County Council
B13	Low Carbon Consultant	Global Consultancy and Professional Services Firm
B14	Responsible Procurement Manager	Top-tier Regional Administrative Body
B15	Head of Supply Chain Research	Environmental Consultancy
B16	(2x Participants) Environmental Advisor (Construction); Sustainable Procurement Advisor	Government Agency
B17	Climate Change Officer	County Council
B18	(2x Participants) Environment and Sustainability Officer; Research Fellow	University
B19	Sustainability Officer	University
B20	Operations Director	Sustainability Unit of National Public Service Provider

The data provided during this second phase provided an internal, 'practitioner' perspective and allowed the themes developed during phase one to be examined in greater detail. A wide range of organisations were canvassed during phase two. This was due to difficulties in recruiting suitable organisations, in part due to SC GHGE management being a new and embryonic area of environmental management for organisations. This fact meant that the number of organisations qualifying as data sources was low. The level of diversity within the sample reduces the ability to generalise from the results, and potentially impacts on the validity, due to this lack of data sources. However, this diversity also provides an opportunity to undertake a wide exploration of current practice in the UK, including both its public and private dimension, and from diverse industries and types of public sector organisation.

3.4.6 Data Overview

Together, phases one and two form the total primary data collection activity. Figure 3-1 illustrates where phase one and two data originated, as well as the various results and analysis phases. Figure 3-1 also highlights how the data was analysed, noting how initial codes and results contributed towards the identification of key variables and eventually the development of an intervention theory, matrix and framework.

Figure 3-1: Data and analysis overview schematic.



3.4.7 Ethical Consideration

In order to gain clearance to conduct the research, several ethical concerns had to be considered, that impacted the research methods and design. Firstly, so as not to place overbearing demands on participants, it was decided that each participant would be visited a maximum of once; where additional information was required, follow up questions would be asked via email or telephone. In addition, participants were assured that interviews would last no longer that one hour, restricting the time available to question and probe participants.

Secondly, informed consent was required, which was supplied via the information sheets and consent forms, examples of which can be found in Appendix E and Appendix F. Participants were also given the option of not answering questions and of withdrawing from the research at any time. No participants declined to answer any questions, although several participants who initially agreed to take part, did withdraw.

Finally, participants were offered anonymity, both for themselves and the organisations through which they were employed. Blanket anonymity was required, as certain examples came from small industry sectors, where the identification of one organisation would permit the identification, through elimination, of other organisations. Although blanket anonymity meant that examples could not be identified, it did provide a reassurance to certain participants, which may have boosted participation rates.

3.5 Data Analysis

The set of analysis techniques used within this research will be described below, such as the coding strategy undertaken in the initial aspects of the data analysis, followed by the methods used for the development of deeper understanding including inductive methods, such as matrix analysis and for theory/framework building. In line with explorative research, analysis is deemed to begin at the start of the data collection process by noting those observations/factors seen as significant and important (Creswell 2003). The initial coding and categorisation for phase one was completed before the second phase of the research; this allowed knowledge gained through the initial scoping aspects to be applied and inform the second phase of data collection.

Once all data had been collected, through phase one and two, coding and categorisation continued. When significant themes and categories had been developed, the analysis moved on to include theory and framework building, and the extraction of key results required for the answering of the research questions.

3.5.1 Coding and Categorisation

As noted above, once data had been collected through the interviews, it was transcribed and coded using Nvivo 8. This initially involved noting those observations/factors seen as significant and important. Preliminary theory and framework building started at this stage. Typical and frequent elements were coded, alongside information critical to the answering of the research questions initially posed. Thematic analysis formed the focus of the analysis efforts; as data is coded, themes key to the answering of the research questions are expected to emerge (Boyatzis 1998). Abstraction (empirical to conceptual) and generalisation (seeking invariances common in the data) were undertaken during this period, in both phases one and two.

Different coding strategies were utilised within phases one and two. Due to the exploratory nature of phase one and a desire to include all possible relevant information, a lower burden of evidence was required in constructing a theme or category. Within this first phase, only a single source was required. As the project moved in to its second phase however, as explanatory elements took on a greater focus within the research, such as why focal organisations were engaging with SC GHGE management, a greater burden of evidence was deemed as necessary. As such, coding of the phase two data required at least two sources for the development of a theme or category.

For example, during phase one, one key research objective concerned the identification of organisations leading current SC GHGE management efforts. Through the reading of the interview transcripts a pattern emerged, indicating that businesses played a central role, but that government (including public sector organisations) as well as other third sector actors, also potentially fulfilled critical roles. This data was initially coded within a category concerning ‘actors’. Once all relevant data had been placed into this category, it was further refined, with each set of actors forming

additional categories, including ‘business’, ‘public sector’ (including government and public sector organisations) and ‘third-sector’. From the identification of these sets of actors, and ordered into categories, additional codes, concerning drivers, barriers and key activities could be undertaken.

The categorisation of the data involved numerous iterations to ensure internal consistency within the various categories. The same methods were used in the coding and categorisation of phase two. The completion of this process produced a range of codes and categories, with a variety of layers, identifying key themes in relation to the research questions, as well as additional categories.

3.5.2 Additional Analysis and Theory and Framework Building Techniques

3.5.2.1 Inductive Reasoning

The research sought to explore and explain the phenomenon under study, through an inductive approach. Through this method, once initial exploration and coding has taken place, further analysis can be undertaken in order to develop a deeper understanding of the topic. Within qualitative research, this can include the investigation of causal relationships and the development of frameworks, using inductive reasoning (Johnson and Christensen 2010; Patton 2002). Reasoning forms a central aspect of this process, and it will be assumed that agents take a course of action that will optimally achieve their desired ends in any given situation, such as profit maximisation or service delivery.

A further method or level of data analysis concerns data display (Miles and Huberman 1994), and goes beyond data reduction efforts, such as coding and categorisation. It can include diagrams, charts or matrices, and allows contextually embedded data to be viewed and arranged in new and different ways in order to extrapolate new information. New patterns and interrelationship can emerge through this process, deepening understanding and providing further categories, themes and the identification of causal relationships (Miles and Huberman 1994).

3.5.2.2 Framework Building: Intervention Theory

As described above, an additional phase of data analysis was undertaken using inductive reasoning, in order to develop an intervention theory of SC GHGE management. An intervention theory is a description and specification of what is

required in order to achieve a desired goal, including any impacts that can be expected and how they would be generated (Chen 1990). It is a model or theory of 'micro-steps and linkages', identifying causality, from interventions to outcomes (Rogers et al. 2000). The general constituents of such a theory are seen to include the actors involved, the inputs and outputs of the intervention as well as the expected outcomes (Mickwitz 2003). Within this research, inductive reasoning was used in order to predict how the actors being influenced by the interventions would react, using the results obtained from the initial coding and categorisation efforts, and the knowledge this produced.

3.5.2.3 Matrix Analysis

Data display analysis techniques were undertaken in this research, taking the form of a matrix analysis. In order to carry out such an approach, two sets of categories were plotted onto the axes of a matrix, allowing cross-referencing so as to identify any possible causal relationships between the two sets of categories. Once the data categories had been plotted on to the matrixes, inductive reasoning was undertaken in order to extrapolate new patterns and interrelationships.

3.6 Limitations of the Methods and Mitigating Measures

Whilst the methods outlined above were deemed the most appropriate, given resource and time constraints, this research design had several limitations which potentially impacted its relevance and validity.

Firstly, although over 70 potential participants were identified within phase one, only 11 submitted to be interviewed. Although this was felt to be a poor response rate, participant recruitment and data collection was stopped once data saturation was felt to have been reached in line with the views of Strauss and Corbin (1998). Phase two followed similar patterns with 55 individuals identified and 23 interviewed; response rates within the second phase were higher, resulting in a greater number of sources providing data. Similarly, recruitment efforts ceased once data saturation was deemed to have been reached. This was the point at which no new information was being reported. As such, although the response rates within the first phase were poor, the number of participants interviewed was felt sufficient, due to data saturation being obtained.

Secondly, although all effort was taken to minimise the possibility of participant or researcher bias through the interviews, the possibility of it occurring was always present. Efforts to minimise these risks included ensuring that the questions posed to participants were neutrally formed, whilst the anonymisation of the data was felt to reduce any pressures experienced by the participants with regards to reporting the actions of their organisations more favourably, than would otherwise be the case in reality.

3.7 Chapter Summary

This chapter has outlined the methodological approach of the research. Research aims and questions were identified, in order to guide the research, followed by the establishment of a pragmatic realist methodological stance. This stance was felt most appropriate for the answering of the research problem, focussing on the attainment of answers and solutions.

The research design was noted, including its various phases as well as the role of theory, both with regard to this project and qualitative research more generally. The identification of a suitable data collection technique, namely the use of semi-structured interviews, for use with a range of research participants was outlined, including the identification and recruitment procedures undertaken during the securing of the participants. Ethical considerations were also noted, before the chapter outlined the data analysis techniques. These included initial coding and categorisation efforts, followed by additional techniques, such as the use of matrices and inductive reasoning in order to allow further meaning and understating to be gained and theory building to be undertaken.

Finally, the limitations of these methods were noted, alongside efforts taken to mitigate their effect and impact. In addition, an overview and characterisation of the data was provided. The thesis will now move on to highlighting the results obtained from the initial coding and categorisation efforts.

Chapter 4. Phase One Results: Initial Investigations and the Role and Efficacy of Policy and Regulation

The results of the initial analysis phase, from phase one, are presented below. As indicated in the methods chapter, phase one was conducted in order to provide an initial overview of the current state of SC GHGE management. The overview was then used to further refine the focus of the study and its approach for phase two; for example, although private sector organisations were identified as leading current efforts, it was noted that the public sector also contained examples of SC GHGE management actions that should be examined.

This initial phase sought to identify which focal organisations in the SC were considered to be leading current efforts, so as to provide a characterisation. The role and activities of other actors was also included in the questioning. Throughout, both actual and potential activities and roles were felt to be relevant. Data from this phase highlighted that three main actors should be considered in relation to GHGE management in SCs, including businesses, the state (consisting of government and public sector organisations), as well as actors in the 'third' or not-for-profit sector, such as academia, think tanks or business support organisations. The activities undertaken by these organisations are also briefly examined alongside those factors seen to be driving or hindering these activities. The various roles for the government or public sector are also examined, including the regulatory or policy options available.

Data from this phase was analysed in line with the description provided in Chapter 3. Specifically, the interview transcripts obtained from the participants were coded thematically, using Nvivo, in order to attempt to answer the research questions. Through various iterations and revisions, the theme categories were refined to provide the material that will be presented below.

4.1 Leaders of Supply Chain Greenhouse Gas Emission Management

Analysis of the data from the phase one participants showed that private sector businesses were felt to be leading current efforts aimed at managing SC GHGEs. The factors responsible for this assertion will be described below. Participant A04,

however, provides an illustrative quote, highlighting the leading nature of business in this area:

> But the crucial thing is that governments are following the lead of corporations. (A04; 04.02.2011).

It should be noted that although during the interviews it was made clear that the government and public sector controlled the most powerful levers, such as regulation and policy, that they were constrained by factors such as a lack of political will or the diversity and opacity of SCs. Although constrained, it was reported that some public sector focal organisations were active, and would subsequently be worth exploring in later phases of the enquiry:

> Outside that leading business group, only really government and prime public sector organisations like the [redacted] [large public sector organisation] are looking at supply chains and sustainable procurement. (A03; 01.02.2011).

Large focal businesses were reported by the participants in phase one to have the power, scale and necessary authority over their SCs, to be leading current efforts:

> Those 300 companies, and the companies that we work with at the [redacted], [climate change orientated non-governmental organisation] have the power to drive change in those supply chains." (A04; 04.02.2011)

These businesses were also highlighted as being less constrained than the public sector. Those businesses with high brand value and a high proportion of SC GHGEs were noted as being especially active, such as supermarkets or other retailers:

> I think it's the organisations that will have identified big risk in their supply chains. So probably the ones that understand they've got a high carbon instance in their supply chain, and that their business model relies on that. (A11; 18.03.2011).

In summary, the participants and data indicated that private sector brand firms, with high instance of SC GHGEs, together with the resources and expertise to tackle them, are leading current efforts. The section below will explore these factors in more detail and demonstrate that although the public sector holds much potential, in its current constrained state, large brand businesses within the private sector are most active in relation to SC GHGE management.

4.2 Factors Driving and Hindering Business Engagement

The following section will outline the factors identified through the coding process that were seen to either drive or hinder business engagement with SC GHGE management.

The factors felt to drive and motivate business will be outlined and explored first, followed by those that were reported to be a hindrance or present a challenge.

4.2.1 Driving Factors

Factors identified by the participants as driving or hindering efforts were coded and refined through multiple iterations to ensure as much consistency as possible; the categories developed through this process are summarised in Table 4-1. The development of a category or theme indicates that a participant noted the factor during the interviews; the second phase will require that at least two participants noted a factor for a category to be developed. The less stringent requirements within this first phase reflect the goal of producing an overview, and a wish to include any factors or observations. Competitive advantage and market positioning, CR and public relations (PR), the development of best practice and consensus, economic, risk and finally, stakeholders, were all identified through this process; each theme will now be outlined in more detail.

Table 4-1: Summary of phase one driving factor categories.

Category	Expansion
Competitive Advantage & Market Positioning	Winning business
	Differentiate relative to competitors
CSR & PR	Enhance & protect reputation
Development of Best Practice & Consensus	Demonstration of success
	Peer pressure
Economic	SC investment & finance
	Cost & efficiency
Risk	High SC GHGE
	Brand risks
Stakeholders	Customer demand
	Investor/shareholder demand

4.2.1.1 Competitive Advantage and Market Positioning

The ability to gain a competitive advantage and differentiate a business against its competitors through engagement with SC GHGEs was identified as a driving factor, or reason, for businesses engaging with SC GHGE management. This category describes how a business is able to make the claim to its customers, that it was doing more regarding environmental management than its competitors, and as such gain a business 'boost':

> There's also the fact that if they are doing something that their competitors aren't, then there's competitive advantage. (A07; 21.02.2011).

This claim was felt to be sufficient in some circumstances to win business, and position the firm in its market or sector so as to be able to capture customers who attributed a greater value to environmental protection and ethical business practices:

> Based on that difference it may drive some customers to change providers. That's the second threat. (A08; 25.02.2011).

The ability to make these claims and position the business appropriately was reported by some participants to be part of the overall motivation for business engagement with SC GHGE management.

4.2.1.2 Corporate Responsibility and Public Relations

Although similar to the above noted theme, the data indicated that the fear of reputation loss if a business was seen to be doing badly, relative to its competitors was also a driver. In contrast to the 'competitive advantage' driver, engaging with SC GHGE management was reported as necessary for some businesses in order to protect their market position, acting as more of a risk management, rather than competitiveness factor. This factor can also be seen to link into aspects of the business retaining its 'social license' to operate. With brands containing value, poor environmental performance, including in relation to SC GHGEs, posed a significant risk, and as such CR and PR prerogatives meant that they had to be addressed:

> 80% of the value of a high street company is in its brand and its reputation. Being seen to not be very good on environmental issues is detrimental to that and so they take it seriously. (A03; 01.02.2011).

The example of supermarkets in the UK, and the damage that would be done to their brand if they were seen to come at the bottom of a league table for SC GHGE management, was used to illustrate this point:

> The reputational driver for [redacted] [large UK supermarket] for coming bottom of the supermarket league table for carbon; it would be a total humiliation for them. (A06; 11.02.2011).

As such, the desire to keep up and protect a position, in contrast to the first competitiveness driver where business sought to 'get ahead' through SC GHGE management, formed a motivating force according to the data.

4.2.1.3 Development of Best Practice and Consensus

The increasing prevalence of SC GHGE management, as well as the establishment of organisations such as the CDP, also emerged in the data as a driving factor. As more organisations engaged and started to manage their SC GHGEs, it was felt that this led to two complimentary driving forces; firstly the demonstration of best practice and a growing body of evidence that it was a worthwhile and positive area of environmental management:

> [L]eading companies experience will show that it's a positive thing. (A01; 10.12.2010).

Secondly, that as more organisations did engage, that a type of peer pressure would be formed, driving other organisations to do the same:

> I think there is going to be an increasing peer pressure, certainly among companies, especially larger companies, to start reporting Scope Three, including supply chain emissions. (A10; 09.14.2011).

Together, the perception of growing evidence that SC GHGE management is worthwhile, and the increasing prevalence of organisations acting in this space, led to the development of this category as an independent driving factor.

4.2.1.4 Economic Factors

Primarily within this driving category was the belief that engaging with SC GHGEs would provide efficiency gains and costs savings to businesses. Acting in the SC to reduce GHGEs was noted as a method for saving money, aiding the 'bottom line'. In addition to this more simple reason to manage SC GHGEs, it was also noted that such activities also provided a method for investing in the SC and strengthening and aiding the suppliers within it:

> Companies are acting voluntarily, and as a cost reduction measure, as a way to promote investment in their supply chain, and if their supply chains are more efficient, then that benefits them. (A01; 10.12.2010).

4.2.1.5 Stakeholders

It was reported that some stakeholders were demanding or requesting action in relation to SC GHGE management; customers, NGOs and financial stakeholders were all seen as relevant in this regard. This category has clear links to several of those above, including market positioning and differentiation factors, as well as CR and PR, as it is through stakeholders that these factors are operationalised. A wide set of stakeholders are relevant and can raise demands that businesses engage with SC

GHGEs. For example, shareholders were noted as a specific stakeholder responsible for driving some SC GHGEs efforts:

> So the cynic in me say's, well actually, what reasons were they doing it for? To genuinely make a difference, or doing it to keep a) their shareholders, and b) their customers, happy. (A02; 18.01.2011).

4.2.1.6 Risk

Risk management concerns were reported through the interviews as a further driving factor; it was often referred to as an overarching factor. Risk was seen to be derived from having high GHGEs within the SC and was often mentioned in terms of the future; for example the risk of future legislation imposing a tax on SC GHGEs:

> They are motivated by things like risk, regulatory risk, so the possibility of, if your procurement team has done a good job of pushing down the price of all the commodities you buy, or the components you buy from China, and suddenly China decides to impose a 10% carbon tax, you suddenly have a 10% cost coming right through the supply chain, because you've already eaten away at the suppliers margins. (A04; 04.02.2011).

The desire to mitigate such risks forms the central aspect of this category; businesses were reported to see both threats and opportunities within SC GHGE management. The need to manage these risks acted as the driving force.

4.2.1.7 Drivers Summary

These drivers were identified through the coding process as being responsible for the reported situation of current efforts being led by large private sector brand firms. It is these businesses that are impacted by reputation or CR drivers, as well as having the size and resources, and so also expertise, to recognise the need for action. The existence of 'future risks', such as the impact of possible future regulation, was also identified as a factor.

4.2.2 Barriers

During the course of the interviews and the coding process, factors were identified that acted as barriers. The categories developed, summarised in Table 4-2, signify factors that represented challenges involved in the management of SC GHGEs or that acted as a disincentive to engage in the first place. Many of these barriers reflect the difficulties inherent in engaging with a relatively underdeveloped area of environmental management, where the environmental impact is occurring outside the traditional boundaries of the firm.

Table 4-2: Summary of phase one barrier categories.

Category	Expansion
Cooperation Required	From suppliers.
	Wider, in terms of transport and energy systems.
Data Issues	Reliability.
	Methodology.
	Scales.
Financial & Cost Issues	Limited resources.
	GHGEs not a priority.
Lack of Policy, Regulation & Support	No direct policy or regulation.
Lack of Understanding & Belief	Complex issue.
	'Hearts and Minds' battle.
Low Stakeholder Pressure	Little customer demand.
	Low societal/media pressure.
Time-frame Issues	Long pay period on investments.

4.2.2.1 Dependency/Cooperation Requirements

Unlike more traditional forms of environmental management where environmental impacts occurring within the firm are managed, SC GHGEs occur outside the boundaries of organisations. As a result, the need for action or cooperation from suppliers was identified as a key barrier:

> So if you want a zero carbon supply chain, it's not going to happen without everyone changing all the way up and down the supply chain. (A11; 18.03.2011)

Participant A11 continued to illustrate a further aspect of this category: a reliance on wider systems to reduce GHGEs in SCs, such as decarbonisation of the electricity grid and other associated infrastructure systems including transportation:

> I think there is a pretty fundamental question regarding the system that the supply chain operates in. Because it depends on so many issues, like the decarbonisation of the grid, the energy supply, logistics being improved, it's so wide ranging it just can't be done by one organisation on its own. (A11; 18.03.2011)

At the core of this barrier is the lack of control that businesses have over some of the GHGEs within their SC, and the methods for reducing them. Although control is lacking, influence is possible, and it is these strategies that are able to influence SC GHGEs that will be examined in the next section. However, further barriers were identified from the data analysis, and will be covered first.

4.2.2.2 Data Issues

This category was developed in response to several interrelated issues connected to GHGE data. These included the negative impacts of data reliability issues, methodological difficulties and the scales involved in relation to some large organisations.

In relation to reliability, participant A04 noted that verification rates were very low, and that much data on SC GHGEs was estimated:

> Even our data, the primary data we get from suppliers, we're only looking at about 30% verification. (A04; 04.02.2011).

This lack of verification could reduce the confidence in the data, creating uncertainty and impacting upon decision making. Poor verification was linked to another identified factor: methodological ambiguity. Participant A07 noted that several methodologies and standards were available, meaning comparisons were difficult. Further, with such choices available, some businesses were confused about where to draw GHGE boundaries and what to include as a SC GHGE or an internal GHGE. That the process of calculating SC GHGEs causes a barrier, was highlighted as being amplified within large businesses which had more complex SCs, with many products. This forms the third aspect of the category, scale:

> It's more difficult to measure how much carbon there is, in the products that you use. So, if you take the supermarket example, it's quite easy for them to work out how much carbon they use in the building, and it's quite easy for them to work out how much carbon they use in delivering and on the logistics side. It is quite difficult to work out how much carbon there is in a packet of crisps. (A06; 11.04.2011).

The complexities involved in acquiring accurate data, such as methodological ambiguity and the scale of some operations, was identified as a barrier and challenge to businesses wishing to manage their SC GHGEs.

4.2.2.3 Financial and Cost Issues

Through the coding of the data, it became clear that a further barrier to businesses management of SC GHGEs regarded limited resources and their prioritisation. Due to finite resources, expenditure towards the management of SC GHGEs had to compete with other objectives within SCM, and wider corporate objectives. Where SC GHGE management efforts would lead to an increase in cost, it was highlighted that this would be unlikely to be undertaken, as buyers were currently unwilling to pay significant premiums for reduced carbon products:

> So, there are models of where supply chains have been other than cost driven. So it is possible for them to be carbon emission driven, but you would have to be in a position where that meant more than to the buyers, than cost or quality. And I'm not sure what would drive the buyer to start thinking that way. (A05; 07.02.2011).

A further issue within this category was the existence of several carbon prices within the economy, complicating decisions regarding whether or not to spend funds on the management of SC GHGEs:

> Until they have their clear price signal that makes it more difficult to get that kind of investment, you know that kind of un-sexy stuff that actually reduces carbon. So that's from the companies' point of view. (A06; 11.02.2011).

Multiple carbon prices, as well as general cost pressures were seen to be factors acting to prohibit and increase the difficulty of SC GHGE management by business. The sometimes long time-frames involved in obtaining a return from SC GHGE management efforts were also noted as a barrier:

> So, environmental managers try to reduce resource use and cost, whereas purchasing will be mostly cost and quality. But in the business case cost will always be paramount, and we find that anything that has over a two year payback will not be taken on. (A07; 21.02.2011).

Combined, the above noted factors form a set of hindering factors related to the financial and cost side of SC GHGE management.

4.2.2.4 Lack of Policy and Support

It was highlighted, by participant A08 that:

> Policy up to now has not been a major driver; although some people believe it has a higher impact. (A08; 25.02.2011).

As previously indicated within the introductory chapter, there is no direct policy or regulation that impacts SC GHGEs. Through the analysis, including the quote above, it

was deemed that a lack of regulation acted as a barrier. A lack of clear signals or pressure from government reduces motivation for engaging with the issue, and reduces its relative prominence in relation to other goals, that may be covered by regulation, such as direct or internal GHGEs.

Further compounding the lack of policy is a lack of advice and support to address issues such as methodological difficulties:

> Businesses need tools to be able to do that, and ways to identify what criteria they should be looking at, as that's one of the issues you do get, people just don't know what the issues are to look for in a supply chain. (A07; 21.02.2011).

That government or the state is failing to provide either of these aspects was a noted barrier. The space created by this lack of action, acts as a demotivating factor, hindering action.

4.2.2.5 Lack of Understanding and Belief

This category was developed in order to reflect opinions expressed by phase one participants that there was a level of apathy within some businesses, including those currently engaging with SC GHGEs. This was related to a 'hearts and minds' aspect, in which individuals within businesses lacked an understanding of the importance of engaging with climate change mitigation objectives, due to beliefs that it was an unimportant issue.

> I think there's a real hearts and minds job to be done, particularly within the business community, and particularly within the SME sector. There needs to be a hearts and minds campaign. (A02; 18.01.2011).

This category attempts to reflect the participants views that businesses lacked motivation. Included within this assertion is that SMEs, who often constitute a large proportion of SCs, also lacked this belief, potentially reducing supplier motivation. These aspects act as a barrier, due to an associated lack of understanding regarding the importance and opportunities presented by SC GHGE management efforts.

4.2.2.6 Low Stakeholder Pressure

Low levels of stakeholder demand emerged during the coding process as a further hindering factor. Low levels of customer demand were noted specifically, especially where a business was not directly consumer facing:

> [T]he customers don't care; they may not be consumer facing customers, so they may not be too worried about their brand image. (A08; 25.02.2011).

A lack of stakeholder demand was also articulated more generally, and related to the complexity of SC GHGEs, and environmental issues more generally:

> [I]n the last ten years we've seen people highlight the ethical side of their supply chain, I think that the environmental side is slightly behind, because the human issues have made the media more, because if you highlight the sweatshop somewhere it's a more obvious media story. Whereas someone having a high carbon level in their supply chain hasn't got the same kind of appeal to the media. (A07; 21.02.2011).

Combined, these factors lead to a conclusion that a lack of stakeholder pressure, in its two reported forms above, was acting as a barrier.

4.2.2.7 Barriers Overview

A wide range of factors were identified during the coding process as hindering efforts to manage SC GHGEs, including factors that led to a lack of motivation, such as low stakeholder demand, through to aspects that made efforts harder, such methodological difficulties.

That businesses were still reported to be engaging with, and attempting to measure and manage SC GHGEs, indicates that these barriers are not absolute and are either applicable only in certain cases, or are surmountable.

4.2.3 Drivers and Barriers Summary

Many of the factors identified as drivers were also subsequently identified as barriers; for example, stakeholders were noted as a driving factor and a barrier. Although some businesses will have been pushed by shareholders or investors to report and disclose their SC GHGEs, many businesses will not have experienced this driver, and hence, the lack of this pressure becomes a barrier. This demonstrates the importance of individual organisational context as to whether the balance between drivers and barriers meant that action was feasible or required, and ultimately, taken.

This section has outlined the reasons that emerged through the interview process for why large brand businesses manage their SC GHGEs, such as a desire to manage risks to their reputation. It has also covered the factors that can be seen to be hindering their efforts, such as low stakeholder demand. The next section will cover the specific activities undertaken by business and other organisations to manage their SC GHGEs.

4.3 Activities for Greenhouse Gas Emission Management

Participants were asked to comment on the actions that businesses and other organisations who led SCs could pursue in order to manage and reduce their SC GHGEs; the specific actions undertaken were felt an important area of investigation due to the potential implications and impacts they could hold for SCs, organisations and wider society. Responses were categorised into two overarching categories: firstly, those actions that were aimed at scoping and measuring their SC GHGEs, providing information either for its own sake (i.e. for reporting and disclosure) or for detailing further reduction strategies; and secondly, reduction strategies or actions, undertaken by focal businesses to reduce GHGEs in their SCs. Table 4-3 contains an overview of the activity categories identified.

Table 4-3: Summary of phase one activity categories.

Scoping/Informing Strategies:	**Involves:**
Supplier Engagement	Initial engagement to raise issues.
Supplier Disclosure & Reporting	Asking suppliers to disclose and report GHGEs.
SC Mapping	Mapping of emissions instances and points of influence.
Product Level Data	Per product GHGE data.
Reduction Strategies:	**Involve:**
Supply Network Optimisation and Logistics Choices	Changes to transportation modes, tracking technologies and routes.
Contractualised Reductions	Suppliers contracted to reduce their GHGEs over life of contract.
Supplier Selection Criteria	Suppliers partly selected on bases of GHGE performance.
SC Collaboration	Collaborating with SC to achieve reductions.

4.3.1 Scoping/Informing Strategies and Activities

As indicated above, the activities undertaken by organisations to manage their SC GHGEs were split into two categories. This first category concerned those activities that were undertaken in order to measure SC GHGEs. Such scoping and informing strategies were identified as being able to provide both data required for reporting

and disclosure requirements, as well as establishing a base from which further actions could be launched.

4.3.1.1 Supplier Engagement

As an initial activity, it was noted by participant A10, that suppliers should be engaged. This was seen as a way of ensuring that suppliers knew about new concerns regarding GHGEs, and that they would not be taken by surprise by future demands. These engagement activities would be 'light touch' and about raising the issue for the future:

> One of the things we advise clients on sometimes, I guess from a company's perspective, is to initially start to engage with suppliers. So if I'm buying things from suppliers, I have to engage with suppliers and initially let them know that this is an important issue for me. (A10; 09.03.2011).

The activity was categorised as it was felt it demonstrated a key initial activity that needed to be carried out, as a prerequisite to future actions.

4.3.1.2 Supply Chain Mapping

The mapping of GHGE instances and points of influence emerged as a key initial activity due to its ability to provide early indications of large instances of SC GHGEs. Further, it allowed methods for influencing and affecting these high SC GHGE instances to be identified:

> So, that very first step of mapping what the footprint of your supply chain is, and properly understanding it. But not necessarily going to the nth detail, because you're never going to get the most robust and accurate carbon footprint to the decimal point, of your supply chain. But they should know in orders of magnitude what categories you have a huge footprint through. (A11; 18.03.2011).

This activity can be achieved without supplier engagement, through the modelling of financial receipts. But as indicated above, it is unable to provide accurate detail, and rather, is used to provide an initial level of understanding, from which to move forward to more accurate measurement methods or reduction activities.

4.3.1.3 Supplier Disclosure and Reporting

Once engaged, it became apparent through the data that a further initial step was to collect GHGE data from suppliers. Similarly to above, this activity aims to measure and in some cases report the GHGEs that exist in the SC:

> So, the old adage that says 'to measure is to manage' is true, so you have to start measuring their carbon emissions in order to manage and reduce them eventually. (A04; 04.02.2011).

As a category, this activity describes the action of submitting requests to suppliers for them to provide data on their GHGEs. This data can then be used for either an internal strategic purpose, and/or for reporting requirements.

4.3.1.3.1 Product Level Data

In some circumstances, the interview data indicated that per product GHGE data was desired; such activities allowed carbon labels to be affixed to products, and represent a different level and granularity of data compared to SC wide measurement. The coding process highlighted that this action, although able to highlight inefficiencies, was primarily used for reporting per product GHGE levels:

> [A] lot of the supermarkets are competing on this issue, the wider sustainability issue, and carbon is a part of that. [redacted] [Large UK supermarket] are probably ahead of everyone; the fact that they are footprinting some of their products, which is the real hard graft of actually working out how much carbon there is in each particular product. (A06; 11.04.2011).

4.3.1.4 Scoping Strategies Overview

The scoping and reporting activities outlined and described above fulfilled aims towards reporting requirements, such as for the CDP, and were felt to be a pre-curser to reduction and further management efforts; these activities will be explored and described next.

4.3.2 Reduction Strategies

As indicated above, this second set of activities are those that were reported to be undertaken in order to attempt reductions in SC GHGEs. Based on influencing wider SC practices, such as logistics, or more specific interventions in suppliers, these activities were indicated as likely to follow from scoping/informing strategies.

4.3.2.1 Supply Network Optimisation and Logistics Choices

Advanced primarily by participant A08, an international management consultant, supply network optimisation efforts were noted as those that sought to reduce GHGEs within logistics. Specific actions noted included the changing of routes, transportation modes and the use of certain tracking technologies to improve efficiency:

> All these provide multiple solutions for you to choose the way to ship your products, and therefore, because you have so many options, you can actually optimise your choice based on the optimal metric you want to achieve, i.e. if it's financial return, or service efficiency, or environmental efficiencies, or a combination of them. (A08; 25.02.2011).

These activities require little, if any, supplier engagement, and provide the focal business with high levels of control; the overall impact of these activities on the total embodied GHGEs within a SC may be minimal however in certain circumstances. This would be the case where logistics operations constitute only a small proportion of the overall GHGE product footprint. These strategies would be most appropriate where logistics formed a large proportion of the footprint, where the goods themselves contain low levels of embodied GHGEs, and where the transport mode involved high GHGEs, such as air freight.

4.3.2.2 Contractualised Reductions

The inclusion of GHGE requirements into supplier contracts also emerged during the coding process as a strategy that could be undertaken by focal businesses:

> [redacted] [Large UK Telecommunications Company] is a really good example of where they have contracts, rolling contracts, which they renew every now and again, and in each new contract they set a standard which is higher than the one before, so they effectively contractualised continuous improvement. (A11; 18.03.2011).

A relatively mandatory approach to supplier management, the inclusion of GHGE requirements into supplier contracts would provide relatively greater levels of control to the focal business. Adverse supplier impacts are a potential side-effect however, with some suppliers potentially lacking the appropriate capabilities to make the GHGE reductions mandated.

4.3.2.3 Supplier Selection Criteria

The selection of suppliers based on their GHGE management and reduction potential, was a further method identified as able to allow focal businesses to reduce their SC GHGEs. In contrast to the use of contractualised reductions above, this technique judged supplier performance before contracts were issued:

> So I work with their procurement teams, and it's quite high on the agenda of chief procurement officers in the biggest organisations, to develop some form of sustainable procurement score card and actually use this as a characteristic for defining whether you do business with an organisation or not. (A04; 04.02.2011).

Connected to both this and the approach outlined above, is the threat of loss of business to suppliers who are unwilling or unable to reduce their GHGEs. Focal businesses are able to use this threat as a method for motivating the reductions in GHGEs they are seeking, by making these reductions a condition of business.

4.3.2.4 Supply Chain Collaboration

In contrast to the above noted mandatory approaches, collaboration with suppliers also emerged as a method for achieving reductions of SC GHGEs. Likely to be relatively resource intensive, compared to the mandatory strategies, this approach involves working closely with specific suppliers and helping them to achieve GHGE reductions:

> Then there's the real top end, the best practice cases, the very few who are actually engaging with their supply chain and actually helping them and then the very end ones which are, 'are you engaging with your suppliers and asking them to look at their own suppliers and their own supply chains', to keep the process going. (A07; 21.02.2011).

As indicated in the quote from A07, this method can also be expanded and used to pass on requirements beyond the first tier of the SC.

4.3.2.5 Activities Overview

A range of strategies were identified through the responses of the participants, which were able to provide initial answers to some of the research questions posed, including questions one and two (a). The results concerning the use of contracts and collaborative arrangements as methods for managing SC GHGEs, provides a preliminary answer to question two. Further, the objectives of these activities, including measurement and scoping, for both disclosure and reporting purposes, or as a way of identifying areas of future action, were identified; the reduction of SC GHGEs, as an objective, has also been highlighted.

Although most activities involve engagement and cooperation with suppliers, several activities were identified that did not require actions by suppliers, including SC mapping, the modelling of SC GHGEs, and changes to logistics networks. It is subsequently evident that these strategies would avoid some of the noted barriers described earlier, such as the need for supplier cooperation. Although the avoidance of this barrier would be somewhat beneficial, the two specific strategies that avoid it offer potentially limited functionality towards the measurement of GHGEs, and their reduction, respectively.

Although seemingly answers to the questions, the limited perspective provided by the internal participants results in a lack of certainty. As such, and as planned, phase two of the project, and the responses from individuals working within focal organisations, will be used to provide a further perspective to the research questions.

4.4 Government Roles – Policy and Regulation

The previous section advances a view that businesses are leading current efforts due to a wide range of drivers. A variety of barriers were also identified. A range of activities for advancing the management and reduction of SC GHGEs was also described. Although businesses, both in the literature, and through the data above, have a clear role to play in terms of SC GHGE management, the role of government and the public sector was also reported to be significant, due to their ability to regulate organisational activities, and in terms of the scale of public sector procurement.

4.4.1.1 Government Control

As indicated above in relation to a reliance on the decarbonisation of wider systems, government and the public sector were noted as controlling the most powerful levers in terms of SC GHGE management; these encompassed control over policy and regulation, including those aspects related to transport and energy policy. Both could substantially reduce the GHGEs embodied within SCs operating within the UK:

> But clearly the government has the hand on the biggest lever, which is making a big push to decrease the carbon intensity of energy supply in the UK. (A10; 09.03.11).

As well as control of policy and regulation, government has substantial influence over public sector procurement policies, the scale of which holds much potential for demonstrating and advancing SC GHGE management. If SC GHGE management objectives were integrated into public procurement, a large proportion of spending within the UK economy would be advancing these aims. In this regard, the government and public sector are however characteristically different from private sector businesses. Specifically, the public sector lacks a profit driver and pursues objectives more diverse and egalitarian than businesses. In spite of the potential of state power, the data provided by the participants indicated that this power was being constrained.

4.4.2 Policy and Regulation

A significant area of state action in the economy and society is the administration of policy and regulation. The following section will outline both current policy impacts and future policy options in relation to SC GHGE management.

4.4.2.1 Current Policy and Regulatory Impacts

Before moving on to describe results obtained in relation to possible regulatory options, as well as methods for harnessing public sector procurement spending, the

data obtained through phase one also contained information on the current state of UK policy and regulation in relation to SC GHGE management.

Participants were asked to comment on their perception of current policy and regulation, and whether it was impacting on the SCM policies of organisations. Although participants noted that the UK governments policy position was relatively strong with regards to climate change mitigation, they felt current policy was not leading to a cost great enough to motivate action, and was rather, leading to a perception that such policy and regulation could be intensified in the future, and hence operating as a future risk motivator:

> Other polices; you have tax on fuels, that's standard. It's not really linked to carbon. You have some tax rebates on alternative vehicles and alternative fuels, bio fuels are subsidised etc. many many small things. But this hasn't provided a disruptive change in the way companies operate. (A08; 25.02.2011).

More significantly, participant A07 highlighted that current policy was not aimed at SCs, and as such meant that focal organisations, in both the public and private sector, had to be motivated by other factors:

> So, I think there's still a move away from voluntary initiatives with the Carbon Reduction Commitment (CRC) for the bigger ones, but I don't think there's any real push further, and the supply chain initiatives are still voluntary, and there are advantages there, reputation, reduced risk etc. in the same way as ethical initiatives, but they are still voluntary and involve signing up to codes, i.e. fair trade etc. But there's not real loss to companies who don't do it, apart from losing a logo. (A07; 21.02.2011).

In summary, current policy and regulatory arrangements were reported to be having little or no direct impact on SC GHGE management efforts. However, and as will be discussed later, the existence of policies and regulations designed to reduce GHGEs may create the perception that action is necessary and that regulation could expand to include SC GHGEs in the future.

4.4.2.2 Future Policy and Regulatory Options

The policy and regulatory options available to government in the future, which could influence the management and reduction of GHGEs embodied within the SC, were covered in the interviews with the phase one participants. Through the coding exercise a range of options were identified, which are described below:

- Continued reliance on the market and cascade effects: no expansion of policy or regulation, with a continued reliance on drivers that exist within the wider business environment:

> I'm not sure that there will be specific developments around the supply chain. I think government will rely on a natural cascade effect and that's how markets operate. I think they trust that that effect will continue. So they will continue to legislate at the top level. …….I don't foresee government getting specifically involved in supply chains. I think they will continue to focus on the headline targets, and instruments to drive behaviour, which impact across business, rather than specifically supply chains. (A03; 01.02.2011).

- Expert support: the government was highlighted as a key actor with regards to the provision of support and advice to those actors wishing to measure and reduce their SC GHGEs, including advice on methodologies and sources of information:

> But still, many businesses could do with some sort of expert support from outside, and I'm not sure where that support if going to come from. (A05; 07.02.2011).

- Indirect complimentary SC policies: decarbonisation of the electricity grid and transport network was highlighted as impacting, and likely reducing, SC GHGEs:

> So making electricity lower carbon, is clearly a government role, and this will be a big chunk of reducing the overall supply chain, and indeed all industry carbon. (A10; 09.03.2011).

- Information and awareness campaigns: this was considered to be a crucial support policy impacting both organisations and consumers, which would however have little impact if deployed independently:

> I think that kind of information and standard setting and informing work, is done by government; it's done well, but on its own needs an agent to deliver it into the business community, if you're actually going to deliver it. (A03; 01.02.2011).

- Management standards (such as ISO14001) and labelling: such schemes could drive the creation of new markets and more efficient products, reducing SC GHGEs:

> I think labelling and standards are potential roles for government as well, in that if you give consumers good information, they do well. If you look at the example of washing machines, fridges and things like that, where people have a good idea how energy efficient they are; and no doubt there, the suppliers, and supply chain have had to think about these issues in much greater detail. (A06; 11.06.2011).

- Carbon trading: current trading schemes could be expanded to include SC GHGEs, allowing focal organisation to trade GHGEs embodied within the SC.

- Mandatory SC GHGE reporting and disclosure: such schemes could also be connected to tax liabilities, or as above, to a trading scheme; however, it was thought that where left as a reporting scheme, it would have an impact through reputational drivers:

> Well the government side again, I would see, in the UK, you'll have mandatory reporting introduced, with most suppliers measuring and managing their carbon emissions. I wouldn't be surprised if government started, if this data is being disclosed to them through a regulatory system, I wouldn't be surprised if they started to mandate reductions. (A04; 04.02.2011).

- SC project offset credits: businesses who conducted work within their SCs could gain credits which could be used to exempt businesses from tax liabilities or acknowledgment in other schemes, such as the CRC:

> My current thought is the way to do that is through some sort of domestic off-set scheme, where policies, such as climate change agreements, and the CRC, allow companies with targets underneath those, to get credit for reducing their emissions within their supply chains and transport fleets. (A01; 10.12.2010).

Through the interviews with the phase one participants, a range of policy and regulatory options were outlined. These ranged from a continued reliance on drivers present within the wider business environment, to the inclusion of SC GHGEs within current GHGE trading schemes, such as the EU-ETS. The data also indicated however, that due to factors such as the inherent characteristics of SCs and the wider political environment that some problems exist in terms of government action in this area; these factors will be described below.

4.4.2.3 Problems with the Regulation of Supply Chains

Although many policy options were advanced, as described above, several participants noted that problems did exist with regards to regulating GHGEs embodied within the SC.

Firstly, SC specific policies were felt to be problematic due to the commercial and opaque nature of SCs. It was highlighted by participant A07 that as obtaining information on SCs was difficult, their regulation would also be hindered. For example, although mandatory reporting, if implemented, would provide information on GHGEs, it was felt that without additional information, such as SC structures and supplier capabilities, unintended consequence and other impacts of regulation would be difficult to predict:

> [A] lot of this is not publicly available information. You can't just look up who makes all the parts for a certain product. So I think there are real issues there, as even in a CR report they tell you what they're doing and give examples of how they are engaging one or two factories, but unless they are open with it, you don't know. (A07; 21.02.2011).

The administration of such policies or regulations would also be difficult and may require additional legislation that would make the SCs of businesses more transparent, itself raising issues of competitiveness; many businesses use their SCM efforts in order to obtain competitive advantage and are protective of these arrangements.

The global nature of contemporary large businesses also constituted a barrier to regulation. Questions were raised as to whether to include the global element of SCs within any national legislation. Further, government was felt to be vulnerable to political objectives and lobbying, such as the ability of large international firms to move their operations, if they felt regulation had become too draconian and if not, the possibility that organisations would shift areas of their SC out of a territory in order to avoid such regulation:

> I think the key issue you need to consider here, is that supply chains are global now. You need to think about what the scope is, what are you talking about, the UK, the EU or globally. (A10; 09.03.2011).

Further, the complexity of SCs also means regulating in this area would be problematic. Different sectors and industries were noted as having very different SCs, and that it would be likely that policies would have to be drawn up for specific sectors or industries, nullifying the potential of such policies to encompass large swathes of GHGEs:

> That is a big issue. Supply chains are complex things. And I think there's often difficulty in terms of policy, in that you tend to make quite 'broad brush' policy, without understanding the intricacies of the supply chain… So when it comes to influencing things in supply chains, I think you've really got to look at different sectors and see where the power lies, before you can come up with anything sensible at all. (A05; 07.02.2011).

More widely, if such polices become overly complex in nature, a lack of resources, particularly in a time of austerity, may impact the ability of the government to implement such schemes. A lack of political will, especially where a government thought such measures would be unpopular was also noted as a problem.

4.4.2.4 Policy and Regulation Overview

In summary, the government's current policy position was reported to be having a very limited impact on current efforts by businesses to manage and reduce GHGEs in their SCs. Although policy options were identified, it was felt that the current government was more concerned with economic and social matters, and was unlikely to regulate GHGEs embodied within SCs in the near future; mandatory Scope Three reporting was felt to be the most likely policy response, if any response occurred. Were a response to emerge from government, the participants highlighted problems with regards to the legislation of SC GHGEs, such as the global nature of contemporary SCs. A deeper exploration of the implications and mechanisms of these policy options, and their effectiveness in light of the issues highlighted, will be discussed in greater detail in later sections.

4.4.3 Public Sector Supply Chains

Alongside the state's role as originator and administrator of policy and regulation, the data from phase one indicated that a further role could be played in relation to SC GHGE management. This was the integration of GHGE management objectives into public sector procurement practices.

4.4.3.1 Scale of Procurement

The potential impact of such actions was attributed to the scale of public sector procurement budgets, which if harnessed could enable and improve the capabilities of public sector SCs to the benefit of businesses that shared suppliers, and the suppliers themselves. Cooperation and the spread of best practice were highlighted in this regard, as well as cooperation between departments and, potentially, external SC organisations.

> [O]ne of the things that can drive this [SC GHGE management] is government procurement, which is massive. If you think about the NHS or Education Authorities or Central Government, these are big buyers of stuff. They can provide a real lead on this. (A06; 11.02.2011).

4.4.3.2 Public Sector Context and Actions

Although similarities exist with those measures available to businesses in the private sector, such as cooperating with suppliers, mapping and assessing SCs for high GHGE instances and raising awareness across public sector SCs, participants noted that public sector organisations operated within a different context and environment, which

altered the options available to them. It was highlighted that many contracts issued within the public sector tended to be long-term, and so initially participants noted that contract re-negotiation, to include GHGEs, may be a strategy that public sector organisations would have to use, if they wished to integrate this quickly.

EU Procurement Directives were identified through the coding process as a further potential barrier to public sector SC GHGE management. The perception of these rules was reported to restrict how public sector bodies procured goods and services:

> The public sector has traditionally been bound by their perception of EC rules, and EU legislation, so they don't want to be seen to favour any particular supplier, so they don't talk to them anymore than any other supplier. (A11; 18.03.2011).

Public sector working practices were also highlighted as a possible constraining factor on public sector efforts to manage and measure SC GHGEs. Participant A11 noted that working practices within government differed between departments and organisations, and that due to their project based nature, resulted in diversity, or lack of consistency, in the approach taken and the levels of success achieved:

> Individual LAs [Local Authorities] are having conversations with suppliers, as are government departments, but they tend to be very project orientated, and it depends on the individual who is leading the program or project. (A11; 18.03.2011).

The use of market creation and forward commitment initiatives were also highlighted as an area where the state, through its use of procurement budgets, could prompt its suppliers to make changes to GHGEs within their SCs. By providing a commitment to buy certain products, such as those with lower embodied GHGEs, due to the use of low GHGE SCs, the government would be able to provide a demand that does not exist in the wider market. This in turn leads to the provision of these services, and the lowering of GHGEs within SCs:

> Again that helps build the supply chain. Procurement can be a very aggressive driver. A lot of people argue that the government should be saying, 'if you build this product, we will guarantee to buy x number in five years' time'. This can be dangerous though, because it can squeeze out other innovation if they pick a particular technology. And obviously, that depends on what example you're talking about, but essentially that should be a big part of government consideration. (A06; 11.02.2011).

As participant A06 indicates, this can be a strong indicator to SCs and wider markets, but does hold disadvantages, such as stifling innovation and may bring criticisms, politically, regarding the correct spending of 'tax payers' money. Although public

sector SCs hold much potential due to their scale, action was felt to be constrained by a lack of political will and direction and due to other factors such as the perception of EU procurement directives and working cultures. These aspects will be taken forward in the project and considered again at the end of this section.

4.4.4 Government and Public Sector Organisation Summary

These results indicate that public sector focal organisations cannot be seen to be leading current SC GHGE management efforts due to a lack of drivers, including policy; the results also indicate that they are more constrained than their private sector counterparts. This goes some way to achieving research objective one, concerning what type of organisation can be considered to be leading current SC GHGE efforts.

As stated, large private sector brand firms, sensitive to reputational and competitive drivers were reported to be leading current efforts. Although this objective was set in order to provide greater focus to the next stage of the enquiry, the results also indicate that public sector focal organisations are active, and possibly play an important role also; what is more certain, is that they hold great potential for the advancement of SC GHGE management. For these reasons, the project will advance to consider both public and private sector focal organisations in the next phase.

4.5 Other Actors – The Third Sector

Throughout the interview phase, participants were also asked as to whether there were other actors within society and/or the economy that could, or did, play a role towards SC GHGE management. The third sector, containing not-for-profit organisations and NGOs emerged through the interviews and the coding in this regard. The following section will outline specific types of organisations within the third sector that were noted through the interviews, as well as the specific roles they were felt to play or be able to play.

Table 4-4 provides an outline of the types of third sector organisations identified, cross referenced with the roles that they could, or do play. The activities carried out by the third sector were categorised into those concerning scrutiny, education and training, the provision of research, tools and expertise, the raising of SC GHGE as an issue, highlighting best practice and facilitating collaboration.

Table 4-4: Matrix illustrating third sector organisation types and their roles.

	Scrutiny	Education and Training	Research, Tools & Expertise	Demand & Issue Raising	Highlighting Best Practice	Collaboration and Facilitation
Academia	✓	✓	✓		✓	
Representative Bodies		✓			✓	
Pressure NGOs	✓			✓		
Solution NGOs		✓	✓		✓	✓
Community Organisations				✓		

4.5.1 Academia

Academia was highlighted as being able to play several roles within the context of SC GHGE management. Academia's role was seen to include the provision of scrutiny, or ensuring that the information provided by organisations and any claims they make are likely to be genuine or not. For example, academics were highlighted as potentially examining GHGE disclosures, and other assertions.

> I think the NGO community and academic worlds as well have a huge part to play. Once the information is reported, and reported well, then using that and analysing it; there's going to be lot of fun to have working out who is actually green and who isn't. (A06; 11.02.2011).

Academia was also highlighted in terms of its ability to provide education and training. As a new area of environmental management, several participants noted that new skills would have to be learnt by practitioners and that academia had a role in their provision.

> Certainly, when it comes to contributions around training for example, from academia. Including this in curriculums and offering training courses offered to industry associations. (A10; 09.03.2011).

Academia could also provide research on techniques and issues surrounding SC GHGE management, as well as highlighting best practice.

> Academia also has a role in also showing that companies that engage with their supply chain in terms of normal business practice, but also on carbon; if that can be shown to be good business sense, and profitable, and that companies should be doing that, then that would be a big driver. (A01; 10.12.2010).

4.5.2 Representative Bodies

Representative bodies, such as trade or professional bodies were also identified as being able to contribute towards SC GHGE management. Although likely to be sector or trade focused, due to these organisations themselves often being trade specific, it was noted they could provide education and training, similar to academia, although likely more trade focused. Similarly, within their respective areas, they were felt to be able to highlight best practice, and ensure that their members were aware of contemporary methods:

> Organisations like the [redacted] [business orientated NGO], and sector specific trade associations are being asked to do more, i.e. sharing emissions data and best practices. Actually developing initiatives and then talking about what industries are doing to the general public and decision makers. (A01; 10.12.2010).

4.5.3 Pressure Non-Governmental Organisations

Pressure NGOs, also described as campaign groups, were highlighted as being able to scrutinise the claims of organisations, similarly to academia, as well as raising SC GHGEs as an issue. It was noted that this could be achieved through publicity and media campaigns:

> [A]nd there's the role of pressure groups, to actually just keep things going; and actually informing the public about buying choices. (A05; 07.02.2011).

These groups were highlighted as being able to harness the media and provide a higher profile for climate change mitigation objectives, including within SCs. The previously noted problem of environmental issues being harder to promote, in terms of media appeal, in comparison to social issues, is also relevant within this context.

4.5.4 Solution Driven Non-Governmental Organisations

These organisations, such as the WRI/WBCSD or Business in the Community (BITC), provide services to business free or at lower cost than commercial consultancies. Such organisations were highlighted as being able to facilitate collaborations and provide tools and standards, such as those released by the WRI/WBCSD. Their role was also

seen to include highlighting best practise, and providing research, possibly in conjunction with academia.

> There are however non-governmental standards that are coming out. For example, the WRI is coming up with a new or refined standard for measuring Scope Three carbon footprints, which would include your supply chain. (A10; 09.03.2011).

4.5.5 Third Sector Summary

The third sector is highlighted as fulfilling several roles considered to be important and advancing to the overall SC GHGE management agenda. The role of the third sector in facilitating supplier and focal organisation collaboration was highlighted through the literature review, including the establishment of frameworks, within which effective communication can take place (Gascoigne 2002). These results highlight that organisations other than business, government and public sector organisations can play a role in terms of SC GHGE management.

4.6 Summary of Phase One

Phase one provided an overview of the current state of SC GHGE management and reduction efforts within the UK. Large brand firms, with high instances of GHGEs within their SC, were identified as leading current efforts due to a range of driving factors present within the wider business environment.

The state, including government and public sector organisations, was also identified as active and relevant, but was perceived to be constrained by a number of factors. The impact of current government policy was also explored and felt to have little or no impact. Possible regulatory approaches to advance SC GHGE management in both the public and private sectors were also covered. Government and the public sector were identified as controlling the most powerful levers, such as national regulation and policy, public sector SCs, and the scales that they bring.

'Third sector' organisations were also highlighted as able to play a role in SC GHGE management, including actors such as academic, NGOs and trade or professional bodies. The third sector was highlighted as providing enhanced development of methodologies, standards and tools, and education and research. The facilitation of collaborations between organisations and their SCs, as well as simply raising the importance of SC GHGEs were also identified.

The purpose of this initial phase of data collection and analysis was to provide an exploratory investigation of current practice. It sought to provide an overview and identify key organisations, the activities they were or could be undertaking, and the driving or hindering factors. This scoping phase was required in order to provide greater focus to further enquiry.

It was decided that in order to focus the enquiry further during the second phase, that some areas of questioning carried out above should be discontinued, to allow adequate resources for deeper investigation. The role of the third sector as well as the various policy options available to government will not be examined again through the results section. They will however be examined again during the discussion chapters, including a more detailed assessment of the impacts of the various policy options identified above, using further information obtained during the second phase of the research.

Chapter 5. Phase Two Results: Focal Organisational Engagement with Supply Chain Greenhouse Gas Emission Management

This section will outline and explain the results obtained through phase two of the data collection process. Firstly, a brief introduction will be given, highlighting important aspects of the data and a passing reminder of the aims of the phase. After this, the section will go on to demonstrate and explain the categories and themes developed during the coding process, including drivers and barriers, the activities undertaken, supplier engagement factors and strategy variables.

5.1 Phase Two Data Overview

Phase two sought data from participants working within focal organisations, in both the public and private sectors. Data within this second phase was collected from 17 businesses and public sector organisations, from various sectors and industries. Two consultancy and one third sector organisation who had worked directly with participant organisations, and had experience of SC GHGE management projects, were also interviewed during this phase, using the same interview schedule (see Appendix C); in total, 23 individuals from 20 organisations were interviewed. The third sector organisation was a regional not-for-profit social enterprise established to replace the regional development agency and its work on climate change; it had worked directly with one of the County Councils canvassed.

Key differences exist between the data collected through phase one and phase two. Phase one data focused upon the wider context within which SC GHGE measurement and reduction efforts were occurring; in contrast to this, phase two sought data from participants holding senior positions, in relation to SCM, environmental management or CR, within focal organisations engaging with SC GHGEs. Table 3-4 illustrates the organisations from which individuals agreed to be interviewed on topics concerning their own, and their organisations, experiences.

The results of phase one indicated that public and private sector focal organisations operated within different contexts, and although the same semi-structured interviews were used for all types of organisations within this phase, their responses were analysed separately according to their public or private stance. This produced different

sets of drivers, barriers and SC activities. Where, during the analysis, no differences were found, the results were aggregated to produce single sets of results for both public and private focal organisation types.

Research objective one, was primarily concerned with scoping and providing further focus to the study. It identified large private sector brand firms as leading current efforts. Although this answer was designed to allow for the detailed study of these 'leading organisations', it was also highlighted through the results that the public sector was active and held much potential. As such, in phase two the actions of both public and private sector organisations will be considered. The focus now moves on to the subsequent research objectives and the answering of the research questions, concerning why focal organisations are engaging with SC GHGE management, the difficulties and barriers they face, and the objectives and outcomes possible through such efforts. Further, the specific activities undertaken to manage SC GHGEs, how resources are focused upon the different parts of the SC, and variables that impact on the activities used will be the focus of the results presented within this chapter. Research question three regarding the broader role and potential of SC GHGE management as well as the development of deeper understanding between organisational activities and outcomes, will be considered in Chapter 6.

5.2 Driving Factors

The participants in phase two were asked to comment on their experiences and thoughts in relation to why their organisations had engaged in the management of SC GHGEs. The driving factors reported within the private sector will be covered first, followed by those in the public sector. These results will then be compared with each other and with the results obtained through phase one.

5.2.1 Private Sector Focal Organisation Drivers

Those factors identified as driving or motivating private sector organisations to engage and act, with regards to GHGEs in their SCs and suppliers, will be described below and are summarized in Table 5-1. The driving themes identified comprise of four wider driver categories, within which are specific tenants. For a wider category to be established, more than one instance had to be coded, meaning a greater burden of evidence was required than in the previous phase.

Table 5-1: Summary of phase two private sector driver categories.

Overarching Driving Factor	Tenants of Drivers
Differentiation & Competitiveness	Differentiation as competitiveness.
	Future proofing (legislation).
	Reputation.
Costs & Margins	Efficiency and Reductions.
	Future Proofing (Future Prices).
Stakeholders (Compliance)	Stakeholders.
	Investors/ Shareholders.
Other (Facilitating Factors – aiding efforts, rather than driving them)	Methodological Standardisation.
	Increased Salience of GHGEs.

The specific driving factors identified during the data coding process will now be examined.

5.2.1.1 Differentiation and Competitiveness

This category was developed in order to reflect several interlinked reasons that were identified as driving businesses to engage with GHGEs in the SC. All three issues concerned the strategic competitive position of a business. These included the desire to differentiate the business, protect or enhance its reputation, and prepare for a future where it was perceived that legislation would make such actions necessary anyway; action, in relation to this last point, was seen as a way of 'future proofing' the business against these future changes. Each specific tenant will now be explained and described.

Environmental management, more generally, was advanced by the participants as an area where their business competed with others, and so potentially gain competitive advantage. Engaging with the management of SC GHGEs contributed towards wider environmental management goals and helped to differentiate the business in relation to its competitors. As such, investment and action in this area was noted as a way of ensuring that the business could compete and prevent itself from being at a disadvantage. This was seen to operate both now, in terms of reputation, which will be covered further later, and also in the medium-term:

> So there's a set of medium-term, they are not the really short-term commercial drivers, but the 2 to 5 to 10 year commercial drivers, which we recognise that unless the products we sell become increasing sustainable, then we're going to be at a significant disadvantage to companies who have invested in making their supply chain's more sustainable. (B11; 18.11.2011).

Similarly, to the above point, a perception was identified in the data that legislation, or some form of government action in the future, was likely. Due to this belief, preparing for this likelihood was reported as a way of protecting and enhancing competitiveness. This was seen to occur through the minimisation of disruption from new legislation, and to show that they were a 'leading' company, being seen to pre-empt changes:

> [W]e believe mandatory carbon reporting is going to come at some point in the not too distance future, and we might as well as be first in there, or amongst the leaders in there, rather than be a laggard. (B08; 09.11.2011).

Finally, and as mentioned above, reputation was reported as critical to a company's success. SC GHGE management was seen as another way to advance a business's reputation over that of its key competitors. This could be achieved by the management of SC GHGEs, where competitors were not engaged, or through superior management performance:

> And because they are all worried that they are not disclosing their emissions relative to their competition, so [redacted] versus [redacted] [two consumer goods corporations], so you would be looking at who your key global competitors are, and it's increasingly becoming one of the metrics that large organisations are comparing themselves to; trying to advertise their green credentials. So I think for them it's about reputation. (B13; 02.12.2011).

Improving the reputation of a focal organisation was also noted as providing advantages, such as the ability to attract better talent to the business:

> Finally, we do it because we think it helps us to attract good talent into our business. (B06; 08.11.2011).

The tenants of the category presented, attempt to show that through the data, several drivers were reported that concerned the overall strategic competitive position of a business. These drivers together were felt to represent a strategic concern for the management of SC GHGEs, in terms of the competitiveness of a business, relative to its competitors, both now and into the future. This was felt to operate through its position relative to its competitors, as well as in terms of its reputation and impacts on its brand image.

5.2.1.2 Costs and Margins

In contrast to the above noted category, the data also indicated that SC GHGE management was being pursued as a cost-saving and margin increasing activity. This category contained both current and future dimensions.

The data provided by the participants contained assertions that managing SC GHGEs could lead to cost reductions and help to improve profit margins. By reducing GHGEs within the SC, it was noted that this could potentially also lead to savings for the focal company:

> [I]f you understand your Scope Three emissions you can probably work with your supplier and reduce emissions for them, which then means that they will probably be reducing costs for you. (B13; 02.12.2011).

In addition to the belief that a business could achieve savings in the present, it was advanced by some participants that engaging with SC GHGEs formed part of a wider driver, to future proof organisations from the effects of future price increases. Although it was noted that these price increases would be felt through numerous commodities and inputs, SC GHGE management could impact and protect against increases in fossil fuel energy prices, by reducing their use and increasing efficiency:

> Just look at the trends in commodity prices, and you can see that there are some real issues coming. (B11; 18.11.2011).

In summary, this category was developed to articulate cost and margin arguments advanced by the participants, which included both current and future dimensions.

5.2.1.3 Stakeholders

Throughout the interviews the management of SC GHGEs was noted as a response to stakeholder demands. Consumers, as stakeholders, were felt to be providing little pressure. However, other actors such as NGOs were highlighted as starting to campaign on the issue and ask questions of large brand businesses. This questioning and issue raising meant that businesses had to start to engage with SC GHGE management:

> [A]lso addressing increasing demands from some of our stakeholders; less so consumers directly, but certainly some of our customers, you know the Wal-Mart's and the Tesco's of this world. (B03; 25.10.2011).

A specific set of stakeholders noted through the interviews were financial stakeholders. It was noted that many of these groups were demanding that businesses

that they invested in make disclosures to schemes such as the CDP. It was highlighted that many large institutional shareholders, such as pension funds, now made SC GHGE reporting a condition for the buying of shares in a business:

> Recently the pressure has been cranking up, from the investor community – for example we received a letter from an investor that in no uncertain terms stating that we will join the CDP. (B02; 24.10.2011).

5.2.1.4 Other Supporting Factors

Through the coding process several factors were identified that were seen to support, rather than pressure or drive businesses to engage with and manage their SC GHGEs. The coding indicated that these factors facilitated action through less direct mechanisms. It is presented alongside 'direct' driving factors as these factors were often mentioned through the interviews at the same time as other driving factors. The two supporting factors identified, included the increasing salience of climate change as an issue and methodological standardisation.

Methodological standardisation, as a supporting or facilitating factor was noted specifically in terms of the private sector:

> [T]he large Corporates have now got the GHG Protocol, so the rules of the game have been clarified for the private sector. (B13; 02.12.2011).

Clear guidelines and methods for the calculation of SC GHGEs, provided through the WRI/WBCSDs GHG Protocol was seen to reduce issues surrounding the difficulties inherent in measuring, and managing, SC GHGEs. Therefore, this made it clearer and easier to calculate SC GHGEs, reducing the resource costs involved in the process together with time scales.

The increasing salience of climate change as an issue was also noted as a factor easing efforts within this area. As the argument for tackling climate change mitigation becomes stronger, participants noted that it was easier to win arguments for the mitigation of GHGEs, including those embodied within SCs:

> Underneath that philosophical position, there are some real business drivers, that probably 10 years ago we would have struggled to get much traction with, but I think sadly, it's becoming easier to argue the case. (B11; 18.11.2011).

This quote demonstrates that the weight of argument, in certain instances, has reached sufficient levels for action to be taken. It can be seen to be a function of all the

factors noted above, including increasing understanding of the potential benefits, in terms of cost savings as well as the risks inherent in failing to lead on this issue, in terms of the current and future competitiveness of a business.

5.2.1.5 Private Sector Drivers Summary

Through the coding process four broad categories of factors were identified as driving businesses engagement with SC GHGEs, including differentiation and competitiveness, cost and margins, stakeholder and other facilitating factors.

Although similar factors were identified through phase one of the project, the source of the phase two data provides an internal perspective and stems from data obtained from individuals within businesses, actively engaging with their SC GHGEs.

5.2.1.6 Private Sector Drivers: Comparison between Phase One and Two

The factors identified during this second phase of the project, which obtained data from insiders or practitioners, as noted in the paragraph above, will now be compared to the results obtained from the phase one participants. The phase one participants were chosen to provide an overview and for their more general knowledge in this area.

A comparison of the driving factors identified in phase one and two shows an overall agreement, however some differences are apparent. The CR/PR driver identified in phase one is excluded in phase two, as through the analysis it was felt that the 'reputational driver' aspect, identified within the 'differentiation and competitiveness' category in phase two, was able to incorporate PR and to a certain extend CR concerns. This alteration reflected the data obtained during phase two, but also sought to capture the root of the activity. Although participants noted that SC GHGE management efforts did aid their CR and PR efforts, these efforts were aimed at positioning the business and improving and protecting its reputation. Further, CR as a driver covers a potentially wide area, including differentiation and attention to stakeholders, addressed in separate categories within the phase two results.

Risk was also emitted from the phase two categories, for similar reasons; risk, and its management, can be considered to constitute elements of several of the categories developed during phase two, including future cost and regulatory drivers. As such, it lacked exclusivity as a category.

Phase two data lacked mention of the effects of 'consensus' and demonstrations of best practise as outlined in the phase one categories. This can be explained through either the phase two participants not wishing to indicate that their organisations had been influenced in this regard by their competitors, or that they considered these effects to fall within comments concerning the 'facilitating factors', such as increasing salience of climate change as an issue, and continuing methodological development; these developments were likely to be achieved through experience and the demonstration of success in early cases, an aspect of the phase one category. So although omitted in the phase two driver categories, these phase one drivers are relevant for further consideration of the implication of the overall results obtained.

Although differences do exist between phase one and two driving factor categories, there is overall agreement that businesses are engaging with their SC GHGEs to gain competitive advantage, through reputational and economic effects and to respond to stakeholder demands. As such, the perceptions of the differing types of participants, in phase one and two, can be seen to be consistent within this area of enquiry.

5.2.1.7 Private Sector Drivers in the Literature

The result obtained regarding drivers in the private sector examples fit well with the literature concerning why private sector focal organisations engage with climate change objectives, in the case of the corporate climate change literature, or ESCM objectives, with regards to ESCM literatures. Stakeholder pressures were identified as driving factors in both the ESCM and corporate climate change literatures, and were identified as driving firms to engage with environmental management in the SC (Hoffman 1999; Jennings and Zandbergen 1995), or climate change objectives (Sullivan 2010), respectively. Investors and shareholders, as a specific class of stakeholder, were identified by several participants, often with specific regard to reporting and disclosure; this was also identified in the literature (Okereke 2007; Porter and Kramer 2006; Ramus 2002; Porter and van der Linde 1995). Consumers, noted by Walker, Di Sisto and McBain (2008), in relation to ESCM, were not identified as a driving factor by the participants however, forming an area where drivers acknowledged in the literature were not identified in the results of the project.

Cost pressures, including future price increases, were also found to be present within the results, as well as in the literatures, on both ESCM (Walker, Di Sisto and McBain

2008) and corporate climate change strategies (Jeswani, Wehrmeyer and Mulugetta 2008; Ramus 2002). Hoffman (2005) in particular identified costs, in both their present and future nature as a driver, operating through organisational efforts to capture environmental efficiencies. Finally, Okereke (2007) is also found to be in agreement, although through notions of 'profit'; it is felt safe to articulate that the profit motive runs throughout the responses provided by the private sector focal organisations.

Similarly, the desire for differentiation and competitive advantage, and the effects of market changes, were identified as drivers in both the ESCM (Seuring and Müller 2008; Walker, Di Sisto and McBain 2008) and corporate climate change literatures (Sullivan 2010; Okereke 2007), and in the results of the project. The driving effects of brand image and reputation also formed an area of agreement between the results and the literature (Walker, Di Sisto and McBain 2008; Porter and Kramer 2006; Ramus 2002; Porter and van der Linde 1995). Credibility, a driver noted by Okereke (2007), can also be considered to be consistent with the results of the project in relation to reputation, as businesses wishing to gain competitive advantage and an improved reputation through SC GHGE management would want to be seen as credible in this regard. Ideas of CR, as a driver for action in the SC, as advanced by Kovács (2008), can be seen to be consistent with this projects results, due to the identification of reputation, brand and stakeholders as driving factors, and their relationship with CR. Although, as noted above, no explicit CR driver is presented within the phase two categories, the actions undertaken by businesses/private sector focal organisations can be seen to be beyond those required by regulation.

Risk was not considered an individual category during the analysis of the data; however it is identified in the ESCM literature (Walker, Di Sisto and McBain 2008) and in terms of corporate action with regards to climate change (Kolk, Levy and Pinkse 2008). As noted above, risk can be considered to be an overarching driver of action in this area, in terms of future regulation, future cost increases and in relation to protection of the brand and reputation of a focal organisation. Further agreement with the projects results are found in the ESCM literature, where driving factors are split into two main categories, including reputation and CR versus more traditional SCM objectives such as cost, efficiency and quality (Porter and Kramer 2006; Ramus 2002; Porter and van der Linde 1995).

Several driving factors identified in the literature were not reported or developed as categories during the analysis. Regulation, although heavily advanced in both the ESCM (Croom et al. 2009; Walker, Di Sisto and McBain 2008) and corporate climate change literatures (Jeswani, Wehrmeyer and Mulugetta 2008), was not noted by the participants as a current driving factor in phase two. It is highlighted as an indirect driver in phase one however, through its impact on fuel costs, through taxes, and as a future risk. Other drivers not included in the projects results include the values of owners or founders, enhanced product quality or suppliers (Walker, Di Sisto and McBain 2008), and ethical consideration and fiduciary obligations (Okereke 2007). Technological developments are also absent in the results (Walker, Di Sisto and McBain 2008), however advances in methodological approaches, as a facilitating factor, could plausibly be considered to be an aspect of this factor.

Finally, the factor of managerial perceptions could also be considered a casualty of terminology (Sullivan 2010), as the other reported facilitating factor within the results, such as the increased salience of climate change as an issue, was noted to have impacted on managerial perceptions, and so may not be contradictory with the results.

In conclusion, there is broad agreement from the literatures and the categories developed during the initial analysis of the projects data that businesses, or private sector focal organisations, are engaging with SC GHGE management due to a mixture of factors occurring in the wider business environment.

5.2.2 Public Sector Focal Organisation Drivers

Phase one of the project identified public sector organisations, such as Universities, Local Authorities or other public administrative bodies, as holding great potential in terms of SC GHGE management, and in some instances good examples of action. As a result, public sector organisations were canvassed through phase two to provide a comparison and further perspective to private sector organisations/businesses and their context. It should be noted, that although examples of action were found, that the phase one results indicating that the public sector was following practice in the private sector, proved to be broadly correct from the sample examined. This section will outline the factors identified during the coding process as driving public sector organisations to manage and measure their SC GHGEs; Table 5-2 contains a summary of these categories.

Table 5-2: Summary of phase two public sector driving categories.

Overarching Driving Factor	Tenants of Drivers
Individual Entrepreneurship	Specific Individual Driving from Within
Policy & Regulation	Limited context
Organisational Identity & Mission	Organisational Specific Expertise
	Mission
Costs & Efficiency	Links weak

The driving factors obtained from interviews with public sector focal organisations will now be described below.

5.2.2.1 Policy and Regulation

Within the public sector organisations canvassed, policy and regulation was mentioned as a primary driver, but only within specific contexts. For example, the individuals from the Universities that were interviewed noted that they were being driven to measure and to start to manage their SC GHGEs due to new policies:

> But the main driver was HEFCE [Higher Education Funding Council for England], certainly for Scope Three. (B19; 07.02.2012).

These regulations were originating from HEFCE, the funding authority for higher education within England, who had made certain funding dependent on higher education organisations measuring their GHGEs; although only some aspects of Scope Three GHGEs where a mandatory requirement (such as water and waste), not including those associated with procurement, or SC GHGEs, guidance on their measurement was provided alongside assertions that it would be beneficial for Universities to measure their procurement or SC GHGEs (HEFCE 2013).

Similar regulatory arrangements for SC GHGEs were not found within other areas of the public sector however. Due to this, this identified driver can only be seen to operate within specific public sector areas, such as higher education. It does however demonstrate that regulation can be an effective driving factor; indeed, regulations do exist in terms of wider environmental management for the public sector and push these organisations to manage wider environmental impacts in their SCs.

5.2.2.2 Individual Entrepreneurship

This category was developed to reflect data that indicated that individuals tended to play important and significant roles within public sector organisations that were engaging with SC GHGE management. Several sources noted specific individuals within the public sector organisations with which they worked, who had played a critical role in pursuing this agenda. The action taken by these individuals was often beyond that as required by organisational policy:

> [I]t is also important to mention [redacted], who is the head of procurement in the University. He said he is not very sustainable, but he is really pushing sustainability in procurement, for example when he issues tenders he's asking about environment issues……And that's his own initiative……and I think he is a key person for making procurement sustainable within the University. (B18; 01.02.2012).

Similar reports were obtained from participant B19, from the other University canvassed. That both Universities reported this may indicate that it is sector specific. This dynamic was also indicated within the phase one results, in relation to the project led nature of public sector work and the importance of the specific individual leading projects. That both Universities reported this may indicate that as a subsector of the public sector, they are relatively more advanced in terms of SC GHGE management than other public sector organisations.

5.2.2.3 Organisational Identity and Reputation

Through the coding of the data, the role of organisational identity and the perception of their 'mission' were identified as factors that drove SC GHGE management. Firstly, in terms of the role of organisational identity, it was noted that this linked to reputation. These public sector organisations felt that they could and should be seen as leaders in terms of SC GHGE management, and as such enhanced their efforts:

> [W]e've always been a leader in this field, as I said for well over a decade; we've been responsible for pushing government a lot in these areas, as well as other organisations. I think part of the pressures come internally, from who we are, and wanting to push the value in this area. (B16; 19.12.2011).

The reputational boost to these organisations was noted as being able to raise their profile and enhance their prospects in the future, in terms of funding and projects. The interaction between a perceived expertise and 'special' role, in terms of being a leader of SC GHGE management and the reputational benefits of achieving this, form the first aspect of this category:

> I think part of it was reputation. Because we have the Institute of [redacted], there was a feeling that there was a good opportunity to boost the reputations of the University and the Institute, by looking at the particular issues. (B18; 01.02.2012)

This category was developed to demonstrate that some public sector organisations had a desire to be seen as a leader and recoup the benefits of this exposure. Through the coding of the interview data, it was also decided to include examples of top management wanting to take a broad interpretation of their 'mission' statements, in relation to the environment. So similarly to the first aspects of this category, it was a desire within public sector organisations to account for and manage the greatest proportion of the environmental impact as possible, and as such include the management of SC GHGEs:

> No no, it was a choice. We decided, as a unit, we were set up to look at sustainable development in the [redacted] [large public sector organisation], and we decided to go with carbon because of the Climate Change Act, and it is measurable; but then we wanted to make it as broad as possible, …..And we decided there is no point in just looking at energy, as it is just 20% of the carbon footprint. If you only look at energy efficiency, you have missed most of the point of it all. (B20; 24.02.2012).

Although forming a broad category, this driving factor was felt internally consistent, as it is rooted in engagement for internal reasons; specifically, wanting or desiring to be seen to be doing the best in terms of SC GHGE management. This operated though reputational aspirations, a desire to be leaders and in terms of wishing to manage the largest proportion of an organisational environmental footprint as possible.

5.2.2.4 Costs and Efficiency

Although more narrowly reported than in private sector focal organisations, cost and efficiency drivers were articulated and identified through the coding process:

> [O]n the other side of it, there is the efficiency drive and innovation drive, and it's recognised that by looking at resource efficiency more often than not, it saves money. (B16; 19.12.2011).

As indicated above, this driver appeared weaker within the public sector organisations canvassed. However, participant B20 also noted this driver, and indicated that work to reduce SC GHGEs had resulted in cost savings, as well as further benefits:

> [We] looked at local sourcing of food, and reducing travel miles, and have ended up saving more than £2 per [redacted] [individual], per day on their food, which seems extraordinary, and have managed to have healthy food for [redacted] [individual], as well as less carbon, so it's a win win win in all directions. (B20; 24.02.2012).

Similarly to this factor within the private sector, the desire or opportunity to reduce costs and achieve savings through work to manage and reduce SC GHGEs represents a force driving these public sector organisations to engage with SC GHGE management.

5.2.2.5 Public Sector Drivers: Comparison between Phase One and Two

Although the initial phase of the project identified enablers of government action in the SC, and not driving factors, comparisons are still able to be drawn. Most pertinently, the project led nature of work in the public sector, identified through the first phase, can be held against the importance of individual entrepreneurship, identified here as a driver. This particular factor also links in well with the importance of organisational expertise and particular organisations 'missions', and how they are perceived; this placed heavy emphasis on the importance of individuals and their interpretation of what their public sector organisations should be attempting to achieve, in relation to environmental objectives.

5.2.2.6 Public Sector Drivers in the Literature

Little literature was identified within the literature review, regarding the driving factors present within the public sector. However, the importance of individual expertise and enthusiasm in driving engagement with ESCM is found in the literature in this area as well as the results in section 5.2.2.2, and strengthens previous assertions within the literature in relation to the role of agency factors within the public sector (New, Green and Morton 2002). That regulation was noted, such as the indirect link within the University context through HEFCE, demonstrates that this is an important driving mechanism, reported as absent by other public sector participants; the importance of this driver is also highlighted by (Morgan 2008).

5.2.3 Comparison of Public and Private Sector Driving Forces – Operating within Different Contexts

It is essential to consider how the driving forces for the public and private sector organisations compare with each other. Several of the driving factors identified as operating within the private sector are absent in the public sector, including competitiveness and differentiation factors, the future orientated aspects concerning both legislation and costs, together with the role of stakeholders. Although cost pressures were noted by some participants in the public sector, similarly to 'efficiency

and margins' factors noted within the private sector, such pressures were often noted as weak and poorly understood, further reducing the efficacy of this driver.

It is able to be seen that public sector organisations are operating within a different context to the private sector; within the specific context of SC GHGE management, this results in many driving factors being reduced or eliminated, strengthening assertion made in section 4.1. Public sector organisations did not report differentiation, competition or stakeholders as driving forces. The facilitating factors noted within the private sector are also seen to be weakened within the public sector context, as will be noted during analysis of the barriers present.

That many of the drivers identified in the public sector context, such as organisational identity and the role of individual entrepreneurship, were not noted by the private sector, does not mean they do not operate. Rather, they may be over taken in importance and relevance, and so hence also visibility. For example, the primacy of wider strategic concerns and their ability to drive action on SC GHGE management may overshadow these factors within the private sector context. Alternatively, the presence of the other factors may render these drivers implicit.

5.3 Factors Acting as Barriers

As well as those factors reported to be driving focal organisations to engage with SC GHGE management, participants from both the public and private sectors were asked to comment on any difficulties they, or their organisation, had encountered. During the analysis of the data it became clear that barriers were impacting organisations in two ways: those that were operating internally and those that were operating externally. Consequently, the barriers to be presented below are split into internal and external categories.

Internal barriers were considered those that were surmountable through internal actions or through internal systems or contexts. Conversely, external barriers were felt to be those that the focal organisations had little control over and required remedial actions by external agents, such as government or third sector actors. Barriers effecting the public and private sectors were again separated due to the differing contexts, as discussed in the previous section on driving factors, section 5.2.

5.3.1 Barriers Effecting Private Focal Organisations

Several barriers were identified during the coding of the data in relation to private sector focal companies and are summarised in Table 5-3.

Table 5-3: Summary of phase two private sector barrier categories.

Internal Barriers	**Explanation/Examples**
Conflicting Objectives	GHGEs a relatively low priority.
Costs	SC measures need to be cost effective.
Lack of Understanding & Focus	The complex nature of SC GHGEs poorly understood.
Lack of Systems	GHGE data hard to collect and verify; SCM systems unsuitable for collecting data.
External Barriers	**Explanation/Examples**
Policy Issues & Contradictions	Regulations restricting available options to reduce GHGEs.
Low Stakeholder Demand	E.g. Lack of consumer demand for low GHGE products.
Direct Benefits Difficult	Difficulties in transferring benefits across 'supplier-buyer' divide.
Supplier Engagement	High reliance on supplier actions.
Methodological Issues	Limited standardisation; benchmarking difficult.
Reliance on High GHGEs Inputs	Lack of low GHGE substitutes.

5.3.1.1 Internal Barrier: Conflicting Objectives

Through the coding, a category was needed to reflect interview responses that indicated SC GHGE management as just one issue among many. Due to many issues competing with each other within a business, such as focussing on more 'mainstream' business needs, GHGE management was a relatively low priority. As well as struggling to compete with other issues within a business, it was further highlighted that many businesses in the current economic environment were at capacity, in terms of their ability to take on new objectives:

> [S]o the organisation is suffering from 'initiativeitis'. We have dozens and dozens of stuff going on, with many new pieces in place and it's quite hard to introduce new

> things, because the organisation is almost at capacity in terms of its ability to change, which we're already doing very rapidly at the moment. So that's another barrier. (B02; 24.10.2011).

Further, within environmental management objectives, the data indicated that trade-offs and conflicts could arise. Participant B08, from the construction industry, noted that their organisation wished to reduce SC GHGEs, but also desired waste reductions on their building sites, which caused a conflict. This conflict was partially caused by equipment lease companies unwillingness to alter their practices and hardware; for example, by refusing to allow the use of biofuels instead of industrial diesel. This formed an external element to this internal barrier category:

> What we've been doing then, is looking at crushing – where we've got a site that's got buildings on it, we've been looking at crushing all these materials on site, as an advanced contract, and then either using these materials on site as structural fill, or trying to sell that material to other organisations nearby as they can use it as structural fill. The amount of diesel that these bits' of plant use, in crushing all this stuff up is absolutely astronomic. (B08; 09.11.2011).

Balancing these trade-offs, both in terms of the internal resources employed towards an objective and in terms of competing environmental management demands created tensions and difficulties. In turn, this reduced the ability of a business to easily identify actions.

5.3.1.2 Internal Barriers: Costs

The need for SC GHGE measures to be cost effective also emerged during the coding process as a hindering factor. This was reported to act in terms of both the costs of measuring SC GHGEs, especially at the product level, and in terms of the need to demonstrate a return on investments. In terms of the costs of obtaining per product data, an especially pertinent consideration to businesses with many products, participant B03, illustrates the challenge well:

> [T]here are huge costs involved in this. A cost in terms of building capability, again if you're trying to use it for claims purposes and having to do PAS 2050 standards and go for assurance, that's going to cost you £20,000 to £30,000 a time per product. (B03; 25.10.2011).

Further, a general need to be able to demonstrate the business case and ensure payback on investment from activities to measure and manage SC GHGEs was noted as a challenge, constituted partly from the inherent difficulties of managing an environmental impact in the SC, such as the number of suppliers involved:

> I think at the point in time, this a very time and resource consuming work – so we're trying to find some reasonable approach about how to go about this. One thing is that we have so many suppliers, how do you reach out to all, or the majority of them and how do you do that in a way that balances resources costs and benefits – what's the business case for that is the challenge. (B01; 23.09.2011).

5.3.1.3 Internal Barrier: Lack of Understanding and Focus

Involving a tenant of the above noted 'cost' barrier, the complex nature of SC GHGE management also emerged as a barrier. Due to this complexity, effective and focused actions were felt harder to achieve and involved a greater level of resource commitment as a result. Simple aspects were noted as proving difficult, such as achieving a suitable level of understanding and knowledge of the area:

> [T]here are issues about language as well, just people not understanding what Scope Three is all about. They just think that carbon is energy, and therefore it's just given to the estates manager. That's Scope One and Two emissions, and they don't really understand that there is the whole impact of the supply chain. (B13; 21.11.2011).

The lack of understanding and focus as a result of the complexity and novelty of SC GHGE management formed a further barrier for engagement with this area.

5.3.1.4 Internal Barrier: Lack of Systems

The unsuitability of current SCM systems for the collection and analysis of GHGE data forms another challenge. The ability to collect and verify GHGE data within the SC was felt important for decision-making. The lack of systems meant that data collection and analysis times were long, reducing the ability of senior management to effectively influence behaviour to achieve SC GHGE reductions:

> So again the complexity of tracking and pulling these numbers in is enormous. You may be one company but we've got 300 manufacturing sites, 10,000's of products, 10,000's of suppliers, and there just aren't the information systems, for instance to give you the transparency or the flexibility, to enable you to do the things that some people would like you to do. (B03; 25.10.2011).

5.3.1.5 External Barrier: Policy Issues and Contradictions

This category was developed to reflect interview data that indicated that several policies and regulations within the UK were felt to obstruct efforts to manage SC GHGEs. These included Health and Safety laws; in the case of the construction industry, new practices have been introduced that increased GHGEs in an effort to enhance safety:

> [W]hat we're doing more and more now is constructing a flat metal surface around the circumference of the building, so as to provide a safe working platform for cherry pickers, and then the men drive these cherry pickers around, and you go up the

> building putting the cladding on, using cherry pickers and tower cranes. What we've found is that, again, the energy used on the site is increasing significantly, but H&S is also… improving significantly. (B08; 09.11.2011).

Further, some private sector organisations are impacted by procurement rules, as established through EU Procurement Directives. Such rules dictate how large contracts are to be awarded and prevent practices such as choosing a supplier based on a geographical location, therefore limiting the ability of reducing SC GHGEs through this method:

> I should say that we're a utility and so we're subject to EC regulations, the Utilities Procurement Directives, which do not allow you to award contracts on a geographical basis. So you can't say because a supplier is in Manchester and another in Southampton, I'll go with the Manchester one. (B06; 08.11.2011).

Such regulations can be seen to eliminate some easy options for the reduction of SC GHGEs. These factors impact the options open to organisations, and limit the choices and options available to them for the management of SC GHGEs.

5.3.1.6 External Barrier: Low Stakeholder Demand

A lack of demand by some stakeholders emerged during the coding process as a further drain on efforts to manage SC GHGEs. This factor reduced the motivation for engaging with SC GHGEs. Consumers were mentioned specifically in this regard:

> At the minute customers say they would like to buy greener products, but in practice they are more concerned about price. (B11; 18.11.2011).

Although most pertinent for consumer facing businesses, this lack of demand is also likely to feed through to those focal businesses that supply retailers. Although consumers were highlighted specifically, other customers were also noted, such as by the construction company participant B09.

5.3.1.7 External Barrier: Direct Benefits Problematic

Linked to several of the barriers described above, this category attempts to reflect assertions that although work within the SC to increase efficiency and reduce GHGEs was effective, achieving direct financial benefits was difficult. This barrier resulted from difficulties in transferring savings across the 'supplier buyer' divide:

> [T]o get that benefit across the client supply chain boundary is something that has proved historically very hard to do. So, although there is a massive financial prize out there, to actually gain it, is very hard to do. (B02; 24.10.2011).

Although large financial gains were felt possible, the 'prize' was seen to be dispersed among many, possibly disparate, suppliers. Demanding price reductions from GHGE reductions, and associated efficiency gains, was felt to negatively impact supply relations. Being unable to easily obtain the financial benefits from SC GHGE management efforts, formed a further barrier, and could be seen to demotivate actions in this regard.

5.3.1.8 External Barrier: Supplier Engagement

As the strategies outlined in phase one indicated, many efforts to manage SC GHGEs relied on actions by suppliers. This reliance on actions by other businesses or organisations was seen to constitute a further barrier. Such actions could not be guaranteed, creating uncertainty, and could require motivating efforts, increasing the costs of SC GHGE management efforts. For example, if a supplier was unwilling or unable to produce data, it would impact on the overall accuracy, and therefore value of the data collection exercise, necessary to manage SC GHGEs.

> I think to be honest, the biggest obstacle was getting the suppliers attention and engagement on this. For the workshops we had 80 suppliers participating, but to get 80 suppliers, we probably contacted over 300, maybe 400 suppliers, with our invitations to the workshops. (B01; 23.09.2011).

The numbers, different types and different mentalities of suppliers in some SCs increases the efficacy of this barrier.

5.3.1.9 External Barrier: Methodological Issues

Although standardisation was noted within the facilitating factors for businesses, methodological issues were also identified within the data, as mentioned in relation to barriers. It was highlighted that although standards had emerged, choices and decisions still existed, which required careful consideration, complicating the engagement and management process.

> So whilst there is increasing standardisation, that doesn't mean there's a harmonised way of data production. (B03; 25.10.2011).

Difficulties around benchmarking were also included within the category, making performance comparisons challenging. The methodological issues also meant progress in terms of speeding up the data collection process, was slow. Together these issues mean that data around SC GHGEs is harder to obtain, in turn, increasing management difficulties.

5.3.1.10 Private Sector Barriers and the Literature

The literature on corporate climate change responses and strategies and ESCM, matches well with the results obtained in relation to factors identified as acting as barriers. Lack of financial resources and awareness and lack of understanding or expertise are all identified within the corporate climate change (Jeswani, Wehrmeyer and Mulugetta 2008), and ESCM literatures (Luthra et al. 2011; Min and Galle 2001); indeed, within the ESCM discipline, lack of commitment and interest is noted (Handfield, Sroufe and Walton 2005; Ravi and Shankar 2005). Arguments against the existence of 'win-win' outcomes also find traction within these results in relation to the existence of conflicting objectives or priorities, and assertions in the literature that trade-offs are likely to exist when engaging with environmental management whilst attempting to maintain or improve economic performance (Hahn et al. 2010).

The lack of government policy or support, and the associated regulatory uncertainty, is also included in both the corporate climate change (Jeswani, Wehrmeyer and Mulugetta 2008; Okereke 2007; Pinkse 2007) and ESCM literatures (Zhu and Sarkis 2006; Porter and van der Linde 1995). A lack of training and expertise is encompassed within the corporate climate change literature and within the results presented above (Lee 2012; Hsu and Hu 2008), whilst the same is true of low customer demand (Lamming and Hampson 1996).

Through the corporate climate change literature it appears that the barriers and difficulties in engaging with GHGEs more generally relate well to those difficulties experienced in the SC. The ESCM literature is more specific to the problems faced by focal organisations, as it deals with SCM, and this is demonstrated by the literature agreeing with further results presented above, such as a lack of systems (Hervani, Helms and Sarkis 2005) and supplier difficulties (Luthra et al. 2011; Srivastava 2007; Wycherley 1999). Factors such as inconsistent science and opinion and slow advances in technology (Lamming and Hampson 1996), were not highlighted through the second phase of data collection, but were identified by the external participants in phase one. The omission of these barriers may be due to the individuals interviewed not being involved in technical aspects, in relation to the noted technology barrier. Further, the inconsistent science and opinion driver may now be outdated, as this was identified by Lamming and Hampson (1996); since this date the Climate Change Act has been

enacted and science and opinion on climate change, although not undisputed, are more robust. Previous research also notes the existence of barriers in relation to suppliers' development, such as suppliers themselves or buyers lacking commitment or resources, impacting the success of efforts to manage SC GHGEs (Handfield et al. 2006).

5.3.1.11 Comparison of Phase One and Two Barriers

The categories presented above are comparable to those described within phase one concerning the barriers experienced by large focal brand businesses, and relate well in terms of their consistency. Factors such as the need for cooperation from suppliers, data and methodological issues, limited financial resources and competing objectives, lack of policy, regulation or government support and a lack of understanding, were all identified through both phases.

Additional barriers were identified by businesses in phase two however, including a lack of systems and infrastructure for monitory and measuring SC GHGEs, together with a difficulty in obtaining direct benefits from suppliers. That private sector focal organisations themselves seem to have a better understanding of the barriers and difficulties that they face should be no surprise, represented by the higher number of barriers identified through phase two.

Several factors were noted as both drivers and barriers, such as stakeholder demand. It is important to note that these apparent inconsistencies reflect the importance of each businesses specific context and operational environment; for example, a focal business may have experienced requests from stakeholders to engage with SC GHGEs, forming a driver, whilst another, who has not, has reported the lack of this pressure as a barrier.

5.3.2 Barriers Effecting Public Sector Focal Organisations

Participants within the public sector noted different barriers to those within the private sector, although some similarities do exist. Table 5-4 presents a summary of the categories developed.

Table 5-4: Summary of phase two public sector barrier categories.

Internal Barriers	Explanation/Examples
Conflicting Objectives	GHGEs low priority/reductions would irrevocably impact essential services.
Resource Constraints	Budget cuts etc.
Lack of Understanding & Focus	See private sector barrier, section 5.3.1.3.
Data Issues	Lack of systems, benchmarking difficulties and little methodological guidance.
External Barriers	**Explanation/Examples**
Lack of Policy or Regulation	Public sector reliant on top-down direction in many instances.
Supplier Engagement	Supplier obduracy.
Lack of Methodological Guidance	Public sector methodologies less developed; little advice or support provided.
Procurement Practices	Restrictive perceptions of EU Procurement Directives or use of procurement consortia.

5.3.2.1 Internal Barriers: Conflicting Objectives

As described in relation to private sector focal organisations, conflicting objectives were also reported by public sector participants. Several elements combined to form this category. Firstly, and as in the private sector case, other objectives, such as value for money, were seen to override environmental objectives, including those concerning SC GHGEs:

> What with other pressing initiatives, this has fallen by the wayside, and there has been a greater focus on, from our side, on apprenticeship and employment opportunities. So that's been the key policy we've been driving through the supply chain – so more employment focused. And that will be for the next three years as well. (B14; 07.12.2011).

A further element of this barrier concerned inflexible aspects of the services public sector organisations had to deliver and that trade-offs were not always possible. In some instances it was highlighted that if SC GHGE reductions were made, the service in question could be adversely affected to a degree where service delivery was compromised. For example, one of the University participants noted that in

laboratories the priority was in terms of the research and that some inputs could not be substituted or reduced:

> I guess a big area for us is labs. It has a massive environmental impact, not just on energy usage, but also with the amount of chemicals that are going through that space in the University. There are lots of big barriers – the users priority is research, and so that takes precedence, as it should be. (B19; 07.03.2012).

This reduced the ability of organisations to manage SC GHGE inputs, creating obstacles and barriers to their successful management and reduction.

5.3.2.2 Internal Barrier: Resource Constraints

Related to the impact of conflicting objectives was the issue of resource constraints; this could lead to other priorities being allocated funding over SC GHGE reduction projects. However, an overall resource constraint issue was reported within the public sector, especially in terms of procurement:

> [O]bviously costs in procurement are a key issue. When we get a project where we could save a lot of carbon, but there is a cost associated with that, ultimately it's going to be difficult to spend significant sums of money to reduce the carbon footprint, when we're constrained with budgets and procurement etc. that is a reality. (B16; 19.12.2011).

Many of these issues were linked to organisational change and reductions in budget, associated with the then recent change in government and general economic outlook. Reductions in staff numbers and financial resources were identified as restricting work within this area:

> It's also worth mentioning a lack of resources as well as a barrier – so some of these things could be done if we had more resources. So at the moment we are undergoing huge organisational reviews… and our procurement team has been cut in half. (B17; 27.01.2012).

5.3.2.3 Internal Barrier: Lack of Focus and Understanding

A further internal element identified through the data as hindering efforts was a poor understanding of SC GHGEs and a lack of focus. These issues are likely to be related to the two categories already described, as conflicting objectives and a lack of resources will distract and reduce the ability of organisations to gain the necessary expertise and understanding. This category also reflects however, that SC GHGE management is a complex issue:

> Also, I think indirect emissions are also quite hard to get our head around, and the direct emissions are much more simple communications message. (B17; 27.01.2012).

5.3.2.4 Internal Barrier: Data Issues

This category contains many elements of the private sector barriers concerning the lack of suitable and appropriate systems for SC GHGE management. However, it was decided to broaden this category for the public sector, due to additional data issues within the public sector. In comparison to the private sector, it was noted that methodologies were not as well developed, creating further problems for the public sector. This led to greater time periods required for data collection and analysis, and also made comparison more difficult than in the private sector. The inability to benchmark made performance judgements harder, and consequently made the identification of suitable strategies and changes more troublesome.

> I think it's hard to benchmark ourselves as well. I think this is a weakness, not just for us, I think it is a weakness for all organisations. This area is difficult to put accurate carbon numbers to, because there have been different ways of working, different methodologies…. (B16; 19.12.2011).

5.3.2.4.1 External Barriers: Lack of Policy or Regulation

Through the data coding process, the reliance of many public sector organisations on top-down direction, often through regulation or policy, created a barrier in relation to SC GHGE management. Public sector organisations reported that they were given little guidance or targets for work related to SC GHGEs:

> I think there needs to be a government lead. (B14; 07.12.2011).

A lack of pressure or direction from government, on public sector organisations to measure and manage their SC GHGEs, meant that many were left to make the decision themselves for different reasons:

> (Interviewer) *Was there any input or pressure from government to manage for supply chain emissions?*
>
> No no, it was a choice.
>
> We decided, as a unit, we were set up to look at sustainable development in the [redacted] [large public sector organisation], and we decided to go with carbon because of the Climate Change Act, and its measurable; but then we wanted to make it as broad as possible, due to the influence the [redacted] [large public sector organisation] has, as it's an icon public sector organisation. (B20; 24.02.2011).

5.3.2.5 External Barrier: Supplier Engagement

The same barrier was identified by private sector participants in terms of the requirement to work with the SC for SC GHGE reductions, and the associated difficulties that this brought:

> But when we're dealing with supply chains, you have to work with them for change. (B14; 07.2.2011);

5.3.2.6 External Barrier: Lack of Methodological Guidance

As noted previously, methodologies for Scope Three, or SC GHGEs, were highlighted as less developed in comparison to those used in the private sector. This compounded the difficulties associated with this barrier in public sector organisations as previously outlined in terms of the private sector:

> Scope Three is just emerging now [for the public sector], whereas in the CDP, the large Corporates have now got the GHG protocol, so the rules of the game have been clarified for the private sector, but not for the public sector. (B13; 02.12.2011).

5.3.2.7 External Barrier: Procurement Practices

Two specific elements of procurement in the public sector were reported to act as a barrier to the management of SC GHGEs; these included the rules imposed by EU Procurement Directives, and the use of procurement consortia.

EU Procurement rules were highlighted as reducing the flexibility available in procurement in the public sector. This prevented organisations from basing procurement decisions on GHGEs in some instances, as outlined by participant B14:

> In the private sector it's a lot easier to change suppliers based on whatever initiative you want to implement, so you can chop and change. I.e. supplier x has emissions a, and y has emissions b, so let's speak to y to see if we can get a deal. But in the public sector we're bound by the EU Public Procurement Regulations, so we can't just chop and change. (B14; 07.12.2011)

A further aspect of public sector procurement practices that impinged SC GHGE management was the use of procurement consortia. These organisations are created in order to increase the purchasing power of smaller public sector organisations and act to purchase goods and services for groups of organisations. The aim of increasing purchasing power should also increase the ability of public sector organisations to demand and enact changes that reduce SC GHGEs. However, the diluted control, due to several organisations forming a single consortium, meant that unless all members pursued SC GHGE management objectives, the consortia acted to create a further layer between buyer and supplier. This reduced the ability of individual public sector organisations to communicate and interact with the supply base, reducing their control and options for motivating changes that reduced SC GHGEs:

> They are actually fairly good at taking sustainability on board. But it's just because you are separated from suppliers, it makes it more difficult. Also, if you have higher aspirations than other University's [who procure through the consortium], then that makes it difficult. (B19; 07.02.2012).

5.3.2.8 Public Sector Barriers and the Literature

Although the literature concerning public sector barriers in relation to engagement with ESCM is sparse, several aspects can be found to agree with the results presented above. Morgan (2008) noted a lack of project management skills, overly bureaucratic culture and a lack of sharing of best practice, which correlates with the impact of procurement practices and the data issue categories in the results respectively. Morgan (2008) also highlights the impact of poor project management skills, not identified in the results; the same is true of technological constraints and SC complexity (Preuss and Walker 2011). The impact of negative perceptions over EU Procurement Rules is also highlighted in both the results and the literature (Preuss and Walker 2011).

Further agreement with the literature is found concerning the premium of cost in decisions, over environmental objectives and budgetary cuts (Preuss 2009; Preuss 2007; National Audit Office 2005). This demonstrates a conflict of priorities, a lack of political or organisational leadership, and is demonstrated by the lack of policy or regulation reported by the public focal organisations, other than the University examples.

5.3.2.9 Comparison of Phase One and Two Results

The barriers presented above extend the results obtained through the project's first phase. A lack of political will, demonstrated through a dearth of policy and guidance above, and the impact of perceptions regarding EU Procurement Directives were identified through both phases. Further barriers were reported during phase two however, including resource constraints and difficulties in prioritisation, supplier engagement, as well as issues around data collection, analysis and benchmarking.

One hindering factor, the impact of project orientated working within the public sector reducing the ability to implement best practice and a 'joined up approach', noted within phase one, was not identified during the second phase. This barrier concerned the working practices of public sector organisation employees, who made up the participants within phase two. That they did not identify this factor may not be

surprising, as it may require an external perspective to recognise it, and such a perspective was offered by the phase one participants; indeed, this is why they were selected as data providers.

A comparison with those barriers identified as affecting businesses in the private sector highlights key differences. These include less methodological clarity, a more restrictive procurement process, and greater reliance on top down direction, highlighted through the reported lack of policy and regulation, and greater reported difficulties in engaging with suppliers. This assertion supports previous observations in this project, concerning the constricted nature of the efforts of public sector focal organisations in comparison to businesses, leading to the current situation of these businesses being prominent in terms of current practice.

5.3.3 Conclusions of Barriers and Driving Factors

The categories developed above show the factors reported to be driving and hindering efforts in both the private and public sectors to manage SC GHGEs. They demonstrate that the private sector is being driven by a range of factors present within the wider business environment, many of which were not reported by public sector organisations. Reported barriers also differed between the two sectors.

These results demonstrate that public and private sectors focal organisations are being motivated and hindered by different factors, indicating that they operate within different contexts and under different incentives. However, a range of barriers, such as conflicting objectives and associated resource constraints, were identified in both public and private sectors. These results also confirm that actions to manage SC GHGEs within the private sector are not being driven by current policy; a key outcome of the first phase of this project.

The identification of the drivers and barriers contributes somewhat to the answering of research question one. Although phase one did provide an indication of driving and hindering factors, for both the public and private sectors, these assertions were obtained from a single perspective, from a single set of participants. The added perspective provided by the participants internal to organisations engaging with SC GHGEs was able to provide greater certainty and validity in attempts to answer the research question posed.

5.4 Additional Outcomes and Benefits of Supply Chain Greenhouse Gas Emission Management

Data collected during phase one indicated that efforts within SC GHGE management were aimed at the collection of data for reporting purposes, as part of CR programmes, or in an effort to better manage and reduce SC GHGEs. The data obtained from the phase two participants however included answers to a question concerning whether any additional outcomes or benefits had been achieved through work to manage SC GHGEs. Any additional benefits through SC GHGE management efforts would add to arguments advocating this as an appropriate area of environmental management for organisations, and alter any cost benefit analysis or investment decisions in favour of SC GHGE management. Due to these reasons, this is an interesting and important area of analysis. Although some factors identified as 'additional outcomes' were initially identified as drivers, their inclusion within this area of analysis is due to their occurring where they were deemed to be secondary or 'additional' outcomes or objectives, that is, they were not reported or felt to be the core aim of the activity which resulted in their occurring.

The data coding process identified a range of additional benefits from work to manage and reduce GHGEs in suppliers; these will be described and explored below. Table 5-5 summarises the categories developed.

Table 5-5: Summary of phase two objectives/outcomes and additional benefits.

Objective /Outcomes		**Details**
GHGE Reporting & Disclosure		Reporting and disclosure through CR reports, NGO organisations or regulatory schemes.
		Non-reporting: data collected used to measure internal performance.
SC GHGE Reductions		Actions and initiatives to reduce SC GHGEs.
Other Objectives & Benefits	Efficiency Gains/Cost Reductions	Actions to reduce GHGE also increase efficiency and/or producing cost saving.
	Increase Financial	Efficiency increases for SC, reduces costs,

	Resilience/Health of Suppliers/SC	increasing financial resilience of SC.
	Improving SC Relations & Dynamics	Collaboration enhances supplier relationships, to benefit of future business.
	Other	Context specific benefits.

5.4.1 Efficiency Gains/Cost Reductions

The possibility of achieving savings and cost reductions through the increased efficiency achieved by some efforts to reduce SC GHGEs, a noted driver, was also identified as an additional benefit. Although stated above, that if a factor was identified as a driver, it could not be an additional benefit; difficulties were noted concerning achieving cost reductions in relation to passing benefits across the buyer-supplier divide. Where companies had achieved this, it was felt this could be seen as an additional benefit.

It was highlighted that 'gain share' initiatives were possible, overcoming the buyer-supplier divide problem, where any savings from changes enacted by the supplier and focal business were shared; this was articulated by B07, the Dairy Company participant:

> [I]t would be a shared benefit, which is exactly the same way that one of our customers would work with us. So they don't necessarily want all of the saving, but may want at least some of the saving. (B07; 09.11.2011).

So although difficulties were acknowledged, methods, such as gain share, had been identified that allowed focal organisations to obtain direct financial benefits from work to manage SC GHGEs.

5.4.2 Increased Financial Resilience/Health of Suppliers

Where direct financial benefits were not possible, or where they were too small to justify the costs of setting up and negotiating gain share initiatives, other less tangible benefits were identified. One of these was the belief that work to reduce SC GHGEs would provide financial benefits to suppliers in many cases. This in turn resulted in a SC, and suppliers, that was financially more resilient and healthy.

> You might get other benefits, rather than getting a direct financial gain, for examples your supply chain may become more robust, robust financially because they have a little bit more leeway as they are not spending so much on energy, and it would certainly be more robust to legislative changes and carbon taxes. (B02; 24.10.2011).

So although the financial benefits of SC GHGE reductions may not be achieved by the focal business, the financial benefits enjoyed by suppliers could increase the robustness and resilience of the SC. This reduces the chances of supply shocks and disruptions, from a multiplicity of destabilising events, such as new regulations, and provides a benefit to the security of supply to the focal organisation.

5.4.3 Improving Supply Chain Dynamics and Relationships

As many SC GHGE management and reduction initiatives required supplier engagement, the opportunity that supplier relations and dynamics were improved was raised. Achieving closer relationships with suppliers was felt to reduce transaction costs and improved SC performance, as communication improved. Further additional benefits, such as capturing SC innovations, as will be described below, were also thought to become more likely where SC relationships were enhanced:

> I think that any engagement with the supply chain, from my experience, is welcome. Having been involved at both ends of the scale, where you put a lot of effort into engaging with suppliers and regular meetings, whether it be carbon or health and safety or whatever, I think that's always welcome, and it always improves relationships and the way we deliver work. (B16; 19.12.2011).

5.4.4 'Other' Additional Benefits

Further context specific benefits were identified. Within one of the University examples, it was noted that closer working with one large supplier could aid student training, and furnish them with more appropriate skills. In turn this could improve graduate employment rates and benefit the University:

> I know one thing they are trying to get out of the [redacted] [multinational information Technology Corporation] project, is not to just buy products from them, but also to try and access their expertise, maybe in our teaching, learning and research. So we are looking at developing courses which are run specifically with [redacted] [multinational information technology corporation], so that graduates from [redacted] [participants University] who have got knowledge and expertise of working with companies like [redacted] [multinational information technology corporation], so that there is a ready-made market for well skilled graduates that big global companies like [redacted] [multinational information technology corporation] can pick up, which would be good for [redacted] [participants University] in terms of our reputation. (B18; 01.02.2012).

Within the same example, it was also highlighted that their work to measure SC GHGEs had results in publications within academic journals.

> Part of that was building in a research element, so that you didn't just produce your report, but so [redacted] [participant] wrote a paper for a Journal, which is in the process of being published. So there were many different hooks that we could hang the project on in terms of benefits to the institution. (B18; 01.02.2012).

5.4.5 Private and Public Sector Supply Chain Greenhouse Gas Emission Management Objectives and the Literature

These reported benefits of SC GHGE management find similarities with those reported in the literature in relation to engagement with climate change objectives and ESCM. Further, reported drivers, such as increased competitive advantage, through efficiency gains or improved reputation, are also appropriate to consider here, as although core drivers of GHGE management, they also form potential outcomes.

The possibility of increased competiveness through engagement with environmental management more generally is well established in the literature (Lash and Wellington 2007; Nehrt 1996; Porter and van der Linde 1995), as are the short-term economic benefits, such as increased efficiency (Hoffman 2005; Rothenberg, Pil and Maxwell 2001) and improved reputation (Klassen and McLaughlin 1996). Specifically with regards to ESCM, 'win-win' possibilities, such as increased efficiency through remedial environmental actions, are noted as occurring, and are amplified where collaborative relationships are established with the SC through the sharing of best practice and technology transfer (Green, Morton and New 1996; Lamming and Hampson 1996). Improved supplier relations are also highlighted (Rao and Holt 2005; Zhu and Sarkis 2004; Klassen and Vachon 2003). The possibility of increased supplier resilience is not noted specifically within the literature however, but could be considered to follow on logically where environmental management through the SC increases their efficiency and correspondingly reduces suppliers' costs.

Within literature concerning corporate engagement with GHGE management more widely, research has investigated the differences in the reduction of GHGEs between organisations that note self-interest as a driver in comparison to those who cite ethical considerations. Those organisations who reported acting out of self-interest were found to have reduced their GHGEs to a lesser degree than those acting out of ethical concerns, which has potential implications, to be considered later, in terms of policy (Le Menestrel and de Bettignies 2002).

The identification of additional objectives and outcomes pursued by the public sector focal organisations is consistent with literature in this area, which notes that procurement efforts could be used as an instrument of government, for example to improve the local economy and the capabilities of local businesses (New, Green and Morton 2002). That positive 'spill-overs' can result from supplier engagement is also well documented in the literature (Holt 2004; King 1996), including improved performance in the buying firm (Kannan and Tan 2006), or focal organisation.

Public sector SCs are identified in the literature as being able to be used as an instrument of government, for the achievement of policy aims, from encouraging innovation, to social policies or stimulating the local economy and the capabilities of local businesses (New, Green and Morton 2002). This corresponds somewhat to the results in terms of the 'other' category and specifically in relation to the additional positive outcomes noted by respondents B18, who noted the additional expertise, in terms of curriculum development able to be obtained from collaboration with a large IT supplier.

5.4.6 Additional Benefits Summary

This section has highlighted that a range of benefits are obtainable from work to manage SC GHGEs. These were in addition to reporting options and reduction efforts. Their existence further strengthens arguments for SC GHGE management. It should be noted that the primary reason for engaging with and managing SC GHGEs is for either measuring or scoping reasons, so as to be able to report and disclose GHGEs, and/or to achieve reductions.

The benefits presented above where not reported as expected outcomes, or as reasons for engaging with SC GHGEs. They were, as indicated, additional benefits or outcomes. This discovery provides an answer to research question one, concerning 'the objectives and outcomes of SC GHGE efforts'. The results presented above demonstrate, and add to assertions initially obtained through phase one, that focal organisations engage with SC GHGEs, to measure them for reporting purposes, or to reduce them. Their reduction provides reputational and competitive benefits, as well as the potential to reduce risks around future resource cost increases, and possible legislation.

In addition to these central goals and objectives, it has been found that additional outcomes are also reported as possible, including the increasing financial health of the SC, increasing its resilience, improved SC relations, as well as more context specific benefits.

5.5 Activities in the Supply Chain

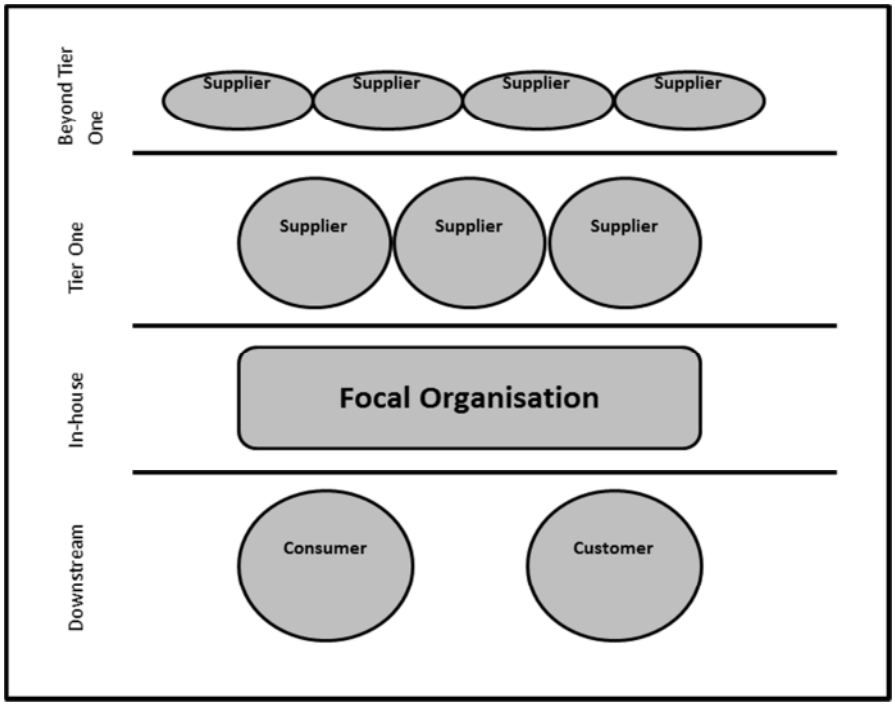
As also investigated through phase one, the specific activities and initiatives undertaken by focal organisations is an important area to explore. These activities will each impact the SC, and its constituent suppliers, in specific ways. Each will have certain externalities, positive or negative. Further, efforts to enhance SC GHGE management, through policy or regulation, will require some understanding of the likely responses of focal organisations.

As many of the activities undertaken were similar in the public and private sector organisations canvassed, this section of the results, as with section 5.4 concerning additional benefits, have been approached without separate public and private sector categories; however, where only one sector noted an activity, this is noted through the use of a '✓' in the corresponding table.

In attempting to identify activities, it was felt important to separate these 'activities' from the objectives they were trying to achieve. For example, although SC GHGE reporting and disclosure could be considered an activity, it was felt more appropriate to see it as an objective. So rather than identifying this as an activity, the activities that lay beyond the objective of SC GHGE reporting and disclosure were identified, such as information sharing and dissemination, or the use of supplier questionnaires.

The activities identified through the data will now be described. During the analysis, and as noted within the literature, it was recognised that it was important where action was occurring, i.e. in terms of whether in the SC or in the focal organisations. As such, the actions identified were segregated according to where in the SC they occurred; these SC areas included aspects beyond the first tier of suppliers, within the first tier, within the focal organisation, or downstream in the SC, as illustrated by Figure 5-1.

Figure 5-1: Schematic of analysis framework for focal organisation supply chain greenhouse gas emission management activities.



5.5.1 Supply Chain Greenhouse Gas Emission Management Efforts beyond Tier One of the Supply Chain

The activities identified as occurring beyond the first tier of the SC will be described first; these are summarised within Table 5-6. These were activities seen to be occurring in suppliers of suppliers, where no direct commercial relationship existed with the focal organisation. Examples of these activities were not substantial, and only identified within a single case in the public sector and a single case within the private sector.

Table 5-6: Summary of 'beyond tier one' greenhouse gas emission management activity categories in public and private sectors.

GHGE Management Activities 'Beyond Tier One'	Private Sector	Public Sector
Conversation and Dialogue	✓	✓
Management Standards	✓	✓

5.5.1.1 Conversation or Dialogue

This category was developed to reflect informal efforts by focal organisations to communicate with suppliers beyond the first tier of the SC. These efforts were often

designed to establish likely future expectations around the measurement and management of GHGEs, as detailed future work in the SC would require all suppliers up and down the SC to measure and manage GHGEs.

> [F]or instance I was at an event in Manchester last week where one of our suppliers, who isn't top 50, but contracted to [redacted] [participants organisation], called [redacted] Construction, were holding an event for their suppliers and I went to speak to them as a [redacted] client. (B06; 08.11.2011).

Within the public sector example, B16, this contact was more formal and aimed at ensuring that environmental management efforts by smaller contractors were suitable.

5.5.1.2 Management Standards

Codes of conduct and other management standards were also identified as being used to influence the behaviour of suppliers beyond the first tier of the SC. Participant B03, from the consumer good company, noted that supplier codes of conduct were used to ensure that certain practices, including those around GHGE management, were passed up through the SC.

5.5.2 Supply Chain Greenhouse Gas Emission Management Efforts within Tier One of the Supply Chain

Activities occurring within the first tier of the SC concerned those actions with direct suppliers; these suppliers would have a direct commercial relationship with the focal organisation. These activities were more numerous and diverse than those occurring upstream, beyond this tier. Many of the activities noted could be used toward reporting and disclosure requirements, i.e. the collection of GHGE data, or GHGE reduction, depending on their specific focus and context. Table 5-7 contains a summary of these activities.

Table 5-7: Summary of 'tier one' greenhouse gas emission management activity categories in public and private sectors.

GHGE Management Activities in 'Tier One'	Private Sector	Public Sector
Information Sharing and Dissemination	✓	✓
GHGE Inclusion in Contract and Tendering Specifications	✓	✓
Partnering and Collaboration	✓	✓
Direct Supplier Interventions	✓	
Management Standards and Verification	✓	
Supplier Involvement in Design	✓	
Supplier Training and Schools	✓	✓

5.5.2.1 Information Sharing and Dissemination

Through the coding of the data it was decided that a category was needed that reflected efforts by focal organisations in both the public and private sectors to share and disseminate information, as an activity in itself. Although several other activities will involve information flows, it was felt that these were necessary in order to complete a specific activity, whilst in the examples to be outlined in this category, information sharing and dissemination was the activity in itself. These information flows were diverse, in that they could flow from focal organisations to the SC, between them, or from the SC to the focal firms, or between suppliers. Further, they concerned a wide range of areas, from GHGE data to general advice to suppliers.

The primary information sharing methods identified within this category included the use of questionnaires to survey suppliers, GHGE data collection, the use of websites and online communication forums and supplier conferences; all of these activities were identified as being undertaken in order to share or obtain information. Alongside these more specific information sharing activities, informal dialogue and efforts were noted. These efforts were often the initial issue 'raising' of GHGEs with suppliers. These initial informal efforts were often noted as pursued through contract managers, as an aside, or included within other general communications.

The use of irregular or 'one-off' questionnaires was highlighted here to reflect the scoping efforts many organisations are attempting in terms of SC GHGEs. This served to either examine general environmental management efforts by the supply base, or in terms of whether suppliers knew their levels of GHGEs, and asking for these to be reported. In some cases, these questionnaires were opportunistically released when procurement systems were changed, or when other supplier engagement efforts were occurring:

> So we've taken this opportunity to send them a supplier questionnaire asking them about their environmental credentials. So which types of internal policies they have, like health and safety, environmental strategy, carbon management plan etc., if they have ISO14001. If they have product carbon footprints, the type of practices in sustainability they do, like recycling and measuring GHGs etc. (B18; 01.02.2012).

Often included within the use of questionnaires, and likely to run at least on an annual basis, was the collection of GHGE data from suppliers, frequently aimed towards reporting efforts, such as through the CDP. Where external schemes were used it was noted that often a third sector organisation or consultancy would lead the data collection efforts. Frequently, the data collected through these efforts would be self-assessed by the supplier, and hence unverified.

A more novel approach noted by the retailer questioned, B11, concerned the spreading of information, including best practice, within the SC. Although these efforts often constituted 'training', to be dealt with in a different category, the retailer in question had established an online space where suppliers could share best practice information around managing GHGEs with each other. The focal firm was happy not to be directly involved in these exchanges:

> So we thought to try and just link these guys up, we'll share a load of our information with them, we'll run fortnightly webinars, we'll run site visits, this that and the other, just to try and provide a forum and environment within which our suppliers are happy to talk to each other….. we're quite happy not to be involved in conversations between supplier A and supplier B. (B11; 18.11.2011).

Best practice was noted as shared through the formation of 'supplier alliances', where similar suppliers are brought together to share problems and solutions, including those relevant to SC GHGEs:

> They are called 'Supplier Alliances'. So not just a partnership, or an arrangement that takes us forward, but we will bring suppliers of a similar nature together, to talk about common issue's and talk about a sustainable approach. (B06; 08.11.2011).

In summary, this category attempted to capture the phenomenon of focal organisations in both public and private settings attempting to share and obtain information from and with the SC, in relation to SC GHGEs. These included general information provision and issue raising, the collection of SC GHGE data, the sharing of best practice, and the creation of areas where SC members could share their own best practice experiences, without the involvement of the focal firm. All these endeavours focused upon information sharing and provision.

5.5.2.2 Greenhouse Gas Emission Inclusion in Tenders and Contracts

A further area of action identified as applied to tier one of the SC concerned the inclusion of GHGE requirements within tenders and supplier contracts. These could include requirements to measure and report GHGEs, or targets for their reduction.

> Some of the procurement teams I've been working with, have started to put more language into their producer codes, and their specifications for tender, about disclosure and about Scope Three emissions to their suppliers. (B13; 02.12.2011).

This type of activity was one that was seemingly impacted by procurement rules within the public sector, and some regulated industries in the private sector, such as the Utilities sector. Most private sector focal organisations canvassed however noted flexibility in this regard. Some of these requirements, as noted above, included stipulations to report GHGEs, which could involve the use of questionnaires in a less ad hoc nature in comparison to the category noted above, in section 5.5.2.1. The difference between questionnaires for obtaining information as a general requirement external to a contract, and in order to collect GHGE data as a requirement of a contract should be distinguished. This is demonstrated in this quote from participant B09 from the construction industry:

> [W]hen somebody comes to work for us, there is a standard monthly reporting template including waste, etc. sometimes that's a bit of a shock to companies when they see it. When we sit down and explain it to them, and the reason as to why we are doing it, they understand and they especially understand more, as if your saving stuff like energy, waste or carbon, and its them that will be doing it, they will get the financial gain from it. (B09; 11.11.2011).

5.5.2.3 Collaboration and Partnering Agreements

The above noted activities were often undertaken across a majority of suppliers. 'Top' or 'primary' suppliers often enjoyed closer and more collaborative relationships with focal organisations through partnering agreements; where this was the case it was

found that these arrangements were being taken advantage of to make progress with regards to the management of SC GHGEs.

Through closer supply relationships, focal organisations noted that they could exert more influence and apply further requirements. These could include more regular GHGE reporting, and mechanisms that introduced competition into the supply arrangements, such as the use of league tables, explained by participant B06:

> The top 50 are managed through supplier relationship management. They are assessed against their performance, including sustainability criteria, among other things, and are scored on a quarterly basis and they go into a league table. (B06; 08.11.2011).

5.5.2.4 Direct Supplier Interventions

Focal organisations' acting directly to intervene in suppliers was deemed as an area of activity requiring its own category. Such interventions could include free GHGE assessments for suppliers; here the focal organisation would arrange and conduct a full GHGE footprint assessment for the suppliers, for use towards reporting requirements:

> [A] program looking at carbon management in farming supply chains and agricultural supply chains, and we developed a tool there called the '[redacted]', which allows farmers to measure the carbon footprint of their operation and report those. (B03; 25.10.2011).

In some cases, GHGE inefficiencies identified through the assessments would lead to further interventions. If projects were identified that could lead to reductions, capital could be supplied by the focal firm, for improvement works:

> We're setting up at the moment this green fund. This will be for, in effect, green innovations. If a supply chain member has something that they want to get us to use, but they need some financial assistance to get it on to one of our projects, as a demonstration, we can lend them money, and we'll get it back over the course of the contract. (B09; 11.11.2011).

B04 also noted instances where capital or funding would be provided to the supplier to carry out such work, as originally noted in phase one of this project:

> We have a thing called an 'energy kisan', which was developed in house, which means we can go into one of our own factory's and find 30% of savings with a 5 year investment plan, and we're starting to take that into our supply chain.
>
> Yeah, and sometimes of course once we ID the projects for them, then there's a debate about whether they have the capital in order to do it, or whether we would supply the capital. (B04; 01.11.2011).

5.5.2.5 Management Standards and Verification Activities

The imposition of management standards on suppliers and other verification activities emerged in the data as a further area of action. Management standards, as in other areas, were applied to GHGEs in an effort to ensure that their management is standardised across the SC. In some cases, these standards also allowed verification by external agencies, such as with 'Carbon Emissions Management And Reduction Scheme' (CEMARS) Achilles Ltd:

> So if we take carbon, we're active members of CEMARS, by Achilles Information Ltd – it is something that we helped develop with Achilles and we encourage suppliers , not just top 50, but all of our suppliers effected, to sign up to something like CEMARS. So they are not just measuring their carbon footprint, which is a start, and is a difficult step for companies to take, but getting that grasp and whole of what their initial footprint may be, but we want them to have targets for reduction and we want them to be seen to be reducing that carbon footprint and for it to be certified. That's the big difference between a lot of schemes; CEMARS is certified reduction. (B06; 08.11.2011).

Where GHGEs were verified, a greater level of confidence could be taken in the data, enhancing decision-making within both the supplier and focal organisation concerned.

Such standards were also noted as including 'framework agreements', and could be applied to repeat suppliers. Such agreements provided greater control and certainty over supplier performance:

> All significant suppliers that are not just one off, but repeat suppliers have to sign up to this framework agreement. So that's quite a powerful mechanism to get people motivated, because you can't do business with [redacted] [participant's organisation] unless you do sign up. (B02; 24.10.2011).

5.5.2.6 Supplier Involvement in Design

A further area of action that involved closer and more collaborative working relationships with suppliers concerned the involvement of the SC in the design of services and products in order to reduce embodied, and so also, SC GHGEs. Suppliers were involved as it was felt that they could provide greater insight into the production processes occurring further up the SC, about which the focal organisation may have limited knowledge:

> Whereas before, we would have gone to them and say 'we want your best machine, and your best pasteuriser, and your best filling machines, and your best packer' – we've now locked them all in a room and said, 'we want the best production line' – we want your bit to work to the lowest environmental impact with that from all the suppliers. (B07; 09.11.2011).

Supplier innovation competitions were also run in this regard, where the SC was invited to submit ideas and innovations. Winners were identified and rewarded, either with further business or an invitation to an annual conference or award ceremony.

> We have an annual supply chain [redacted] [environmental] Award – this goes onto our external website, anyone can enter, they don't have to work for [redacted] [participants organisation] – if they have a solution that fits in to these four areas, they put in a two pages submission to the award. Last year we had 50 entries – this we have 110 – which is great, we can't believe it. The short list of the top three, they come down to the award ceremony – an evening event, they get invited – they don't know who's going to win and the winner gets presented on the night. (B09; 11.11.2011).

5.5.2.7 Supplier Schools and Training

Due to a lack of capabilities within some suppliers, training events and workshops were identified as an activity being undertaken by focal organisations.

> So last year, we ran a programme of 5 workshops for suppliers, co-hosted with the carbon trust on that very subject. (B01; 23.09.2011).

These events were designed to inform suppliers of GHGE management techniques and requirements, and provide them with the skills and capabilities required. In one example from the construction industry, it was highlighted that a supplier school was to be created, focused on those contractors unable to fulfil the environmental management requirements, including GHGEs:

> We're looking to set up, what we call a supply chain school. (B09; 11.11.2011).

5.5.2.8 Tier One Activities Overview

A range of activities were identified as reported to be taking place within tier one of focal organisations SCs. These ranged from initial information provision to all SC members to involving specific suppliers in the design of products and services, in an attempt to reduce SC GHGEs.

5.5.3 Supply Chain Greenhouse Gas Emission Management Efforts within Focal Organisations

A range of activities were identified in the data that occurred within the focal organisations themselves. Although these affected suppliers and the overall SC, the activity itself took place within the focal organisations, and did not require supplier engagement. Table 5-8 provides an overview of activities identified as occurring within focal organisations.

Table 5-8: Summary of 'in-house' greenhouse gas emission management activity categories in public and private sectors.

GHGE Management Activities 'In-house'	Private Sector	Public Sector
SC GHGE Modelling and Assessment	✓	✓
Design Changes	✓	
Training and Information Provision	✓	✓
Embedding of SC GHGE into Commercial Teams	✓	✓

5.5.3.1 Greenhouse Gas Emission Modelling and Assessment

As outlined from the phase one results, an initial aspect of SC GHGE management concerned the identification of SC GHGE hotspots and points of influence. Several of the participants noted that their organisation, rather than collecting data from suppliers, had used financial or other data to model and estimate SC GHGEs. Input-output models were often used, using GHGE conversation factors:

> We've done two carbon footprints, so the measuring phase, in 2009 and 2010, and we'll repeat it this year, once the year has finished. In 2009 and 2010 the approach used input output analysis of the supply chain/Scope Three emissions. (B02; 24.10.2011).

This approach to SC mapping and GHGE assessment avoided difficulties associated with supplier engagement and was noted as an effective initial strategy for early quantification efforts. However, accuracy was deemed to suffer, as these models relied upon GHGE conversion factors, which did not represent the actual GHGEs within suppliers.

5.5.3.2 Design Changes

A further method for controlling SC GHGEs is for focal firms to alter the designs of their products and services therefore changing the production processes used. This strategy is employed in order to reduce SC GHGEs.

> We often focus on mitigation, so we're trying to reduce that in our design, so low carbon design, that sort of thing. So that would be our design work. (B10; 14.11.2011).

Although this would no doubt effect the actions of the SC, the work itself can be conducted internally, with no supplier input, in contrast to the activity noted in section 5.5.2.6.

5.5.3.3 Internal Training and Information Provision

The cross-cutting nature of SC GHGE management efforts within an organisation often includes the involvement of individuals from procurement, SC management and environmental management departments. As environmental management capabilities are not found within all such departments, and are central to SC GHGE management efforts, internal information provision and training was identified as a key activity and category. This capability raising, especially in areas such as SCM and procurement, was highlighted as an important area for action. Within large organisations this activity took on further dimensions, as the sharing of best practice could be difficult. As a result some organisations introduced systems to share solutions to environmental problems, including those concerning SC GHGE management:

> On our intranet, we have a section called the '[redacted]' which has loads of environmental stuff on it – and that's how we share best practice. Training packages, loads of documents, and we do things called green solutions – these are circulated internally (B09; 11.11.2011).

> A team and a responsible procurement policy were set up in 2006 – to have a single consistent approach to responsible procurement, rather than having conflicting messages going out to market and to create efficiencies within our approach internally and externally. (B14; 07.12.2011).

As this second quote demonstrates, within the public sector, sharing best practice and other information also occurred between other focal organisations.

5.5.3.4 Embedding of Supply Chain Greenhouse Gas Emissions into Commercial Teams

Conducted in order to 'mainstream' SC GHGE management efforts, criteria and management activities associated with this are passed to commercial teams, including the collection of GHGE data, or targets on their reduction. This integrates GHGE criteria into the commercial relationship and treats it as any other SCM objective. Commercial teams are then able to start to use GHGE data as part of overall decision criteria. This could include target setting or benchmarking of suppliers, as well as the collection of GHGE data:

> The third piece is what we describe as 'trying to mainstream carbon' into the commercial relationship. The key link to suppliers is our commercial function, which do all the buying. We need them and their technical manager's within the technical teams to pick up reasonability for sustainability and carbon reductions. (B11; 18.11.2011).

5.5.3.5 Overview of Internal Focal Firm Activities

Activities were identified though the coding process that took place within focal organisations, ranging from SC GHGE modelling using input-output models, to the integration of SC GHGE objectives into standard commercial functions. These activities represented opportunities for focal organisation to start to enact changes that reduce and manage SC GHGEs, which do not immediately require supplier engagement.

5.5.4 Supply Chain Greenhouse Gas Emission Efforts Downstream within the Supply Chain

Activities occurring throughout the SC, including focal companies, have been identified and described above. Although limited, activities downstream of the focal firms were also identified; Table 5-9 provides a summary of these downstream activities. These included attempts to reduce the overall GHGE footprint of products by influencing consumer use, as well as efforts to conduct research on how consumers used products and services, and how this impacted on SC GHGEs. Although many methodologies used to calculate SC GHGEs do not consider the downstream use phase, some organisations did include this into their calculations, and as such attempted to manage this area.

Table 5-9: Summary of 'downstream' greenhouse gas emission management activity categories in public and private sectors.

GHGE Management Activities 'Downstream'	Private Sector	Public Sector
R&D on Consumers	✓	
Influencing Customer Use of Products	✓	

5.5.4.1 Research on Consumer Use of Products

Efforts to impact downstream GHGEs concentrated on those products or services that had a high proportion of their overall GHGEs within their use phase. The inclusion of these aspects meant a choice had been made to expand the area over which the organisation took responsibility for the products GHGEs.

> [A]nd there's downstream: we have a particular product which is [redacted] [specific product]. So they are about a 1/3rd of our footprint, so to be an honest, we're just concentrating to a large extent on the downstream emissions of [redacted] [specific product]. (B04; 01.11.2011).

In order to attempt to reduce downstream GHGEs, focal organisations had to conduct research and examine whether interventions were feasible:

> So again, there may be intervention strategies or innovations around trying to reduce that. The reduction can be measured, but actually a lot of the initiatives will really be about consumer behaviour change. (B03; 25.10.2011)

5.5.4.2 Influencing Customer Use of Products

Specific influencing strategies include the use of carbon labelling on products that inform the consumer of the amount of GHGEs within a product, or providing directions on use, or changing the design of the product. Carbon labelling in particular was felt to be ineffective:

> We are in the process of thinking hard about how we can make labelling more effective, as not that many consumers really understand the Carbon Trust label. Very few have a context within to understand whether their bag of crisps is good or bad, and quite what to do about it. So, we think about how we do labelling, in order to make it more effective for customers. (B11; 18.11.2011).

5.5.4.3 Downstream Actions Overview

Although many of the organisations examined did not consider the downstream GHGEs of their products, or include them within their SC GHGE management efforts, some did. Their efforts focused on research that sought further understanding on how consumers used products and what could be done to influence their use, so as to lead to a reduction. Carbon labelling, a method of informing consumers of the embodied GHGEs within a product were noted as ineffective.

5.5.5 Supply Chain Greenhouse Gas Emission Management Activities and the Literature

The literature concerning corporate climate change activities and strategies noted that businesses would be active within the SC, seeking improvements (Lee 2012; Kolk and Pinkse 2005), and that such measures would be composed of both internal, such as developing systems, and external, including supplier collaboration elements (Jeswani, Wehrmeyer and Mulugetta 2008); both of these are corroborated through the results. Further agreement, in relation to ESCM literature, is found in terms of design changes (Donnelly et al. 2006), supplier enabling and capacity development (such as training) (Ciliberti, Pontrandolfo and Scozzi 2008; Lamming and Hampson 1996), the use of supplier requirements such as codes of conduct, auditing and questionnaires (Preuss 2010; Ciliberti, Pontrandolfo and Scozzi 2008; Lamming and Hampson 1996) and supplier forums (Keating et al. 2008). This does not represent a new area of action;

such initiatives have been used in relation to labour standards in clothing SCs (Weil and Mallo 2007), but does confirm their use within a new context.

The use of formal agreements in supplier 'partnerships', are all found within the literature concerning supplier development efforts, which notes the use of introducing competition into the supply base and supplier evaluations, both formal and informal (Krause 1997). Further agreement is found in terms of the recognition of good performance, training and education efforts within suppliers and direct investment within suppliers (Krause 1997). Some aspects of tier one activity do present a more novel approach than those noted in the literature, such as efforts by focal organisation B11, the Multinational Grocery and General Merchandise Retailer, to ensure that information is passed through the SC so that best practice is realised and solutions shared. B11 established an online 'space' where suppliers could contact each other directly and discuss their own individual approaches to GHGE management issues; B11 noted that it was happy not to be involved in such exchanges. The practice of supplier footprinting, where a focal organisation visits and calculates the GHGEs of suppliers, was also felt to fit well with supplier development efforts noted within the literature (Handfield et al. 2006; Krause 1997).

The literature concerning corporate climate change strategies noted the SC as an area of action (Lee 2012; Kolk and Pinkse 2005), and that has been confirmed by the results obtained through the project, providing another intuitive result. The results have however been able to deepen this assertion, and provide specific actions, and contexts within which they are occurring. Further, literature concerning ESCM and more generally supplier development and engagement efforts, was also confirmed within this new context. However, some results obtained in this area, such as the use of online communication spaces, or communities, to spread best practice within the SC, present a new and novel area of supplier relationship management.

5.5.6 Summary of Activities for Supply Chain Greenhouse Gas Emission Management and Reduction

Through the coding process, it was found that activities were occurring throughout the SC, including beyond the first tier of suppliers and downstream from focal organisations, demonstrating the scale of action required when attempting to manage SC GHGEs. Many actions were however occurring within the first tier of suppliers,

where a direct commercial relationship existed. This should be no surprise, as here focal firms have the most ability to influence behaviour, through the threat of sanctions or use of rewards. A range of actions were also identified as occurring within focal firms themselves. These actions allowed focal organisations to engage with SC GHGEs, without having to overcome barriers concerned with supplier engagement.

The private sector was reported to be active throughout the SC, imposing conditions and seeking dialogue with suppliers beyond their first tier, as well as collecting data and seeking to influence the users and consumers of their products. Analysis showed that the public sector was more restrained, as previously indicated, by the barriers and drivers they were experiencing. These results also compare favourably with those obtained through the initial phase of the project.

These results will aid in the assessment of these efforts as a method for managing climate change mitigation objectives more widely, as well as in the consideration of future intervention options. The activities undertaken by focal organisations contribute to these objectives, as both rely on SCM methods to achieve their respective goals, that being, the management and reduction of SC GHGEs.

5.6 Supplier Engagement Factors

The phase one results and the literature indicated that many of the actions undertaken to manage SC GHGEs involved supplier engagement. Due to this, phase two participants were asked whether the action their organisations took within the SC involved all suppliers, and if they did not, what factors they took in to consideration when deciding which suppliers to work with and target. The aim of this questioning was to uncover how supplier engagement efforts were prioritised, and was linked to the answering of research question two (b).

During the analysis it become apparent that both the public and private sectors were using the same, or very similar factors in their decision-making; for this reason a single set of factors are shown in Table 5-10. Participant B04 illustrates the decisions that are required when engaging with the SC in terms of GHGE management:

> So, we've got a whole universe, spectrum, of suppliers in there. And it's a question of deciding who to work with. And that's where we are now; we're actually engaging with certain suppliers, finding out those who are prepared to work with us and getting

> much more involved with them around getting more precise details of their footprint and so on. (B04; 01.11.2011).

The categories described below concern the factors identified through the data as being used to focus resources in the SC.

Table 5-10: Summary of supplier engagement factor categories identified during phase two.

Supplier Engagement Factor
Suppliers Level of Capacity or Previous Engagement
Level of Influence over Suppliers
Level of GHGEs from Supplier
Level of Spend with Supplier
Strategic or Critical Suppliers
State of Relationship with Supplier

5.6.1 Suppliers Level of Capacity

It was reported that a supplier's ability to deal with SC GHGE management requests was a factor in some engagement initiatives. Supplier capability would be relevant when identifying where extra support or training to deal with SC GHGE management demands was required. The telecommunications organisation, B01, had followed this strategy when attempting to identify suppliers who it felt were underdeveloped, in terms of their understanding and abilities around GHGEs:

> [W]e were particularly targeting companies we thought were, or knew were, a little bit behind the curve in engaging and understanding issues around climate change and therefore what they can do about it. (B01; 23.09.2011).

5.6.2 Level of Influence over Suppliers

Focal organisations were felt to require knowledge of this factor, as it effected both what was asked or demanded of suppliers, and also how. For example, the participant from the Dairy Products Company, B07, noted that they felt that their organisation had little influence over dairy farmers. Because of this, the company took a different approach to engagement with them:

> But when you come to farmer[s], they are such big parts of the supply chain; it's almost reversed a bit, as they are almost free spirits who can and will go to one of our competitors and sell milk to them if they either offer better price or potentially if they are not putting them under as much pressure as us. (B07; 09.11.2011).

This was seen in contrast to packaging suppliers, who were identified as suppliers able to be put under greater pressure:

> It's probably a different relationship to another supplier, you know, perhaps getting a packaging supplier or someone else on board is easier as you can challenge them that you're just going to go to the next packaging supplier if they can't offer something better. (B07; 09.11.2011).

This demonstrates that the level of influence over certain suppliers within the SC is an important consideration when developing a focal organisations supplier engagement strategy.

5.6.3 Level of Greenhouse Gas Emissions from Supplier

The identification of GHGE hotspots within the SC has already been noted as an important initial activity, noted within phase one. Identifying where large point sources of GHGEs are, allows resources to be focused so as to achieve the greatest GHGE reductions. This rationale was also highlighted as a way of choosing which suppliers to engage; engagement within these terms would likely lead to direct interventions or GHGE reduction targets:

> Which I think is probably going to be where the big wins are – because if you're bringing the worst up to the level of the best, rather than improve on the best farm to make them slightly better, there's more benefit to bring the worst up. (B07; 09.11.2011).

5.6.4 Level of Spend with Supplier

The level of expenditure with a supplier was also highlighted as a factor to take into account when directing resources within the SC for GHGE management. This factor is somewhat linked to the factor above, as it is possible that high spend suppliers would also be high GHGE suppliers. Participants noted that focussing on those suppliers, with which they spend large sums, meant that the financially significant supplier would be targeted; where large sums where spent with a supplier, it may also mean that the focal company had greater influence:

> In terms of the work we've been leading on, it's more focused on the larger players, as we want more traction and a bigger bang for our buck. (B11; 18.11.2011).

5.6.5 Strategic or Critical Suppliers

Suppliers seen as central or crucial to the business were highlighted as an area that could be prioritised for a number of reasons. Influence here, already identified as an engagement factor, was likely to be higher where collaborative or partnership

arrangements were in place. An example of suppliers that fit within this category were those seen to be closely aligned with a firms brand; due to this alignment, their poor performance brought greater risks, but also a greater ability for the focal organisation to influence them:

> [A] lot of work to date has been focused on our own brand where we have great leverage. (B11; 18.11.2011).

5.6.6 State of Relationship with Supplier

Likely to be effected by several of the factors noted above, the form of the relationship was also cited as an important consideration. If relations were poor, expending resources towards engagement efforts may be unwise, if it was likely to be met with a negative or poor response:

> It was based around having a good relationship with them, where the contracts ran for 2 years at least. (B14; 07.12.2011).

Previous levels of engagement may also impact on the state of the relationship, or how much is known about a supplier's capability, by the focal organisation.

5.6.7 Supplier Engagement Factors Overview

In contrast to the categories developed previously, there is no difference in the factors being taken into account by the public and private sectors. In some cases within the public sectors, SMEs were engaged specifically, as per aspects of government policy designed to increase SME inclusion in public tendering. However, it was felt that this fit within the 'level of capacity' category, as SMEs were targeted due to their perceived weakness in terms of environmental management, or in terms of their wider importance.

These results demonstrate how focal organisations are prioritising their actions in the SC in relation to GHGEs; whether they are taking a blanket approach or not, and if not, how are they rationing their resources. This impacts the scope of organisations to successfully manage their SC GHGEs. Where organisations are rationing their involvement in the SC, (i.e. in all cases), and if so, whether they are choosing based on size and contribution or in terms of the potential impact on their reputation and brand. Where involvement with suppliers is based on proximity to brand and reputational impacts, it is possible to conceive that such activities are more in line with CR efforts, as opposed to reducing and managing the whole of the SC GHGE footprint;

such efforts may be focused in this way however, due to the leverage that such brand and reputational proximity bring.

That these results have identified the reported factors taken into consideration when rationing and focusing resources in the SC, has provided an answer to research question two (b). It has demonstrated that due to finite resources and a desire to ensure that the highest impact is obtained for the resources expended, that only certain suppliers are targeted; or that depending on their characteristics, that suppliers are engaged in differing ways. This has potential implications for how policy may be developed and the impacts on SCs of specific interventions undertaken by focal organisations.

5.7 Variables Effecting Strategy and Approach of Focal Organisations

Previous sections, including the results obtained from phases one and two, have developed themes and categories relating to several aspects of organisational engagement with SC GHGE management. These include the driving and hindering factors operating within the public and private sectors, the objectives and additional outcome attainable, as well as the identification of the activities being undertaken to manage SC GHGEs. The factors taken into consideration when deciding which suppliers and where in the SC to focus these management efforts has also been described

In an attempt to further deepen understanding concerning how and why focal organisations are measuring and managing their SC GHGEs, those factors that impact on the form of the specific actions taken more generally, rather than specifically with regards to suppliers, is desirable. These variables would also aid in the consideration and answering of research question two (c), and more generally to research question three.

Table 5-11 provides an overview of those variables identified. This analysis involved identifying factors indicated as significant to specific approaches taken, or where factors led to a change in the way a focal organisation attempted to manage its SC GHGEs. Once all the interview data had been considered and the initial factors and categories had been developed, these preliminary variables were considered in more detail and categorised. Through several iterations, they were further refined.

Table 5-11: Overview of variables identified as impacting focal organisation supply chain greenhouse gas emission management activities.

Variable
Maturity of SC GHGE Efforts
Position within SC
Size of Focal Organisation
Type of Product or Service and Business Model
Private versus Public Stance
Location of SC GHGEs
Stakeholders
Brand Visibility
SC Power and Relations

5.7.1 Maturity of Supply Chain Greenhouse Gas Emission Management Initiatives and Strategy

The maturity of SC GHGE management efforts, or environmental management more generally, was highlighted as a possible variable through the coding process. In its simplest form, the variable demonstrates that focal organisations that have engaged with and reduced their operational, or internal, GHGEs are more likely to start to look within the SC for GHGE reductions. Participant B04 illustrates this point well, by noting that as GHGE management reduced GHGEs internally, the SC becomes the focus of subsequent efforts:

> Well clearly, for years we've been working on our operational footprint….. and it's starting to get expensive to reduce carbon within our own facilities …….But actually it makes more sense financially to look at the whole supply chain and see where you can spend your money. (B04; 01.11.2011).

This variable also captures the order with which most SC GHGE management efforts are undertaken. SC assessment and modelling, and initial supplier engagement occur before reporting and disclosure efforts, and management and collaboration with suppliers to reduce SC GHGEs. Further, many focal organisations noted that they were seeking opportunities for 'big wins' or easy reductions, for example where the largest instances of GHGEs are located; this in turn means that those organisations at the beginning of their efforts will look at different areas of GHGEs to those organisations who have already captured these 'low hanging fruits':

> Because ultimately, as we get closer and closer to that 34% target, when the easiest and big obvious savings have all be delivered on, the tough challenge will be 'where are we going to get that last ½% from?' and that's maybe where you'll come to business travel, or stationary providers etc... That's not to say we don't do things in those areas, it's not really the priority focus at the moment. (B07; 09.11.2011).

This is in some respects a false dichotomy however, as disclosure and reporting can be seen as a precursor to efforts to manage and reduce SC GHGEs, or conversely, disclosure and reporting may be the final objective; in this case, increased maturity of such efforts would increase data accuracy and verification, but would still impact on the approach taken. Further, early SC GHGE disclosure and reporting efforts are often undertaken through the use of modelling, and as these activities mature, they are able to move on towards the use of verified supplier data. The example of moving from modelled to verified GHGE data, further illustrates the impact of the maturity, or stage, of SC GHGE management efforts, on the specific actions being taken.

The construction sector offers a good example here. Participants B08 and B09 operated under similar business models and context, based on high levels of outsourcing. B08 however was at the start of its GHGE measurement efforts, whilst B09 in contrast, had engaged earlier and had developed its own SC GHGE calculator for projects and was collecting some data from the SC on GHGEs:

> So, we know where the vans, the other thing that's linked in, is vehicle tracking, but the vehicle tracking tool that we use, which is an off the shelf tool called 'IsoTrack', that actually pumps out all the carbon data as well. (B09; 11.11.2011).

B08 was just starting to investigate the scale of its SC GHGEs and as such was still attempting to establish where its methodological boundaries were, a process noted as fraught with difficulty, as well as formulating plans and scoping areas of influence:

> For the last few weeks I've spent some time employing [international strategy consultancy] to spend some time with us, and we've also engaged with another couple of niche consultancies. Their advice in terms of developing the boundary for [redacted] [participants organisation], to be specific, is amazingly variable. There is no consistency to the advice that we're getting. (B08; 09.11.2011).

This example demonstrates that a focal organisation, at the start of its SC GHGE management engagement efforts, undertakes very different activities to an organisation that has been conducting these activities for some time. As such, the maturity of SC GHGE management efforts can be seen to be an indicator of the specific activities being undertaken; as such, it is identified as a variable.

5.7.2 Position in Supply Chain

The position of a focal organisation within the SC is also identified as a determining factor, seen to impact several features of SC GHGE management. This variable operates through reputational impacts and can affect the ease of management and measurement of the SC.

Although focal organisations by their definition tend to be situated at or near the end of the SC with a close proximity to consumers, they can have direct consumer contact, or be removed by a tier of the SC. Where focal organisations have a direct link with consumers, it is likely that these organisations will have more reputational vulnerability, such as the retail industry example, B11. Conversely, focal organisations who are one or two tiers further up the SC, such as the consumer goods industry examples, B03 and B04, can be thought to have lower reputational vulnerability. This is because many of their brands are not directly linked with their overall business:

> I think the ones that are closer to consumers are probably more interested. So the [redacted] and [redacted] [international retailers], the people can advertise the fact they are working with their supply chain, and engaged. They can advertise it publically. (B13; 02.12.2011).

Due to SC position impacting reputation vulnerability, it could be expected that focal organisations with a direct link to consumers would be more concerned with the measurement of GHGEs and attempts to convey their efforts to consumers. This was found to be the case with B11, who had trialled GHGE product labelling, versus B03 and B04 who had focussed to a greater extent of GHGE reduction efforts, which produced efficiency gains, and hence cost reductions.

SC position also impacts the ease with which a focal organisation is able to manage its SC, in terms of the number of SC tiers between the focal organisation and the extraction of the natural resources involved in the product or service. Although other factors, such as the specific product in question, as well as the business model utilised are also relevant, the further down a SC the focal organisation is will tend to increase the number of SC tiers they have to try and manage GHGEs within. It is assumed that as the number of tiers increases, so does the difficulty of managing GHGEs within them. This distance from upper areas of the supplier chain reduces the influence able to be exerted:

> I think, to a certain extent again, depending on where you are in the value chain probably influences what you do in this space as it can make things either easier or harder. (B03; 25.10.2011).

This point is illustrated in the quote above, by participant B03, who notes that the resources and efforts involved in managing change are affected by where in a SC a focal organisation is located. This variable has identified that SC position impacts on reputational vulnerability and ease of management of SC GHGEs, which in turn would impact on the activities undertaken. Focal organisations with direct links to consumers, and with a more vulnerable reputation, may focus more on those measures that provide reputational benefits, such as product labelling. Those organisations further down the SC will also find it harder to manage SC GHGEs in the upper reaches of the SC, and so may chose a strategy, such as the use of standards, that are able to pass responsibilities for supplier engagement and enforcement to other suppliers. This would, however, also reduce control.

5.7.3 Focal Organisation Size

The size of a focal organisation was identified through the coding process as linked to several factors that impacted SC GHGE management strategies, and as such was identified as a variable. These factors included its access to resources and expertise, and also, loosely, to the number of products and/or suppliers.

Having greater resources and access to expertise was highlighted as allowing these organisations greater ease in terms of management and measurement of SC GHGEs. These qualities would allow methodologies to be refined internally more easily, and also aid in the administration of SCM activities, including the collection and analysis of SC GHGE data. This was illustrated by participant B13, a consultant, who had worked with several organisations in relation to their SC GHGEs:

> I think with a lot of these organisations …. especially the large ones with a CSR team, whose job it is to find about these things. But the smaller organisations don't really have that benefit, and be that in the public or private sector. (B13; 02.12.2011).

With size however, may also come increased scope of operations in terms of the number of products and services being produced, as well as the length and geographical diversity of the SC. Longer, more geographically diverse SCs, supplying many products, presents an increased complexity that would likely lead to greater efforts to focus resources on the use of more general SCM activities, such as the use of

management standards, rather than collaboration or closer ties with suppliers, due to their numbers and location:

> Again these things become more or less significant depending where you sit in the value chain and the size of your business, be that the number of products you produce or the global nature of your business. If you're a single manufacturer in one country then it may not be such an issue for you. If you operate in over 100 countries and have the range of products we do, then that has a multiplication factor, on some of these aspects. (B03; 25.10.2011).

B03, a consumer goods focal organisation faced this problem. This focal organisation had many brands and global SCs, and as such was presented with difficulties associated with these characteristics. Although furnished with substantial resources for engagement in this area, the main impact was on the activities undertaken. Management standards and other tools were developed that reduced the need for supplier collaboration, as such collaboration would not be repeatable on the scales required. This variable demonstrates that the size and scope of a focal organisation can impact strategy in several ways, including the resources and expertise at its disposal, as well as the activities it is able to undertake, due to the likely long and complex SCs used to produce its products.

5.7.4 Type of Product/Business Model

The types of product or service produced, as well as the business models used to produce them, were also found to impact on the specific strategy and activities undertaken to manage SC GHGEs. Products and business models that led to a high degree of outsourcing would be likely to lead to greater efforts to manage SC GHGEs and would encounter difficulties similar to those complications associated with the production of a diverse product range, produced through global SCs, as described above.

That the SC is impacted by the business model is illustrated well by the construction industry example, B08. It was indicated that, as a business, they owned very little and leased and 'contracted in' most of the resources they required. This can be seen to shift GHGEs into the SC, out of operational areas, leading to less control and influence. It also leads to higher SC GHGEs, creating greater risk, and amplifies both drivers and barriers:

> We own nothing as a company. So we don't own any cars, vans, plant, computers, pencils, well we probably own some pencils – but nothing basically. So that then means, for example in my recent meeting with [redacted] ['Big Four' international professional services firm] when we looked at our van fleet, where we have about 1000 vans, I started off with treating that as our Scope One emissions and following a discussion with [redacted] ['Big Four' international professional services firm], is to put it into Scope Three emissions. (B08; 09.11.2011).

Where this occurs, it would be expected that these focal organisations, due to higher SC GHGEs, would be employing more resources towards their management and engaging to a greater extent with the SC. Within this example however, the maturity variable identified earlier is also active. So in the case of B08, where measurement of the GHGEs was in its infancy the focal organisation was struggling with how to measure SC GHGEs, i.e. this barrier was amplified, due to their business model.

The type of suppliers, impacted by the specific product being produced, is also an important consideration within this variable, as indicated by participant B07, the Dairy products producer. They noted that their farmers were a very different type of supplier, in terms of engagement and management, than their packaging suppliers. This was noted as impacting upon how they attempted to manage GHGEs:

> Then away from the farm, other suppliers, other Scope Three suppliers, people like packaging suppliers - we obviously work very closely with them, as we can track much more directly than a farmer, what their impact is and what the impact of any improvements a packaging supplier is bringing to us. (B07; 09.11.2011).

If a majority of suppliers within the SC are homogenous, this would ease management efforts, such as in the case of a dairy, however, if there is a high degree of diversity, then a wider range of engagement efforts would have to be employed.

A final element of this variable, illustrated again through the Dairy products focal organisation participant B07, concerns a reputational element to some aspects of products. Due to milk production involving cows, and animal welfare issues, participant B07 noted that SC GHGE management efforts were impacted, as additional factors had to be taken into account with the parts of the SC that involved animals. As animal welfare had to be taken into account, it was felt that options may be constrained and that extra care had to be taken:

> You can't hide cows, they are quite emotive – there have been various negative publicity around the environmental impact that dairy and meat eating have on climate change. It's just a much higher focus for us – so I think we do well, but these factors

> have encouraged us to take steps perhaps sooner than other sectors. (B07; 09.11.2011).

The type of business model used, and the type of products produced have been shown above to impact on how SC GHGE management is conducted. Business models can change the amount of overall GHGEs that are found in the SC, as opposed to internally, impacting their relative prominence and how easily they can be influenced. Further, different products use different inputs, and hence suppliers, which in turn can impact on how SC GHGEs can be managed.

5.7.5 Private versus Public Stance

As has been discussed throughout the results, a dichotomy between focal organisations in the public and private sectors can be considered to exist. The data collected appears to show major contextual differences between the two types of organisation, not necessarily unexpectedly, but which also impacts how these focal organisations approach and undertake SC GHGE management. These contextual differences can be seen as significant factors impacting on attempts to manage SC GHGEs. These include the drivers and barriers under which focal organisations are operating and the objectives and outcomes of their initiatives.

The public sector was reported to lack the competitive and reputational drivers seen most prominently in the private sector, as well as some stakeholder pressures. In the absence of these drivers, the public sector are reliant on policy or regulation to drive behaviour; however it was reported that little policy existed in the wider public sector context. Where policy or support did impact efforts, such as in the University participant data, actions were being undertaken and progress being made. The public sector was also held by a perception that it was bound by EU Procurement Directives, which whilst admittedly a barrier, was being overcome in some instances, indicating that the perception of this factor may be stronger than in reality; indeed, the Water Utility industry example, B06, was also highlighted as constrained by EU procurement rules, but had circumvented much of their negative effects.

Indeed, B16 does note that EU Procurement Directives do hinder such efforts, but indicates that if suppliers cannot be selected on their GHGE performance, that approaches can be made once the contract has been awarded:

> Now, one of the problems we face with Procurement Law, as a public sector organisation, is that you can only assess a supplier, so the supplier selections, evaluation, those sorts of things, are for things that are relevant to the subject matter of the contract. For example if we couldn't demonstrate or argue that something wasn't, say if we were purchasing something, and couldn't link carbon directly to the subject matter, then we couldn't put it into the contract, and would have to work with the supplier on a voluntary basis, post award. (B16; 19.12.2011).

The existence of stronger drivers in the private sector, and more easily surmountable barriers, means that the public or private stance of a focal organisation is a good indicator of the extent of SC GHGE engagement efforts:

> In the private sector there is much more stakeholder engagement and I think those are the big drivers in the private sector. I think that is why business tends to lead in this area. (B15; 07.12.2011).

Due to the public sector being less driven (apart from in specific contexts), facing more barriers and more constraining factors, it would be expected that this sector would be less active in its SC in relation to GHGEs; the data collected indicates this as being the case, especially in participants B12, B14, B17 and to an extent B20. As such, the private or public stance of a focal organisation is a good indicator of its level of engagement with SC GHGEs and forms a variable.

5.7.6 Locations of Greenhouse Gas Emissions

The location of GHGEs in the SCs of focal organisations also emerged through the data as an indicator of the actions being undertaken to manage SC GHGEs. As was shown through the 'supplier engagement factors' in section 5.6, focal organisations often focus their efforts towards those aspects of the SC where large GHGE instances were located, governing which suppliers are targeted by engagement and management efforts. For example, the Dairy products company participant, B07, noted that many of their SC GHGEs were within packaging, and as a result, much of their efforts were employed towards this aspect of the SC:

> But there's a significant focus on Scope Three for us, which is the packaging. So the embedded carbon the plastic milk bottles, the tetra pack containers, the cream pots. So businesses like ours have very much picked on the big stuff. But we don't necessarily focus on business travel or flights at present as that is the less than 1% stuff. But if we were in a different business sector, that could be different. (B07; 09.11.2011).

This variable is impacted by factors such as the type of product produced by a focal organisation, as well as the structure of its SC and its business model. The type and

characteristics of the suppliers where the GHGEs are located, will also impact on the strategies chosen; this may result in this variable alone being of little use. However, this variable would be of use in predicting action when resources are concentrated within a certain area of the SC. Where this is the case, activities to manage and reduce SC GHGEs can be expected to be seen, such as the efforts with regards to packaging noted by the Dairy product industry example.

5.7.7 Stakeholders

Stakeholders were also identified as impacting how focal organisations managed their SC GHGEs, and as such have been identified as a variable. Different industries and sectors can be seen to have stakeholders of relatively different importance, with different demands.

Where institutional investors and other shareholders are considered central stakeholders, such as in the construction industry, through participants B02, B08 and B09, focal organisations were identified as focussing on the reporting and disclosure of SC GHGEs. As a result, at least in the first instance, the Construction industry would then be expected to prioritise the reporting and disclosing of their SC GHGEs. This results in participants focusing on the measurement of SC GHGEs, rather than with supplier engagement and collaboration, in initial instances:

> If you're a construction firm, you don't really have as many stakeholders, as you aren't that close to the public; I guess your stakeholders are the …in the CDP the pressure all comes from the large investing groups, pension funds, and hedge funds and stuff like that, who say 'we won't buy your shares, unless you disclose your emissions'. So from that point of view, large private sector ones are under some pressure from those set of stakeholders. (B13; 02.12.2011).

As financial stakeholders have power, in the form of finance and are making specific demands, it can be expected that a company would start focussing resources towards the reporting and disclosure of GHGEs. Where stakeholders have less power, less of a reaction could be expected. Construction industry example B02 received this demand, and consequently, followed this path:

> Recently the pressure has been cranking up, from the investor community. For example we received a letter from an investor that in no uncertain terms stating that we will join the CDP. We hadn't done historically, because we didn't have very good data, but in 2011 we have and are now in the CDP FTSE 350 report for 2011. (B02; 24.11.2011).

The brand orientation or vulnerability of a firm also links to the role of stakeholders. Non-brand focal organisations, who do not have a significant proportion of their value incorporated within a brand, are likely to be less impacted by stakeholders such as consumers and pressure groups, and hence more likely to concentrate resources on SC GHGE reductions in the name of efficiency and increasing the financial resilience of their SC, rather than the reporting and disclosure of their SC GHGEs. The type and specific demands of the stakeholders is an important determinant in the specific actions and activities undertaken by the focal organisations, and so has been identified here as a variable.

5.7.8 Supply Chain Power and Relations

Although not mentioned specifically with regards to strategies by phase two participants, this factor was noted during phase one. As such, it was decided that it should be included as a variable, impacting on the approach undertaken by focal organisations.

Power relations within the SC moderate how a focal organisation approaches and engages with suppliers, and are directly comparable with the 'collaborate versus mandate' dichotomy identified in the phase one results (see section 4.3). Although participants within phase two noted SC areas where they had greater leverage, such as with their 'own brand' products, in the case of retail participant B11, power over suppliers was not mentioned specifically.

Participant B11, from the Retail industry example, noted a potential shift in buyer supplier relations. It was highlighted that work to aid their suppliers' engagement with GHGE management was a way of improving supplier ties and relationships:

> You can look at our ability to have stable supply bases, and the increasing instability in our supply base. In some product areas you can see a switch from where we as the retailer were able to choose which suppliers to work with, to a position where suppliers are now able to choose which retailer they would like to work with as there is a scarcity of supply. (B11; 18.11.2011).

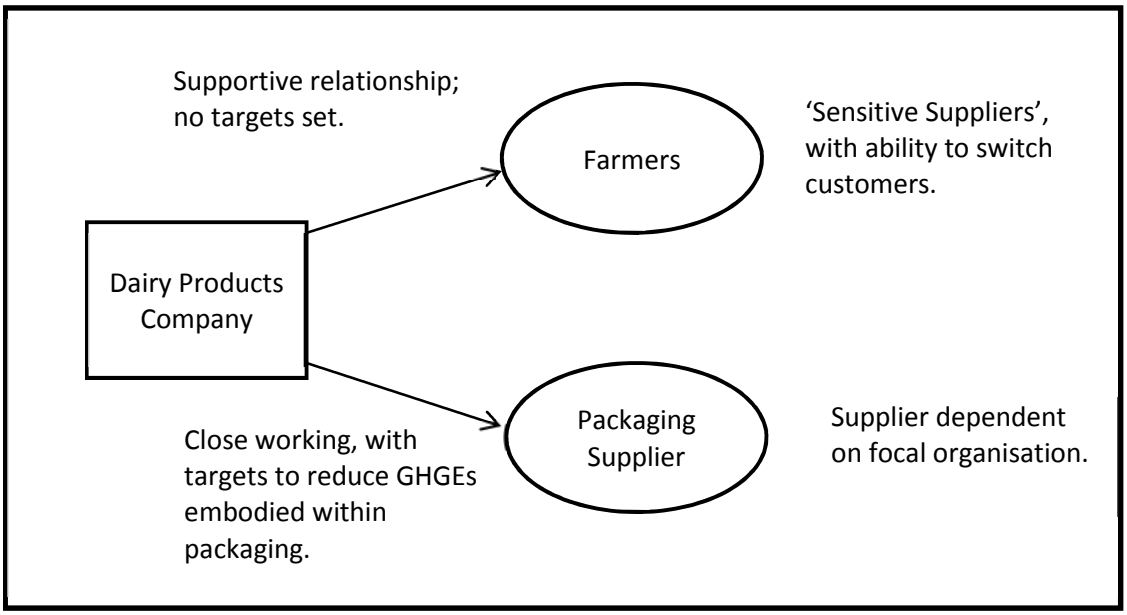
So in this regard, power was noted in relation to having a stable supply base and as a reason for supplier engagement. Other participants also noted the characteristics of suppliers, and how this impacted their decisions.

The Dairy products company, B07, noted a difference in how it engaged its suppliers depending on their characteristics; for example, farmers were highlighted as 'sensitive creatures' able to change dairies if they perceived overbearing demands. As a result, support was offered to them in the form of workshops designed to inform them of new and best practice, and whilst data was collected (for internal management purposes), this was not published or reported and no targets were imposed on the farmers. In contrast, B07 noted that with regards to their packaging suppliers, they felt more able to demand reductions (see Figure 5-2):

> So a big stick approach which may well work in a more traditional supply chain, doesn't particularly work with the British dairy farmer, which is why we've gone with the 'not setting the hard targets' approach, and doing these much more low key, educational types of engagement in a supporting way rather than in a more challenging way, which you could perhaps do with a different supplier. If you went to a logistics provider, then you just say 'we want better efficiency, more miles per gallon and we want to see that turned into a cheaper rate to deliver a pallet of butter, 100 miles, or whatever, but it's a very different, more supportive relationship and a lot more selling the benefits into them. (B07; 09.11.2011).

As demonstrated above, the levels of SC power and type of SC relations can impact how an organisation approaches and engages with the management of SC GHGEs. These differing factors impact supplier engagement tactics, the ease of measurement within the SC and ultimately how a focal organisation attempts to manage and reduce its SC GHGEs. For these reasons, SC relations and power were identified as a variable factor of SC GHGE management activities.

Figure 5-2: Dairy company supply chain dynamics schematic.



5.7.9 Identified Variables and Business and Climate Change Literature

The literature concerning private organisations engagement with climate change and wider environmental objectives, although lacking specificity, does note some significant or important factors that affect how such organisations engage with climate change objectives.

The emphasis on business context, perceived risks and opportunities, as well as the type of regulatory regime highlighted within the literature (Kolk and Pinkse 2007; Kolk and Pinkse 2005; Kolk and Levy 2004) is somewhat reflected in the categories of variables presented. 'Business context' is a broad term and concept, which can arguably be seen operating within all the variable categories identified above.

Similarly, 'perceived risks and opportunities', as well as 'regulatory regime' (Kolk and Pinkse 2007; Kolk and Pinkse 2005; Kolk and Levy 2004), are not reflected specifically in the factors presented in the results above; although it is highly likely that these factors would impact on the activities and approach chosen. The lack of a regulatory regime in relation to SC GHGEs means that this is currently not a moderating factor in the specific actions undertaken by focal organisations; that said the threat of future regulation was explicitly cited as a reason for pursuing a more general engagement with SC GHGE management. The existence of a state run regulatory regime in the future would likely lead to the inclusion of this variable at that time. That perceived risk and opportunities are also mentioned within the literature (Kolk and Pinkse 2007;

Kolk and Pinkse 2005; Kolk and Levy 2004), but not within the factors above, can also be explained with similar logic, in terms of this balancing of factors, leading to a driving or hindering effect, i.e. whether or not a firm would engage with SC GHGE management or not.

The importance of stakeholders is well established in both the business and climate change (Boiral, Henri and Talbot 2012; Nishitani and Kokubu 2011; Sprengel and Busch 2010; Sullivan 2010; Jeswani, Wehrmeyer and Mulugetta 2008; Kolk and Pinkse 2007) and more general ESCM literatures (Sharma and Henriques 2005; Buysse and Verbeke 2003; Jawahar and McLaughlin 2001; Mitchell, Agle and Wood 1997; Egri and Pinfield 1996), and was also identified within the results of this project as an important consideration in the management of SC GHGEs. The role of stakeholder management is identified in relation to the protection and enhancement of brand image and reputation (Sharma and Henriques 2005; Buysse and Verbeke 2003), but also in terms of the resources that stakeholders control, which are needed by focal organisations to make profits (Jawahar and McLaughlin 2001; Mitchell, Agle and Wood 1997).

Although this is not contradicted by the results of this research, participants from focal organisations specifically mentioned investors and shareholders as stakeholders in relation to SC GHGE reporting and disclosure. This is supported by work from Egri and Pinfield (1996) who found that the choice of environmental strategy undertaken by focal organisations had more to do with the needs of financial stakeholders. Stakeholders are subsequently identified as a mediating force in both the literature reviewed and the results of this research and form an area where the project has confirmed pre-existing knowledge within a new context, pointing to a potential role for stakeholder theory in future research in this area.

As the research methods used identified only those organisations that had engaged with SC GHGE management, means only those organisations that had weighted these factors and found in favour of SC GHGE management, were canvassed, rather than those focal organisations who decided not to pursue actions in relation to SC GHGEs. Ultimately, these factors seem more relevant to an overview analysis of the drivers and barriers faced by a focal organisation, rather than the specific actions undertaken.

The role of national or regional context is also noted within the literature (Jeswani, Wehrmeyer and Mulugetta 2008; Levy and Newell 2000), and no doubt stands true. Similar factors are also highlighted by Weinhofer and Hoffman (2010) and Dunn (2002). However, as this research was set within a UK context due to its design and focus, is unable to speculate as to the validity of Jeswani, Wehrmeyer and Mulugetta (2008) and Levy and Newell (2000) assertions regarding the moderating effects of national and regional focus.

Where this literature is able to apply to the results highlighted above, is in terms of the noted impact of historical environmental performance and time horizons (Weinhofer and Hoffman 2010). The authors assert that these factors can be used to partly explain current environmental performance by private organisations, and indeed, the 'maturity' variable proposed in the results would seem to be consistent with ideas that past environmental performance can be used as a guide to present efforts and activities.

As in some instances the corporate climate change literature is unable to offer much of a comparison to the result presented, an opportunity is presented for the project to add to knowledge in this area. Where relevant and comparable factors were found, in terms of historical performance and the impact of time horizons, the variables highlighted through the results were found to be consistent with the literature.

5.7.10 Summary of Identified Variables

The variables identified above shed further light on the reasons for specific SC GHGE management activities and strategies. Such knowledge and understanding will aid in discussing intervention options and implications, critical for the answering of elements of research question three.

5.8 Summary of Phase Two Results

The results of phase two of the data collection process have been presented above. They included the factors reported to be driving and hindering public and private focal organisations to engage with SC GHGE management; these supported initial assertions from phase one, that businesses within the private sector had more drivers and were less constrained than the public sector. Central to this was the existence of

competitive drivers, through strategic market positioning and reputation factors, present in the private, but not public, sector.

Additional benefits, such as improved SC relations, were also identified through the data. These benefits were seen as 'positive spill overs' of work in the SC to manage GHGEs. The identification of such benefits adds weight to arguments for the management of SC GHGEs.

The specific activities undertaken by focal organisations in order to manage SC GHGEs were also described. These activities were identified as occurring throughout the SC, from beyond the first tier of supplier, to areas downstream of the focal organisation. Activities that involved supplier engagement and action were most prominent, but given that SC GHGEs are largely upstream within the SC, this should be of no surprise. This section also identified a range of activities that focal organisations undertake within themselves, such as the estimation of SC GHGEs through the use of models, as well as design changes and efforts to integrate GHGE concerns into commercial SC arrangements.

Finally, the factors that focal organisations took into account when deciding which suppliers to focus upon and engage with were noted. These factors were reported by focal companies as being used to prioritise efforts within the SC. The identification of critical suppliers or those with which large sums were spent or where large instances of GHGE resided, were all factors considered in these decisions.

These results provide further information on the future potential of SC GHGE management as a method for contributing towards climate change mitigation goals, as well as in the consideration of policy. These factors effect and represent how focal organisations resources are employed within their SCs towards the goal of GHGE management, and so are important in considering the impacts of potential interventions. They also shed light on which aspects of the SC may require further government or public support and the requirements under which certain suppliers will be placed.

The results from phase two have also provided answers to research questions one and two. These questions concern why focal organisations engage with SC GHGEs and the

difficulties that they can face, the objectives pursued and the outcomes obtainable, as well as the activities undertaken towards these ends. Further, the factors taken into consideration when targeting resources within the SC have been identified. Question one had been partially answered by data provided in phase one; however, the added perspective form the second set of participants, from within focal organisations, increases the validity of the asserted answers. Research question three has not been considered within this section.

Chapter 6. Framework Development, Discussion and Research Outcomes

The previous chapters have provided answers to research questions one and two, concerning which organisations are leading SC GHGE management, why and how. This chapter will undertake two roles. Firstly, it will provide greater clarity with regards to the activities focal organisations are undertaking, by attempting to link these activities with specific outcomes and objectives of SC GHGE management. This will be achieved through the development of matrix; this will be referred to as the 'Focal Organisations Supply Chain emission Activity/Outcome' (FOSCAO) matrix.

Once this has been completed, the chapter will move on to consider the conditions under which SC GHGE management efforts could be enhanced, including through the use of interventions by government or other actors. Together, these actions are hoped to provide answers to both elements of research question three.

Both wider changes within organisational contexts, including regulation and policy emanating from government (which does not currently directly impact SCs), will be considered in answering this question. This is felt to be an important area within which to increase understanding, as SC GHGE management could be a fertile area within which to pursue climate change mitigation goals, as it is able to utilise the power of focal organisations, and takes into account the overall GHGE footprint of products and services.

In order to consider these impacts, an intervention theory will be developed; this will be referred to as the 'Emission Reduction INtervention Options' (ERINO) SC approach. Using inductive reasoning, the results obtained through research questions one and two, will be used to develop a framework of expected impacts and resulting actions of the interventions highlighted during phase one of the data collection and analysis phase.

In addition to the FOSCAO matrix and ERINO SC approach, an overview framework will be developed. This will synthesise the FOSCAO matrix and the ERINO SC approach, representing an integration of the results of the research, illustrating a conception of the current state of SC GHGE management efforts by focal organisations; this will be

referred to as the 'Supply Chain Emissions ManagEment' (SCHEME) framework. Once this has been achieved, the implications both practically and in terms of the literature, will be considered.

6.1 The Relationships between Supply Chain Management Activities and the Outcomes and Objectives of Greenhouse Gas Emissions Management

During consideration and analysis of the data, it was decided to attempt to plot the activities being undertaken by focal organisations to manage SC GHGEs (section 5.5), against the outcomes and objectives (section 5.4). By plotting these factors into a matrix, it was felt possible to identify the specific activities that had to be undertaken in order to achieve specific outcomes or objectives; in turn, by identifying these relationships, senior managers within focal organisations would be able to better manage their resources in the achievement of specific outcomes and goals. Conversely, by identifying these relationships, the additional outcomes possible whilst undertaking a specific activity would be able to be identified.

6.1.1 Development of FOSCAO Matrix

Following the use of inductive reasoning as a method for identifying generalised causation, several matrixes were produced comparing the activities and outcomes associated with focal organisational efforts to manage SC GHGEs (Johnson and Christensen 2010; Patton 2002). For such a matrix analysis, the two sets of factors are plotted against each other, in order to identify relationships. The use of such analysis techniques, as noted within the methods chapter (section 3.5.2), allows the data to be displayed in a way that facilitates new ways of assembling and considering contextually embedded data (Miles and Huberman 1994), or in this case, the relationship between activities and outcomes.

In total, four matrixes were produced, one for each SC area of action identified within the results, including activities beyond the first tier of the SC, within the first tier, within focal organisations and downstream in the SC (as described in results section 5.5). The specific activities within each of these areas of SC action were plotted vertically on the matrixes, whilst the outcomes were plotted on the horizontal axis. The outcomes included within the analysis contain the core outcomes or objectives of SC GHGEs, including reporting and disclosure efforts and the reduction of SC GHGEs.

Those outcomes identified as 'additional' (see section 5.4) were also included in the matrix, as well as the possibility of an improved reputation.

Whilst considering the relationships between the activities and outcomes, it was felt activities had different levels of impact upon the achievement of specific outcomes; some activities contributed towards the achievement of outcomes, but in isolation were not sufficient for their completion. For example, the use of 'management standards and verification activities' contributed towards 'GHGE reductions', by improving management techniques in the SC, but in isolation would not lead to GHGE reductions. In other instances, it was recognised that activities would only achieve an outcome, or contribute towards the achievement of one, through certain conditions. For example, 'direct supplier interventions', could directly achieve 'GHGE reductions', where they involved the provision of funds for capital works, but not where the interventions involved free supplier GHGE assessments. As such, four types of relationship between activities and outcomes were established, shown in Table 6-1. The four matrixes that relate to this analysis can be found in Appendix H.

Table 6-1: FOSCAO matrix relationship types.

Relationship Type	Description
Direct	Activity, in isolation, will fulfil or achieve the objective or outcome.
Contribute	Activity contributes towards an objective or outcome, but would be unable fulfil or achieve it when undertaken in isolation.
Conditional Direct/Contribution	Where activity can, if designed and applied appropriately, directly fulfil objective or contribute towards fulfilment of objective or outcome.
None	No relationship exists between activity and outcome or objective.

6.1.2 Activities for Fulfilment of Core Objectives and Outcomes: Reporting and Disclosure and Greenhouse Gas Emission Reductions

This section will outline the results of the FOSCAO matrix analysis for the two core objectives or outcomes of SC GHGEs management, those being the reporting and disclosure of SC GHGEs, and their reduction.

6.1.2.1 Activities for the Fulfilment of Reporting and Disclosure Objectives

The reporting and disclosure of SC GHGEs was identified as a central objective of SC GHGE engagement in both the literature review and through the results; it involved the calculation of SC GHGEs, either through the modelling of the SC and its GHGEs, or through suppliers assessing and submitting their GHGE data. Table 6-2 illustrates the activities identified as involved in reporting and disclosure. The matrixes illustrating the analysis can be found in Appendix H.

Activities that were induced to directly aid the fulfilment of reporting and disclosure efforts included the use of 'management standards' beyond their first tier of the SC; the use of such standards was felt to facilitate the measurement of GHGEs within this area of the SC, and hence achieve reporting by suppliers. In addition, activities within tier one that directly fulfilled this objective included 'information sharing and dissemination' and 'management standards and verification activities'. Information sharing and dissemination encompassed both formal and informal efforts, but included the use of supplier questionnaires that could be used to collect any information held by suppliers concerning their GHGEs. The use of management standards and verification activities, such as the use of CEMARS (see participant B06) aids facilitation in the same way as their use beyond tier one suppliers, as noted above. Finally, in-house activities that directly fulfil this objective included SC GHGE modelling and assessment. This reflected the method used by some focal organisations to estimate, with the use of such models, their SC GHGEs, and as such, the activity directly fulfils reporting and disclosure efforts.

Several activities were identified that could directly achieve reporting and disclosure efforts, depending upon their specific design and implementation. These activities encompassed the inclusion of GHGEs into tenders and contracts, where contracts included conditions that suppliers had to report their GHGEs to focal organisations.

This was deemed to realise reporting and disclosure efforts, as the provision of this information was made a condition of business for the supplier.

Table 6-2: FOSCAO matrix relationships for reporting and disclosure.

Relationship	SC Stage	Activities	Rationale/Examples
Direct	Beyond Tier One	Management Standards	Management standards, such as CEMARS (i.e. B06), provides a structured and sometimes certified management system for suppliers, that produces more reliable GHGE data for focal organisation, directly fulfilling reporting and disclosure efforts.
	Tier One	Information Sharing and Dissemination	Information sharing by suppliers provides focal organisations with the data required for reporting and disclosure.
		Management Standards and Verification Activity	See 'Beyond Tier One' 'Management Standards'.
	In-house	SC GHGE Modelling & Assessment	SC GHGEs calculated through the modelling of financial receipts directly provides focal organisations with data required for reporting and disclosure requirements.
	Downstream	n/a	n/a
Contribution	Beyond Tier One	n/a	n/a
	Tier One	n/a	n/a
	In-house	n/a	n/a

	Downstream	n/a	n/a
Conditional Direct	Beyond Tier One	n/a	n/a
	Tier One	GHGE inclusion in Tenders and Contracts	Where contract requirements include the need for information sharing in relation to suppliers GHGEs, this would directly fulfil reporting and disclosure needs.
		Collaboration and Partnering Agreements	Where collaboration and partnering include the need for information sharing, or facilitate it, in relation to suppliers GHGE levels, this would directly fulfil reporting and disclosure needs.
		Direct Supplier Interventions	Where interventions such as free supplier GHGE assessments would directly fulfil reporting and disclosure needs.
		Supplier Schools & Training	Where training or school included aspects in relation to supplier GHGE measuring and assessment.
	In-house	Internal Training and Information Provision	Provides direct fulfilment where information required for reporting and disclosure held by different departments, or where departments required training or information in relation to SC GHGE modelling efforts.
	Downstream	n/a	n/a
Conditional Contribution	Beyond Tier One	Conversation and Dialogue	Where focal organisation dialogue is aimed at encouraging reporting by suppliers. In isolation would not provide information, but would contribute in terms of motivation and 'issue raising' within the SC.
	Tier One	n/a	n/a

	In-house	Embedding of SC GHGEs into Commercial Teams	Would contribute where this 'mainstreaming' improved collection of data from SC, for examples by tasking procurement teams to collect GHGE data within standard commercial engagement.
	Downstream	Influencing Consumer Use of Products	Only in relation to product labelling efforts, which could involve collection of data from suppliers or the modelling of SC GHGEs in order to produce per product GHGE levels.
		Research on Consumer Use of Products	Where focal organisations included downstream GHGEs within its reporting boundary.

Similarly, collaboration and partnering agreements were also identified, as this activity made working relationships in the SC closer, aiding the provision of GHGE information to focal organisations. Direct supplier interventions, such as free GHGE assessments, were also included within this category, as where specific direct interventions were undertaken, GHGE data could be obtained. The setting up of supplier schools and other training schemes was identified as allowing GHGE data provision by the SC, where these schemes helped suppliers measure and report their GHGEs. Finally, internal training and information provision, if directed towards enhancing internal team member's ability to model SC GHGEs, was identified as providing information necessary for reporting and disclosure efforts.

Through the analysis, no activities were identified that contributed towards reporting and disclosure efforts. However, this is slightly misleading as a range of activities were identified that could contribute conditionally, i.e. that is, depending upon their specific design and implementation. These included conversation and dialogue beyond the first tier of the SC, as information on how to measure GHGEs could be passed to suppliers. The embedding of SC GHGEs management efforts into commercial teams within focal organisations was felt to allow GHGE data to be collected more easily, due to its integration into core commercial teams. Research on the use of products by consumers, in the downstream SC activity category, was also identified as conditionally contributing toward reporting and disclosure efforts, as it was felt this was able, in

certain circumstance, to provide GHGE data on this downstream area, sometimes included within focal organisations reporting activities.

In summary, the activities identified above either directly fulfilled SC GHGE reporting and disclosure efforts, or conditionally directly fulfilled or conditionally contributed towards its fulfilment.

6.1.2.2 Activities for the Fulfilment of Supply Chain Greenhouse Gas Emission Reductions

A range of activities were identified that enabled focal organisations to enact reductions in their SC GHGEs. These included activities that directly fulfilled this objective, or contributing in some circumstances, depending upon their specific conditions. Only one activity, design changes, was identified through this analysis as directly facilitating SC GHGE reductions, as illustrated in Table 6-3.

Table 6-3: FOSCAO matrix relationships for greenhouse gas emission reductions.

Relationship	SC Stage	Activities	Rationale/Examples
Direct	Beyond Tier One	n/a	n/a
	Tier One	n/a	n/a
	In-house	Design Changes	Direct reduction in SC GHGEs from changes to design of product or service, or to how the product or service is produced.
	Downstream	n/a	n/a
Contribution	Beyond Tier One	n/a	n/a
	Tier One	Management Standards and Verification	Would aid, but not directly fulfil reductions, by improving GHGE management processes within suppliers.

		Supplier Involvement in Design	Would aid, but not directly fulfil reductions, as supplier input into design process in isolation would not lead to reductions; design changes required.
	In-house	Embedding of SC GHGE into Commercial Teams	Eases efforts to engage with and influence suppliers, aiding other activities. In isolation only relationship impacted, rather than level of GHGEs.
	Downstream	Research on Consumer Use of Products	Where information on the use of product or service by consumers highlights changes that could reduce SC GHGEs. Provides information, rather than the changes required for GHGE reductions.
Conditional Direct	Beyond Tier One	n/a	n/a
	Tier One	GHGE Inclusion in Tenders and Contracts	Direct impact, where contracts stipulate reductions, rather than just a reporting requirement for example.
		Collaboration and Partnering Agreements	Direct impact dependent upon collaborations or agreements including specific requirement to reduce GHGEs.
		Direct Supplier Interventions	Where focal organisation intervention, for example through capital funding, leads to changes that reduce SC GHGEs.
		Supplier Schools and Training	Direct impact only where suppliers trained in GHGE reduction, rather than say reporting requirements.
	In-house	n/a	n/a
	Downstream	n/a	n/a

Conditional Contribution	Beyond Tier One	Conversation and Dialogue	Contribute where conversation and dialogue leads to motivation of suppliers to reduce GHGEs.
		Management Standards	Where management system improvements are used to aid GHGE reductions.
	Tier One	Information Sharing and Dissemination	Where information provided by suppliers is used to aid in design changes or other activities that reduce SC GHGEs.
	In-house	SC GHGE Modelling and Assessment	Where modelling used to identify hotspots and enable focusing of resources for SC GHGE reductions.
		Internal Training and Information Provision	Where information shared internally aids in efforts to reduce SC GHGEs, for example between design teams and SC managers.
	Downstream	Research on Consumers Use of Products	Where information on consumer use of products highlights changes that could reduce SC GHGEs, aiding reduction efforts.

This may be due to the narrow definition of the activity, however it should be noted that 'design changes' were felt to include changes in the design of production processes and systems (i.e. the SC), rather than purely changes to the design of the product or service. Several activities that could directly facilitate SC GHGE reductions, depending upon their design and application were also identified, such as including GHGEs into the tendering process and into contracts, collaboration and partnering agreement and supplier schools and training, all occurring within the first tier of the SC. Where GHGEs are included into the tendering process, or in to contracts, the potential exists for conditions to be established that require the suppliers in question to reduce their GHGEs. With regards to collaboration and partnering, this aids in passing on capabilities to suppliers, allowing them to reduce their GHGEs; these closer working relationships may be established in order for SC GHGE reductions to be

enacted. Supplier schools and training can also equip suppliers with the necessary capabilities to achieve GHGE reductions, similarly to collaboration and partnering agreements.

Several activities were also identified that were seen to contribute towards reduction efforts, including the use of management standards and verification activities and the involvement of suppliers in design efforts, both occurring within the first tier of the SC. Although management standards alone are unable to result in GHGE reductions, their use aids in their measurement, which in turn is likely to aid their management, and hence reduction. By involving suppliers in the design of a product or service, it was felt that additional perspectives and specialised knowledge of upstream production techniques could be provided; which could aid changes that reduced SC GHGEs. In-house activities that contributed towards SC GHGE reductions included the embedding of SC GHGEs into commercial team functions; this, it was felt, would allow those teams dealing with the SC regularly, concerning commercial aspects, to also take responsibility for GHGEs, making it a core concern of the supply relationship.

Those activities that were identified that could conditionally contribute included conversation and dialogue and management standards beyond the first tier, as they would improve communication and management efforts, within suppliers, respectively. In tier one, information sharing and dissemination would fulfil similar contributions to conversation and dialogue, such as through the provision of advice for GHGE reductions. In-house efforts could also conditionally contribute towards SC GHGE reductions, such as SC GHGE modelling and assessment, where this was used to identify GHGE hotspots in the SC. Finally, downstream research on the use of consumer products would potentially be able to highlight ways in which products were used, allowing design changes, which could design-out unnecessary elements, and reduce GHGEs within the SC.

6.1.2.3 Summary and Knowledge Gained from FOSCAO Matrix Analysis

The analysis concerning reporting and disclosure efforts, demonstrate that such efforts rely upon the sharing and provision of information concerning SC GHGEs. The activities identified through the FOSCAO matrix analysis, such as the use of management standards and verification activities, establish methods for GHGE data collection, whilst

other activities, such as including reporting requirements in supplier contracts, demonstrate the importance of motivating the SC to provide this data. This analysis has highlighted the activities required to report and disclose SC GHGEs, offering a guide and road map to focal organisations wishing to engage with this area of environmental management.

The analysis concerning the activities required for SC GHGE reductions establishes that the central way to obtained SC GHGE reductions is through changes to the design of products or changes to the design of the production process and SC. However, it also demonstrates that a range of activities, if applied correctly, can also fulfil GHGE reductions, including motivating suppliers and guiding their actions, such as stipulating supplier GHGE reduction targets (through contracts) and providing help through information provision and dissemination or through supplier training. The activities identified here as able to motivate changes within suppliers also reflect the mandatory and collaboratory dichotomy recognised previously within the results, such as the use of contract conditions, or through involving suppliers in the design process, or through collaboration and partnering arrangements.

By establishing the relationship between specific activities and outcomes, where a focal organisation is undertaking activities that contributed towards a core goal, which other additional outcomes these activities could contribute towards, is also shown. This would allow a focal organisation to achieve additional objectives within the existing activities, without the use of additional resources. For example, direct supplier interventions, such as the provision of finance for supplier capital works that reduce SC GHGEs, would also improve supplier financial resilience where efficiency was increased, as well as potentially aiding supplier relations. Consequently, where a focal organisation decided to reduce SC GHGEs through such methods, with the matrixes, senior managers would be able to identify possible supplementary outcomes and work towards these in addition to their core outcomes. These additional objectives could increase the pay back from SC GHGE management efforts, increasing the benefits to focal organisations, and increase the likelihood they are undertaken.

In summary, this section has described a matrix analysis that plotted SC activities against outcomes and objectives of SC GHGE engagement efforts, enabling causal

relationships to be identified between the two. This provides a tool for managers or other stakeholders wishing to engage with and further the management of SC GHGEs by focal organisations.

6.2 The Enhancement of Supply Chain Greenhouse Gas Emission Management: The Development of Intervention Options and ERINO Supply Chain Approach

In terms of answering research question three (b), it is important to understand both how changes within wider organisational contexts could spur greater efforts for SC GHGE management, as well as the regulations and options open to government and how these would operate. Although it is clear that policy and regulation from government can have a profound effect on the wider context within which organisations operate, other factors, not emanating from government, can also have an effect; it is these factors that will be considered first, using the knowledge gained through the answering of research questions one and two.

6.2.1 Contextual Changes Leading to Increased Levels of Supply Chain Greenhouse Gas Emission Management

The results indicate that a range of changes to the overall context within which SC GHGE management occurs could cause it to be taken up to a greater degree. For instance, many of the driving factors identified within the results, if amplified, would lead to greater engagement with SC GHGE management. An increase in stakeholder demands, especially amongst institutional and individual shareholders, would no doubt push more private focal firms to engage, and to engage to a deeper level. Further indications of resources scarcity, especially concerning fossil fuels, may also lead these organisations to conclude that increasing efficiency within their SCs through efforts to reduce GHGEs, would be beneficial. These actions would be taken to increase the resilience of their SCs to fuel or price shocks. Although these wider 'environmental' factors are significant to focal organisations, this analysis is more concerned with active interventions.

6.2.2 Regulatory and Policy Options: Typology of Phase One Policy Options

Phase one participants outlined several possible policy and regulatory options for furthering SC GHGE management aims. These included:

- No expansion of policy or regulation, with a continued reliance on the market to provide wider driving forces.
- The provision of expert support and advice required by both public and private focal organisations, by government and other non-governmental actors, including development of methodologies etc.
- Indirect complimentary policies, such as decarbonising of power systems.
- Increased mandatory use of management standards and product labelling, in the public and/or private sectors, to drive demand for a reduction in SC GHGEs.
- Mandatory SC GHGE reporting for private and/or public focal organisations.
- Connection of tax liabilities to SC GHGEs, or their inclusion in cap and trade scheme.
- The creation of a SC GHGE credit scheme, where work with suppliers to reduce their GHGEs would provide credits that could be used against current tax liabilities or brought into existing GHGE trading schemes, i.e. the EU-ETS.

An initial aspect of the development of the ERINO SC approach is to place the options above into the typology of regulation outlined in section 4.4.2.2: (1) command and control, (2) economic, (3) information, (4) informal/self-regulation and (5) support and capacity building. The categorisations of these options are shown in Table 6-4.

Table 6-4: Categorisation of reported regulatory options for supply chain greenhouse gas emission management.

Regulation Type	Identified Intervention Options
Command & Control	Nil – not suitable
Economic	SC GHGE Taxation Scheme
	SC GHGE Trading Scheme
	SC GHGE Credit Scheme
Information	Management Standards
	Product Labelling Schemes
	Mandatory SC GHGE Reporting
Informal/Private/Self-regulation	No Expansion of Current Policy
Supporting Mechanisms and Capacity Building	Expert Support and Advice
	Indirect Complimentary Policies

6.2.3 Key Considerations for ERINO Supply Chain Approach Development

Having categorised the intervention options, it is necessary to return to some of the conditions that the phase one participants set regarding what they felt effective policy should include. These included clarity, specificity and certainty, all necessary to enable investment decisions. Policy complementarity was also advocated, in terms of the ability of several policies to work and pull in the same direction. It was also reported that such policies would have to protect the UKs international competitiveness, in order to ensure that the necessary political and business support was garnered. Responsive regulation was also advanced as a facet of desirable policy; following Foley (2004), such a stance should start with 'lighter' efforts, concerning capacity building and support, and information based policies. Where these proved ineffective, policy should, correspondingly, be increased in terms of its power to effect focal organisation action, until a desired state or level of action or engagement is reached.

The characteristics of SCs are also important, as although the different intervention options presented above are aimed at focal organisations, their purpose is to impact SCs. SCs complexity, opacity and heterogeneous nature further complicates the assessment of policy and regulatory options and the development of an intervention theory. It is also critical to consider the motivations and incentives of the actors being impacted, in this case, focal organisations. That data was collected from focal organisations from both the public and private sectors created further difficulties, as they operated within different contexts, and as shown in the results, were motivated and constrained by differing factors. The data collected through phase two of the project will allow these factors to be explored through the policy and regulatory options outlined above in Table 6-4.

The analysis of the driving and hindering factors were used as a guide to assess how the different intervention options might impact and influence focal organisations. Those factors identified as driving factors can be targeted and influenced by interventions to drive focal organisations efforts; conversely, regulation is also able to operate by reducing the effects of barriers on focal organisations. Through the analysis of the barriers it was demonstrated that such factors could be split depending upon their internal or external operation. Regulation and other government action was noted as required for the reduction of external barriers, as the focal organisations

were felt to have little or no control over these factors. Regulation however is also able to impact on the internal barriers through the provision of advice, tools or support, which can affect the competencies and awareness of focal organisations.

By taking these factors into account, it is possible to operationalise the interventions, using induction, and provide an answer to research question three (b). As previously discussed in section 3.5.2.2, an intervention theory is a specification of the actions required to achieve a specific outcome, in this case, the enhancement of SC GHGE management efforts, including the impacts these actions or interventions can be expected to have on a focal organisation (Chen 1990). The actors, specifics of the individual interventions, as well as the outcomes are seen as general constituents of an intervention theory (Mickwitz 2003), and in order to introduce more specific criteria relevant to climate change objectives, the policy conditions of the IPCC (2007a) will also be considered, including environmental effectiveness, cost effectiveness, distributional impacts and institutional feasibility.

The interventions will be operationalised and explored using the data obtained through the results, inductive reasoning and an assumption that agents act in their best interests, i.e. to achieve optimal outcomes in any given situation, and is linked to neo-classical theories of economics (North 1993). This process will use this method of reasoning to explore and predict how focal organisations would react to the various interventions that will be presented below. Private sector focal organisations will be assumed to be attempting to maximise profits, whilst those in the public sector will be assumed to be attempting to ensure that the services they deliver are not adversely affected.

6.3 Interaction of Interventions with Results Data – Policy Operationalisation

This section will develop and outline the ERINO SC approach for SC GHGE management, using induction. This will allow the data and analysis to be used to develop predicted responses and actions by focal organisations in response to the interventions outlined above, in Table 6-4 (page 214).

6.3.1 Command and Control Policies

Due to the complex, opaque and heterogeneous nature of SCs, and as indicated by the phase one participants, command and control policies were highlighted as inappropriate for the regulation of SCs. Such policies, which prescribe specific actions in order to achieve outcomes, would be unable to operate successfully through such characteristics. As a consequence, such policies would lead to suboptimal outcomes, or would be unworkable from an administrative or practical perspective. As such, they will not be considered or explored further.

6.3.2 Economic Policies

Economic regulations operate by moderating the costs or financial benefits incurred or available to focal organisations. This category includes, as indicated by Table 6-4, taxes, cap and trade/permit schemes and SC credit schemes. These intervention options would be administered by government towards focal organisations.

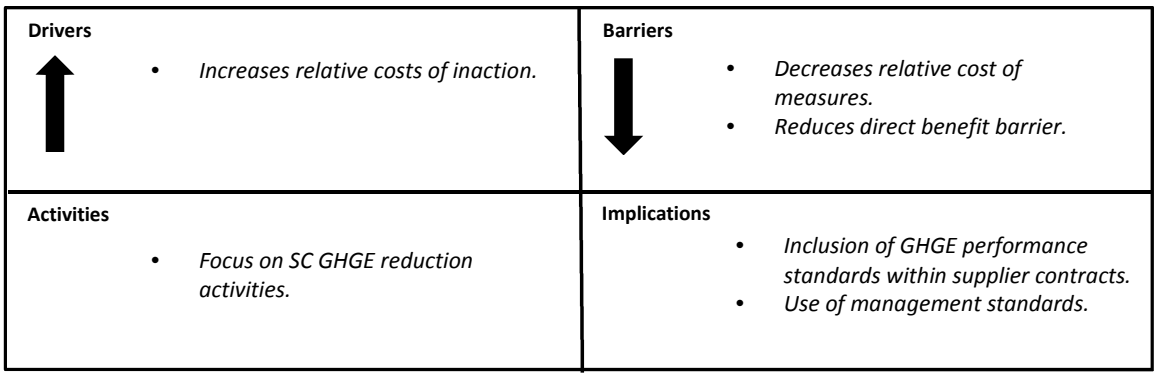
6.3.2.1 Taxation and Cap and Trade Interventions

Taxation schemes would link a tax liability to the SC GHGEs associated with a focal organisation. A cap and trade or permit scheme, would require focal organisations to be allocated, or purchase, GHGE permits which could be traded depending upon the overall SC GHGEs associated with a focal organisation. Both these interventions would levy a cost on GHGEs, creating a more direct relationship between financial liabilities and SC GHGE levels; this in turn would stimulate cost drivers. As higher SC GHGEs would result in higher levels of tax, or a requirement for higher numbers of GHGE permits, at a cost, the costs of inaction to reduce GHGEs, would increase. This would also impact several barriers, by decreasing the relative cost of mitigation measures, due to the increased cost of GHGEs and could reduce difficulties in obtaining a direct benefit from efforts to reduce GHGEs within suppliers, as actions to reduce SC GHGEs would result in a financial benefit, through a lower tax liability or a reduced need for GHGE permits.

The impact of tax or cap and trade measures would be similar on both public and private sector organisations, motivating the provision of resources to initiatives designed to manage SC GHGEs. In terms of the impact of such interventions on the specific actions undertaken by focal organisations, taxation and cap and trade

interventions would place a direct emphasis on the reduction of SC GHGEs, as benefits or penalties would be based on GHGE levels.

Figure 6-1: Operation of tax/cap and trade interventions.



The imposition of tax liabilities or cap and trade schemes would reward focal organisations that took action internally or in their SCs to reduce their SC GHGEs, for example through design changes; as such they would allow greater flexibility, but be less focused. More generally, these policies are likely to increase incidents of GHGEs being included into contracts and partnering agreements with suppliers, as focal organisations try to gain control over these new direct liabilities, as well as increasing the need for greater GHGE information sharing within the SC (and internally), in order to enhance management efforts. The use of management standards within SCs and suppliers, as a method of increasing the quality of GHGE management in the SC, could also be expected.

These policies would however also require the accurate and reliable measurement of GHGEs in the SC, a noted difficulty and barrier. Current efforts associated with organisations such as the CDP have low verification rates, as noted by participant A04, a senior account manager from a solution-based NGO. These verification rates would have to be increased if linked to a financial liability. Figure 6-1 provides a visual representation of how tax and cap and trade schemes would operate.

In terms of the environmental, cost, distributional and intuitional effects of these interventions, several assertions can be made. As these interventions impact the costs associated with GHGEs, as long as the finance implications were large enough, action would be undertaken, reducing GHGEs in SCs, and hence the amount entering the atmosphere. Consequently, this approach could prove environmentally effective;

recent research has however shown that within a cap and trade scheme, where permits are allocated, rather than auctioned, that innovation and organisational economic performance can be detrimentally effected (Kroes, Subramanian and Subramanyam 2012). With regards to costs, the administration of a tax, or cap and trade scheme would be a substantial administrative undertaking, with implications for the verification of GHGEs, as noted above. However, this administrative burden can be considered to be somewhat offset, through the increased certainty of these economic policies to result in action by focal organisations. That a price is attached to GHGEs however, would allow flexibility and freedom to focal organisations with regards to how GHGEs were reduced, allowing least cost solutions to be identified; in these terms, these economic interventions could be considered to be cost effective.

Distributional implications are harder to identify however, and would depend on the specific SCs in question, as the cheapest abatement options could be in the SC or internally within focal organisations; as such, it is difficult to comment further on the distributional consequences of this approach, apart from noting that this intervention would be likely to impact both the public and private sectors equally. Finally, with regard to institutional feasibility, although these interventions would require substantial administrative support, similar approaches exist with regards to direct GHGEs, in terms of the EU-ETS in Europe, or the CRC Energy Efficiency scheme in the UK. As institution's with similar roles already exist, they could feasibility take on these additional responsibilities.

6.3.2.2 Supply Chain Credit Scheme

A SC credit scheme, as the most novel of the economic measures, would operate as an 'add on' to other economic measures focussed at direct or SC GHGEs, such as a tax, or current trading scheme, such as the EU-ETS. The SC credit scheme would allow focal organisations who conducted work within a supplier to reduce GHGEs to gain credits, which could then be used to offset linked tax liabilities, or as additional credits within existing cap and trade schemes concerned with direct GHGEs. This approach would be advantageous where government wished focal organisations to exert their influence, power and expertise to the benefit of less able SC members, such as SME suppliers; this could be motivated through the use of specific policy conditions. Such an approach does however raise the possibility of impacts on the selection of suppliers within the

tendering process, and hence potentially impact negatively on the working of supply markets. For instance, suppliers with the most GHGE reduction potential, or those with the most cost effective reductions, may be selected for the benefits accruable through the credit scheme, rather than those who had already reduced their GHGEs.

As with tax and cap and trade approaches, a SC credit scheme would alter the costs and benefits of acting or not to reduce and manage SC GHGEs. It would operate as a driver by increasing the relative cost of inaction, due to eliminating the opportunity to obtain the credits and their associated benefits, and reduce barriers by decreasing the relative cost of interventions within suppliers, relative to other actions within an organisation. Specifically, this intervention also directly tackles the direct benefit barriers, by providing a benefit specifically for work with suppliers. Without such an intervention, activities by focal organisations only provided indirect benefits, such as increased SC resilience, and were a noted barrier in the results. Figure 6-2 illustrates how the SC credit scheme would operate.

This intervention would be likely to increase supplier engagement efforts and trigger efforts by focal organisations to measure supplier GHGE performance in order to identify cost effective abatement actions within the SC. Finally, as the intervention rewards actions within suppliers that reduce their GHGEs, it would be expected that the number of instances of focal organisations enacting changes for suppliers would increase.

In terms of environmental effectiveness, this approach would specifically target GHGEs within suppliers, rather than actions that could be taken within focal organisations to reduce SC GHGEs; this narrows the scope of GHGEs available to be impacted by the

Figure 6-2: Operation of supply chain credit intervention.

Drivers ↑ • *Increases relative costs of inaction.*	**Barriers** ↓ • *Decreases relative cost of measures.* • *Reduces direct benefit barrier.*
Activities • *Focus on SC GHGE reduction activities within suppliers.* • *Increased supplier engagement.*	**Implications** • *Greater demands placed upon suppliers.* • *Increases supplier focal organisation relationship requirements.*

intervention. However, this intervention would be most suited for use in conjunction with other approaches, and as such, its individual environmental effectiveness is of reduced concern. In terms of the cost effectiveness of this intervention, the most significant factor would be the administration and verification of the actions undertaken within suppliers, and their impact (i.e. whether they successfully reduced supplier GHGEs). A robust verification and auditing process would be required, but the cost of this could be limited through the use of management standards and clear calculation methodologies.

With regards to the distributional impacts of this intervention, firstly, such an approach would be expected to impact both the public and private sectors equally; however focal organisations subject to EU procurement directives may experience greater initial difficulties in identifying appropriate actions. Further, is the likelihood that it would lead to greater demands on suppliers through pressure from focal organisations for GHGE reductions, as it is these reductions within suppliers that would provide credits. It is likely that GHGE performance standards would be introduced into supplier contracts, and that focal organisations would attempt to motivate suppliers to reduce GHGEs independently, with minimal focal organisational involvement; this could place over burdensome demands onto some suppliers. However, if seen within a context where suppliers, and especially SME suppliers, were lagging behind efforts to reduce GHGEs, this may not be a detrimental effect, as it is these suppliers who require support, which can be facilitated by the focal organisation, rather than other third sector or government schemes. An element of the verification process should seek to ensure that focal organisations are only receiving credits where work and support had been provided to suppliers, as a method for reducing the above noted problem.

Finally, and with regards to institutional feasibility, although requiring more of a stretch than the tax/cap and trade approach, providing credits for supplier support and GHGE reductions would be consistent with current institutional arrangements. Specifically, as this intervention is designed to be used in conjunction with other GHGE reduction policies, the institutions used in their administration, could also be used to administer the SC credit scheme.

6.3.2.3 Summary of Economic Interventions

Economic based policies, through either tax, cap and trade or a SC credit scheme, would be able to motivate and affect both the public and private sectors, and could be attached to existing schemes, meaning a mere expansion, rather than invention of whole new areas of regulation. Further, they would focus action on the reduction of GHGEs, and in the case of the SC credit scheme, on work to enhance the GHGE management capabilities of suppliers. Finally, although with the possible exception of the SC credit scheme, these policies allow focal organisations to identify the most inefficient aspects of their SC in terms of GHGEs, and in turn the greatest GHGE reductions, at the lowest cost.

6.3.3 Information Policies

Interventions such as the imposition of product carbon-labels, EMS and mandatory or forced reporting (Mackenzie 2010), operate by providing stakeholders, including investors and customers, with information. The provision of this information improves decision making within organisations and is able to provide external stakeholders with the information they need to influence and pressure organisations (Hamilton 1995). Such policies operate through reputational drivers, as the provided information is aimed at improving the decision making of stakeholders also, such as investors or consumers. In turn, where this information is unfavourable, a focal organisations reputation, and hence sales could be negatively impacted.

Three specific types of information based intervention will now be explored, including the use of product labels, EMS and mandatory reporting.

6.3.3.1 Carbon Labels

The use of product eco-labels has been met with confusion and little enthusiasm by consumers (a survey by Boots Plc., in 2008, found that only 28% of customers knew that carbon labels related to climate change, and 44% confused carbon labels with fair trade) although they have proved successful within other contexts, including the nutritional content of food (McKinnon 2009; Deans 2008). Such an approach is designed to alter consumer demand, and hence alter the competitive dimensions through which firms compete. In order to reduce the environmental impact of these products, firms would have to alter their SCs, leading to efforts to manage and reduce

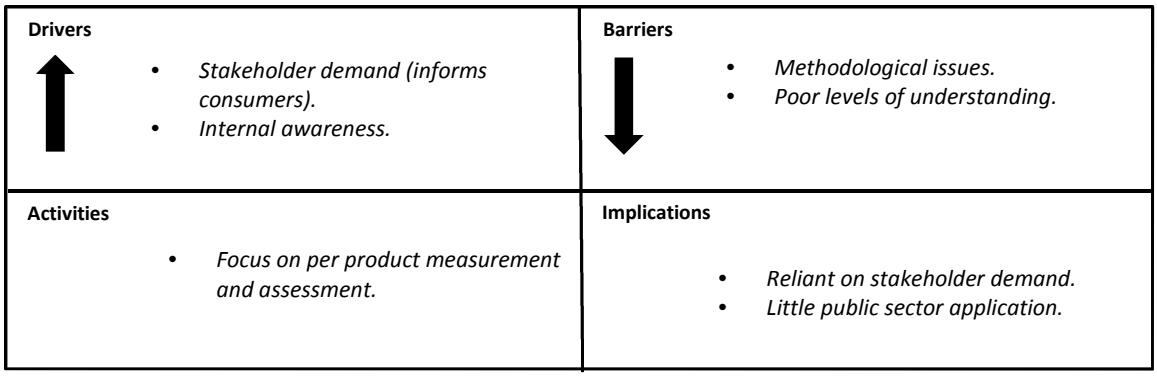
SC GHGEs, if applied to GHGE product labelling. The operation of this intervention is illustrated in Figure 6-3.

This type of intervention is designed to increase consumer demand for low GHGE products, although this does rely on latent demand for such products, which may not be widespread within markets. This intervention is also designed to drive focal organisations internally, by increasing levels of awareness. This occurs as in order to provide a product label, the GHGEs of products have to be calculated, which can highlight inefficiencies within the production process, stimulating alterations by focal organisations and by reducing barriers, including poor levels of understanding, as well as methodological difficulties. Such an intervention would require a methodology applied across all products, allowing comparability, which would have to be provided by government or trade and professional bodies for specific sectors and industries.

Such an approach would be likely to increase measurement efforts by focal organisations, so that they are able to provide the necessary information. Such efforts would provide the potential for inefficiencies to be exposed within the production process. This approach in turn may increase levels of supplier engagement, as focal organisations seek to identify the levels of GHGEs associated with their products and services.

In terms of environmental effectiveness, this approach relies on demand by consumers, which is not guaranteed, as previous research has indicated that price is consistently the most important consideration in terms of purchasing decisions (Mainieri et al. 1997). However, if used in conjunction with economic interventions that increased the price of products, based on their GHGE content, this issue could be

Figure 6-3: Operation of carbon product-label intervention.

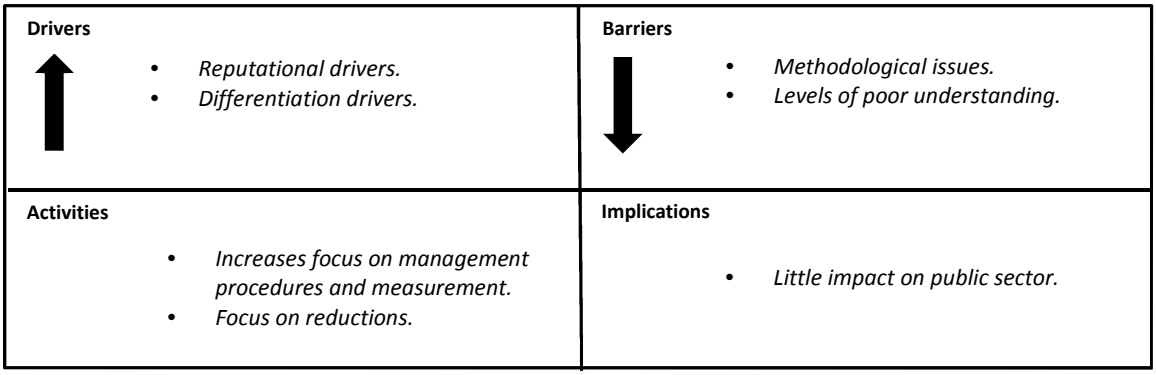


reduced. In terms of cost effectiveness, ensuring that product labels were accurate could involve high levels of administration, and hence cost, although this is unlikely to be above those associated with the other policies and interventions advanced within this section. Distributional effects also raise concerns, as public sector organisations would be unlikely to be able to be included within such as scheme, as the products and services they offer are typically not subject to competition, and as such, could not respond to consumer demands or other stakeholder pressures. However, the identification of product or service GHGE levels would still present the opportunity for public sector focal organisations to identify inefficiencies. The existence of energy performance labels, such as the EU Energy Label scheme, provides institutions through which to administer such policies.

6.3.3.2 Mandatory Supply Chain Greenhouse Gas Emission Reporting

Mandatory reporting, consulted on by Defra in 2011, would impel organisations to report and disclose their SC GHGEs. It would operate along similar dimensions to product labels, although on an organisational, rather than product based scale, as illustrated in Figure 6-4. Such a scheme could also rank companies within a league table, via stock market indexes or via industries or sectors. Such a scheme would again operate through reputational drivers, as firms sought to outperform and differentiate themselves in relation to their competitors based on their SC GHGE performance. Specifically, such a scheme would operate by enhancing reputational and differentiation drivers, as focal organisations sough to outperform their competitors. Mandatory reporting would also reduce barriers associated with methodological issues and levels of understanding, as involvement within such a scheme would require a standard methodology provided by government or third sector actors, and in turn, provide information to focal organisations on the levels of GHGEs embodied within their production systems, allowing inefficiencies to be recognised. Such an approach would encourage firms to reduce GHGEs, as well as increasing efforts to accurately measure SC GHGEs.

Figure 6-4: Operation of mandatory supply chain greenhouse gas emissions reporting intervention.



Environmentally, such an approach relies on focal organisations wishing to be seen to be 'good' and effective with regards to GHGEs and the competition this creates between rivals. Within certain industries, if all actors decided not to compete on such terms, then the effectiveness of this intervention at reducing GHGEs would be limited. This approach does however allow focal organisations to identify and initiate the least cost solutions for the reduction of SC GHGEs, and in terms of administration, could be included within existing plans by the UK government to require certain organisations to report their internal GHGEs (Defra 2011). In terms of its distribution impacts, as the intervention relies on enhancing competitive and differentiation drivers, it would fail to impact public sector focal organisations, due to the lack of these drivers being reported by the participants. Institutionally, as indicated above, such as scheme could be administered as an extension of existing plans by Defra.

6.3.3.3 Environmental Management Systems

The imposition of the use of EMS forms a different type of information based policy, operating primarily through internal information provision; such policies, if mandated by government, can be seen as information based, but where not mandated through regulation, are highlighted as 'professionally regulated self-regulation' by some scholars (Taylor et al. 2012). The results and outputs of such a scheme could be used to provide public reports, or for inclusion in schemes such as those described above; as such, this policy would be highly complementary to economic regulations or used as aspects of other information based interventions, such as mandatory reporting or product labels. The primary impact of such a requirement would be to aid in methodological issues, by specifying how GHGEs in the SC should be measured and managed, and so would impact barriers experienced by focal organisations in relation

to methodological confusion and poor understanding, an impact also true of product labelling and mandatory reporting. As such, this type of intervention assumes a latent level of driving factors, and operates primarily through the reduction of barriers. The operation of this intervention is illustrated in Figure 6-5.

Figure 6-5: Operation of mandatory Environmental Management System intervention.

Drivers ✖ • *No impact on drivers.*	**Barriers** ↓ • *Methodological issues.* • *Levels of poor understanding.*
Activities • *Increases focus on management procedures and measurement.*	**Implications** • *Reliance on existence of drivers within wider organisational environment.*

In terms of their environmental effectiveness, an EMS would aid in the identification of inefficiencies, producing incremental innovation, but would be unlikely to stimulate further radical innovative changes within production systems; this is due to the lack of strong drivers, and the propensity for organisations enacting EMS to focus on current production techniques, rather than the design and implementation of new ones (Könnölä and Unruh 2007). Such an approach relies on wider drivers, already noted as not present within all examples, to drive action. In terms of cost, the imposition of such systems would represent a cost to focal organisation, but as an intervention by government, would involve lower administrative costs than associated with other interventions, such as those with an economic focus. In terms of distributional impacts, such a scheme should impact the public and private sectors equally. Finally, EMS and management standards exist currently, such as through the Carbon Trust, British Standards Institute (BSI) and WRI, and if such an intervention were enacted, similar actors involved in their voluntary use could be used by government, reducing institutional requirements.

6.3.3.4 Summary of Information Based Interventions

The information based interventions outlined above rely on the provision of information, either to stakeholders, or to the focal organisations themselves. Each intervention targets and acts through different drivers and barriers, and as such, encourages different actions by the focal organisations. As information based

interventions, their levels of environmental effectiveness are moderate as they rely on motivations less explicit than those linked to the economic interventions that impose financial benefits or penalties for actions.

With regards to the impact of these policies on the activities undertaken by private sector focal organisations, several assertions can be made. It is likely that such policies, initially at least, would focus efforts on the measurement and quantification of SC GHGEs, as these are the requirements of the policy. However, it is unlikely that all aspects of the SC would be able to report and provide the necessary information, so it can be assumed that such an approach would lead to increases in supplier engagement in terms of free supplier GHGE assessments or equivalent actions. That SC GHGEs are being measured does provide the possibility that SC inefficiencies are recognised and acted upon.

Product labels also provide an avenue through which to influence downstream activities, something which other policy options fail to achieve. The primary benefits of these policies are that they would operate through reputation and differentiating drivers and so would prove especially effective for private sector brand firms who hold value within their reputation. Conversely, those organisations lacking reputational and differentiating drivers, such as public sector focal organisations, would be left unmotivated.

6.3.4 Informal/private/self-regulation: Continuation of Current Context

This category of regulation involves a reduced role for the state and includes a wide range of possibilities. Such policies rely on focal organisations being receptive to the factors or forces used to instigate participation in these schemes, such as stakeholder pressures or fears that their reputation or competitiveness relative to other organisations would be impinged. A further driver within this area could be that of ‘responsive’ regulation, where the state threatens regulation unless actors regulate themselves to an acceptable level; the existence of this ‘threat’ was reported by participants during the data collection process (for example by participant B08).

The option highlighted by the phase one data relevant to this category is the continued reliance on drivers that exist within the wider business environment. This conception also links to ideas concerned with ‘tripartism’ (Ayres and Braithwaite 1992) or the

pluralism of regulation (Gunningham and Grabosky 1998), and a reduced role for the state, where other actors fill the void. These ideas highlight the role played by the CDP and other non-governmental organisations, such as the WRI/WBCSD, who have provided spaces for both public and private focal organisations to disclose their SC GHGEs and who provide methodological tools and guidance. The CDP in particular has used investor pressure to encourage participation by private focal organisations; in return, the focal organisations that respond are able to satisfy a stakeholder demand. The role of other actors besides the state and focal organisations highlights further results gained through the first phase of the research concerning the current and potential roles of third sector actors, as shown in Table 4-4.

Informal, private or self-regulatory methods hold the advantages that they require little use of government or state resources, and so from these perspectives are attractive to government. However, they have low predictability and low control, as the factors governing enforcement of such schemes are beyond the control of the government, including stakeholder and other societal pressures. They do however provide more freedom to business and would also be able to overcome difficulties involved with the international nature of current business, as these governance mechanisms are not nationally based, and would hold organisations to account for their entire operations. As previously noted, the responsibilities of organisations are seen to expand beyond their boundaries, and this includes those areas of the SC that fall outside of specific nations' boundaries (Kovács 2008).

Figure 6-6: Operation of informal/private/self-regulatory interventions.

Drivers  • *Stakeholder pressures (esp. investors).* • *Reputation.* • *Differentiation.*	**Barriers**  • *No impact.*
Activities • *See results.*	**Implications** • *Uneven levels of engagement.* • *Reliance on stakeholders and 3rd sector actions.* • *Low predictability and control.*

The specific drivers, through which this type of intervention operates, include stakeholder pressures, reputation and differentiation, as shown in Figure 6-6. There is no specific impact on barriers. Environmentally, this approach provides little certainty

and would result in outcomes reported as occurring currently, such as sporadic and uneven levels of engagement with SC GHGE management. In terms of costs, these interventions are cheap; however when considered in terms of the outcomes obtained, may not represent a cost-effective solution. Distributional impacts are hard to predict, due to the uneven nature of engagement under this regime; in addition, due to the drivers reported as existing currently, public sector focal organisations are left largely unmotivated. Institutionally, such an approach relies heavily on non-governmental actors within the third sector, who, due to their non-governmental nature, are not under the direct control of the state. Overall, such an approach, although requiring little government action, is highly unpredictable in terms of its impact on SC GHGE levels.

6.3.5 Supporting Mechanisms and Capacity Building

The final category of policy or regulation concerns those efforts to provide support and enhance capacity (Gouldson et al. 2008). The provision of expert support and advice, in terms of methodologies, calculation tools, the demonstration of best practice and general organisational strategies, as highlighted by the phase one data, can be included within this category. The roles highlighted as being able to be played by the third sector can also be noted here, including education and training, research and knowledge generation, highlighting best practice and facilitating collaboration. The impact of such efforts would fall on the barriers being experienced by focal organisations in both the public and private sectors, including methodological difficulties, standardisation issues and the development of tools. Although these issues were also reported as impacting private sector organisations, they operated to a greater extent within the public sector.

Figure 6-7: Operation of supporting mechanisms and capacity building interventions.

Drivers ✖ • *No impact.*	**Barriers** ↓ • *Methodological understanding.* • *Poor understanding (incl.* • *EU Procurement in public sector).*
Activities • *Enhancement of measurement and reduction activities.*	**Implications** • *Focus on barriers, leaving drivers untouched.* • Greater impact on public sector.

A further option or area for action, identified in the initial phase of the research, was the development and establishment of low GHGE energy and transport networks. With regards to low GHGE energy, the government can be considered a key actor within the UK context. Although energy providers are private companies, the state still plays an important role in signalling to this market, and any efforts to further reduce the GHGEs associated with it, would aid and help work towards objectives consistent with SC GHGE management efforts. Transport network efforts differ slightly, and would be more reliant on demand from the private sector, however the EU have instigated GHGE targets for transport (European Commission 2011), which are consistent with efforts to reduce GHGEs embodied within SCs. The dynamics of these types of interventions are illustrated in Figure 6-7.

In terms of provisions specifically aimed at public sector focal organisations, specific barriers such as perceptions around the constraining impact of EU Procurement Directives on procurement activities, as well as the role of procurement consortia, could be clarified through efforts that would exist within this category. The introduction of SC GHGE management aims into procurement consortia would enable their purchasing power (the reason they were established) to be used toward such ends. As a policy area, the provision of support and the development of capacity allow the state and non-state actors to influence the barriers faced by focal organisations.

6.3.6 Interaction of Policy Options with Activity Variables

This section will investigate the interaction of the intervention options identified above with the activity variables outline in section 5.7. This analysis will allow a deeper understanding of the working of the intervention options identified, in terms of how they would operate and impact on focal organisations.

6.3.6.1 Maturity

This variable described the degree to which focal organisation strategies, in relation to SC GHGEs, were 'mature', or rather, to what extent they had been employed and how long they had been in operation. A mature strategy would have proceeded through engagement and measuring phases, towards the management and reduction of GHGEs within the SC and suppliers. Less mature SC GHGE management efforts would likely be attempting to identify hotspots through supplier reporting and disclosure efforts, or through SC modelling exercises.

Economic policies, such as SC GHGE taxes or cap and trade schemes, would likely favour those focal organisations that had moved early and were already adept at managing their SC GHGEs. Such organisations would likely have found GHGE efficiencies through their efforts, and as a result would have less of an exposure to the policy. If the economic regulation were based on a permit scheme that allocated permits over a period, and rewarded those firms that were able to reduce SC GHGEs over that period, then early movers would be at a disadvantage due to their previous efforts to identify and exploit 'low hanging fruit'. Consequently, any policy or regulation devised along these lines should aim to incorporate these considerations and avoid punishing those organisations that moved early and developed mature SC GHGE management efforts. Where focal organisations had less mature SC GHGE efforts, economic policies would prove effective at motivating change, as inaction and poor SC GHGE management performance would result in higher financial penalties to the detriment of economic performance.

Information based regulation would likely have little impact on focal organisations with mature SC GHGE management, who would be likely to be already measuring their SC GHGEs. Information based policies, such as mandatory reporting or eco-labels would be most effective on those organisations with less mature efforts; specifically those who had achieved little in terms of measuring their SC GHGEs and conducted low levels of supplier engagement.

Informal/private/self-regulatory mechanisms, although not instigated by the state, would again have most impact on those organisations with less mature SC GHGE strategies; however, it is also likely that it would be these focal organisations that were less likely to take part in such schemes due to their relative competitive disadvantage, from their less mature strategy stance. Conversely, those organisations with mature efforts would be more likely to take part in self or private-regulation, as their compliance costs would be lower, and may provide further validity and justification to their efforts.

Efforts to enhance capacity and provide support would likely only impact focal organisations whose efforts were less mature, where such policies would reduce the barriers they faced in terms of enacting strategies aimed at managing SC GHGEs. More

mature efforts would likely have overcome the barriers that these policies affect, such as methodological difficulties and lack of knowledge.

6.3.6.2 Position within the Supply Chain

The position of a focal organisation within the SC, in terms of whether they had direct contact with consumers versus retailers, would impact on the ability of policy and regulation to achieve its goals. Central to this point is whether the focal organisation has direct contact with consumers or sells its product or service to retailers. In terms of the impact of economic instruments, as well as some information based policies, such as mandatory reporting, concerns exist of the possibility of double counting and to what extent focal organisations further up the SC than retailers can be held accountable for their GHGEs.

Without considering the above noted point, the SC position of a focal organisation would not impact on how economic regulations or policies affected it. However, information based policies could; for instance, mandatory reporting requirements, rather than eco-labels or the imposition of EMS, would potentially impact firms with a direct relationship to consumers, due to the greater reputational effects. SC GHGEs, however, have gained little traction with consumers, and other stakeholders can be considered to be more important, such as investors and shareholders, whose views are less impacted by SC position. Ultimately, the impact of information based policies would be more dependent on the level of brand value and associated risk, a variable to be considered later within this analysis.

In terms of SC position and the impact of self-regulation style policies, or those aimed at providing support and increasing capacity, little difference in terms of impact is apparent.

6.3.6.3 Focal Organisation Size

Large focal organisations can be characterised as having larger and possibly more diverse SCs. This variable would change how policy impacted specific focal organisations regarding whether any threshold was established in terms of organisation size and their qualification or not, for regulation, specifically in terms of regulations of an economic or information based category. In terms of the impacts on private/self-regulation, size, if related to market power within a specific sector, would

allow a focal organisation to lead and control such regulation. Further, if focal organisation size equates with higher levels of SC control (which is questionable), then such firms would be more able to control and address SC GHGE regulatory objectives through their SC. A large size would also carry disadvantages, in terms of the number of products produced and the potential level of SC complexity, increasing the difficulty of managing and controlling the SC and the GHGEs embodied within it.

6.3.6.4 Type of Product/Business Model

Both economic and information based policies raise the possibility of creating unintended consequences worth mentioning within this variable. The construction sector example demonstrated a highly outsourced SC, increasing the proportion of GHGEs embodied within the SC. Economic or information based policies could encourage less outsourcing and increase vertical integration, allowing focal organisations to reduce their SC GHGEs by transferring them across the boundary of the organisation.

Business models that led to high brand value and visibility would have implications in terms of their interaction with some of the policy options identified above. Although there are few effects in terms of its interaction with economic policies, informational based instruments operating through reputational and differentiation based drivers, would have effects. Focal organisations with high brand visibility and value would be likely to be impacted to a greater extent by such policies, than those with low brand visibility or value. This is due to the reduced risk that poor performance under such regulation would face, where brand visibility and value is low.

6.3.6.5 Private versus Public Stance

Economic policies would impact both public and private focal organisations equally, due to their operating through economic drivers; however this parity would not be reflected in terms of the effectiveness of information based policies. Such policies operated through reputational drivers (although also in terms of improving decision making and awareness). That public sector focal organisations lack these drivers renders such an approach ineffectual, unless linked in some way to an economic aspect.

6.3.6.6 Location of Supply Chain Greenhouse Gas Emissions

For both economic and information based schemes, this variable could lead to similar unintended consequences as outlined above in relation to the impact of specific product types or business models; that such policies, could under certain circumstances, lead to focal organisations internalising some operations in order to move GHGEs from the SC to within the boundaries of the organisation. This would have the result of reducing SC GHGEs (whilst increasing internal GHGEs) and increasing the control they are able to exert over them.

6.3.6.7 Stakeholders

The use of economic instruments would interact little with stakeholders such as consumers, as these policies operate through economic drivers, internal to focal organisations. However, where investors or shareholders are prominent stakeholders, the imposition of such regulations could cause these actors to demand actions that reduced focal organisational liability, due to these stakeholders having a financial interest. In terms of information based instruments, stakeholders take on a central role, as these policies aim to provide information to stakeholders, both internally and externally. As these instruments operate primarily through reputational drivers, the provision of information to third sector campaign organisations, consumers and investors, could lead to these stakeholders changing their behaviour and placing new demands onto focal organisations. The imposition of these instruments would increase risks associated with greater stakeholder power.

Stakeholders would also play a central role in the establishment and administration of self-regulatory regimes in a similar way as explained above. The demands raised by stakeholders would often be needed for self-regulation to be established, as it is the fulfilment of these demands that provides some of the benefit of self-regulation, including demands on government for action, under a responsive regulatory scheme.

6.3.6.8 Supply Chain Power and Relations

Economic instruments could impact on SC power and relations, especially in the case of a permit scheme, were focal organisations obtained credit for working with suppliers. Such schemes would encourage focal organisations to engage and work directly with suppliers for credits, possibly enhancing SC relations, due to closer working. But they could also impact on the power dynamic between the focal

organisation and the supplier in question. How this relationship would change is hard to predict, as suppliers could become more powerful as their cooperation is required for access to the policy's reward. However, where suppliers are plentiful and competing for business, when one supplier is uncooperative, then another would step in. Such a scheme may increase focal organisation power through the promise of support to suppliers, as an added reward, which could be used to coerce suppliers into action they would otherwise not have taken; indeed, this line of reasoning indicates that focal organisation may become more mandatory in their supplier relations (and indeed, supplier selection activities) as they seek the direct financial gains that can accrue from actions to reduce GHGEs within suppliers.

In terms of the impact of this variable on information based policies, again, the picture is mixed. Focal organisations would be in a position where they would require suppliers to provide and disclose GHGE performance data; however it would be the specific tactics used to fulfil this aim that would be most likely to impact on SC power and relations dynamic. Such policies though would expose the focal organisation to greater scrutiny in terms of its SC practices, and as such may increase the relative power of the suppliers.

6.3.7 Interventions Impacts Summary

The policy options outlined above range from economic based approaches, which aim to change the costs and benefits of actions, to those aimed at providing support and information. As noted, interventions can operate by aiming to increase the impact of existing driving factors or by reducing and eliminating barriers. As was highlighted within the results chapters, the factors acting as barriers were found to be able to be categorised according to the internal or external operation. In order for policy to be most effective, it should target those barriers that are beyond the control of focal organisations, such as efforts to reduce the GHGE intensity of the electricity generation system, or methodological issues.

It should also be noted that some of the interventions advanced above fail to motivate both the public and private sectors, resulting in an uneven distribution of effects, reducing environmental effectiveness. For example, those interventions that operate through reputational drivers are unlikely to motivate public sector focal organisations,

who have little to benefit from a good reputation, i.e. they are not profit driven and will not lose sales if their reputation is negatively affected. As such, certain policy options that only operate on private sector focal organisations, if enacted, would have to be supplemented by additional measures within the public sector. It was shown through the results that the public sector had much potential in terms of its ability to manage SC GHGEs, due to the scale and size of its procurement practises, and due to its centralised nature. As such, efforts should be made to ensure public sector focal organisations are pressurised to engage with and manage their SC GHGEs. One method could be to utilise procurement consortia, created to increase the purchasing power of smaller public sector organisations. If harnessed, procurement consortia could be used effectively to advance SC GHGE management efforts.

The reported regulatory options, as outlined in Table 6-4, form a narrower range of climate change interventions as noted from searches within the academic and grey literatures, in section 1.6. Subsidies are not included, however, their application to SCs would require focussing on specific SCs or sectors, and as such is not felt relevant to the exploration and operationalisation of interventions here. The use of voluntary agreements is also omitted; this is due to their often unique and bespoke nature, for example within specific industries or individual organisations.

Additional strategies that were not identified by the respondents also include 'energy audits' (although these can be seen to enact the same influences and impacts as EMS and product label interventions), and the impacts of indirect interventions such as building codes, R&D, technical support and 'portfolio standards'. As such, the range of interventions noted by the phase one participants was felt appropriate with regards to those interventions available for the advancement of SC GHGE management by focal organisations, and although not covering all available interventions, did include those most applicable to SC GHGE management by focal organisations.

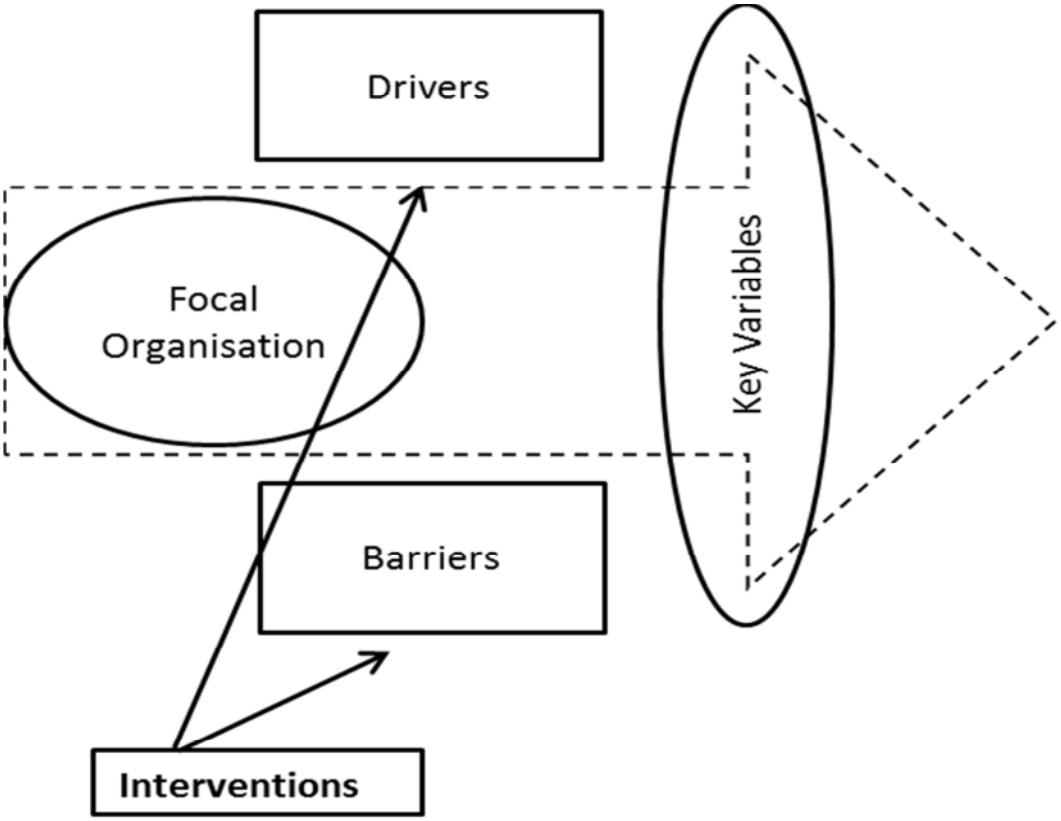
Not discussed above through the policy and intervention options, although an important point, is the scale upon which policy or regulation could be deployed. As noted, SCs are complex and differ widely between different types of focal organisations. Although some policy options would be appropriate to expand across numerous sectors, such as a tax liability linked to SC GHGEs, some may be better suited

if taken on by specific sectors. An example of this was found within the data, within the higher education industry example. HEFCE, the industry regulator, had mandated that higher education institutions measure elements of their Scope Three GHGEs, such as water, but not those associated with procurement, but had provided a methodology and support tailored to these specific SCs (HEFCE 2013). The same is true of the Utility example provided by participant B06; as a water utility, the industry is regulated through Ofwat (The Water Services Regulation Authority) and since 2007, Ofwat has required firms to collect and publish information on their operational GHGEs. As part of a 2009 review, information on embedded GHGEs was also collected (i.e. those originating in the SC); guidance and methodologies were provided as part of this exercise (Ofwat 2010). This model of sector or industry specific regulation may be an advantageous route for advancing SC GHGE management, as it could be tailored to contextual specifics.

6.4 Summary of Intervention Operationalisation

The analysis and thoughts presented above investigate how the policy options identified by the phase one participants may operate if they were enacted. This operationalisation was attempted using factors and variables identified through phase two. This exercise demonstrates that many factors need to be considered in designing and enacting interventions aimed at enhancing SC GHGE management, including motivating factors and their effect on specific organisational contexts, such as an organisations public or private stance. These options can be considered an answer to research question three (b), which sought to identify and examine the options available to government and other actors to enhance and increase the management of SC GHGEs. Figure 6-8 provides a simple illustration of how interventions aimed at focal organisation operate, including their impact on drivers, barriers and key variables.

Figure 6-8: Schematic outlining operation of intervention theory.



6.5 SCHEME Framework

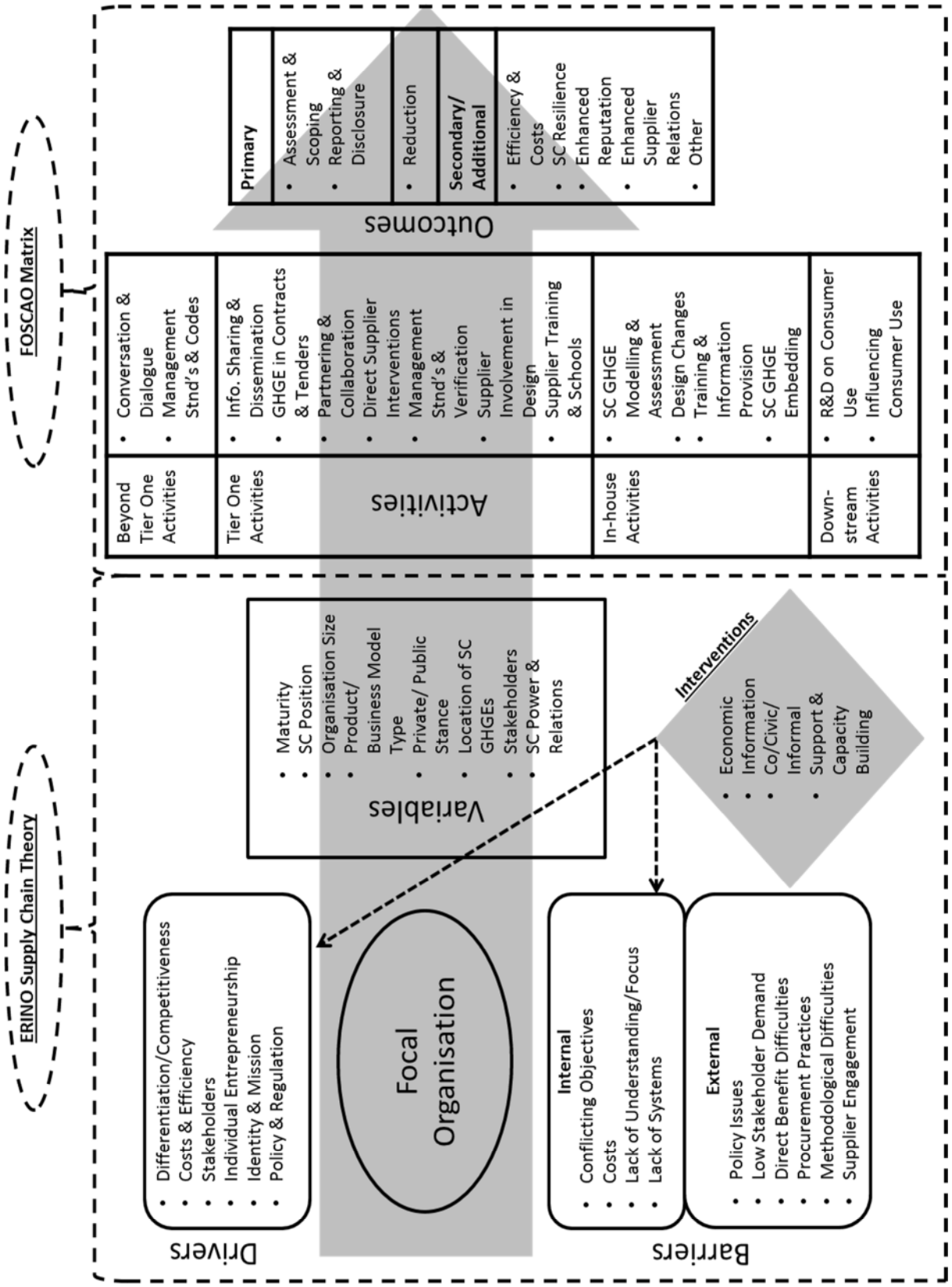
In the previous section, an ERINO SC approach and FOSCAO matrix were developed outlining the relationship between SC GHGE management activities and outcomes, as well as a range of interventions designed to enhance and increase SC GHGE management efforts. These two aspects, representing key findings of the research, can be displayed together to create an overview framework, which will be labelled the 'Supply CHain Emission ManagEment' (SCHEME) Framework. This is represented through Figure 6-9.

This figure demonstrates that focal organisations experience a range of barriers and drivers, which are leading to different levels of engagement with SC GHGE management, depending upon the specific contexts experienced by focal organisations. Variables moderate SC GHGE management activities, where the balance

of drivers and barriers results in actions. This first half of the schematic represents those factors taken into account when devising the ERINO SC approach.

The ranges of activities reported as being undertaken by focal organisations are also illustrated, noting where in the SC they take place. In turn, the objectives and outcomes of SC GHGE management efforts are noted; this second aspect of the schematic, as highlighted, forms those aspects taken into consideration when devising the FOSCAO matrix.

Figure 6-9: SCHEME Framework.



6.6 Discussion of Key Findings and Frameworks

The development of the individual FOSCAO matrix and ERINO SC approach, as well as the SCHEME framework, requires consideration in relation to the ideas, theories and existing knowledge upon which this research was built. In addition to this, the following section will seek to explore in more depth why focal organisations are engaging with SC GHGE management.

6.6.1 Supply Chain Greenhouse Gas Emission Management and Environmental Supply Chain Management

This area of knowledge and practice was highlighted as relevant to the study of SC GHGE management due its focus upon the management and mitigation of environmental impacts in SCs. The impact of the findings of this research will be discussed in terms of how they relate to existing theory and knowledge within ESCM literature.

6.6.1.1 Environmental and Sustainable Supply Chain Management Frameworks

The overarching SCHEME framework illustrated in Figure 6-9, as well as its constituents parts, those being the ERINO SC approach and the FOSCAO matrix, can be compared and contrasted with frameworks of E/SSCM outlined within section 2.5.1 of the literature review; namely, those developed by Carter and Rogers (2008) and Seuring and Müller (2008).

Both frameworks highlighted in the literature review dealt with wider sustainability rather than more specific environmental concerns, creating a first divergence in comparison to the SCHEME framework developed through this research. Both frameworks were also developed through literature reviews and conceptual theory building. This is in contrast to the frameworks and theories built here, which have utilised specific empirical data, rather than data and thinking which is embodied within a wider body of knowledge. The framework development by Seuring and Müller (2008) in particular could be easily applied to the data and framework developed in this research and as such, the rest of this analysis and discussion will be focused accordingly. This is due to Carter and Rogers (2008) framework being concerned more explicitly with sustainability criteria and as such, operates on a higher and less comparable level to the theories and frameworks developed through this research.

Although concerned primarily with triggers of SSCM, leading to the identification of wider stakeholders, customers and government (consistent with the results of this research), Seuring and Müller (2008) also note divergent strategies as a result of these pressures; those being supplier evaluation for risk and performance and SCM for 'sustainable' products. Although not split in this way in the SCHEME framework developed above, these strategies are embodied within the activities identified through section 5.5 and through the FOSCAO matrix. For instance, the use of management standards and verification activities can be seen to be consistent with those strategies aimed at managing suppliers noted by Seuring and Müller (2008), versus design changes reported within this research and those aimed at 'sustainable products' by Seuring and Müller (2008). The multi-tier nature of SCM towards sustainable or environmental aims can also be seen to be an area where both frameworks compare favourably, in terms of the identification of activities occurring beyond the first tier of the SC, as noted within this research.

The SCHEME framework developed through this research was constructed using a more 'bottom-up' approach, using data from a more focused empirical enquiry, versus data from a conceptual literature review. The difference in method provides an opportunity for a type of triangulation, in that the similarities found demonstrate a consistency and possibly more accurate conception of the factors and phenomena relevant to E/SSCM. In this way, the SCHEME framework developed here can be seen to be an effort to advance and compliment previous efforts at conceptual framework building by Seuring and Müller (2008). However, the SCHEME framework developed within this research also draws upon data and results concerning the variables that impact SC GHGE management efforts as well as the barriers and challenges faced by focal organisations. In this way, the SCHEME framework developed here provides a wider and more categorical conception of an ESCM topic.

A further advantage of the SCHEME framework developed through this research is the identification of a range of policy options. The inclusion of these options, in addition to the driving factors representing the existence of more organic drivers within the wider organisational environment, demonstrates the levers available to government or other external actors wishing to enhance levels of SC GHGE management. It can also be asserted that the SCHEME framework could be applied towards additional

environmental issues within the SC that embodied similar characteristics and criteria to GHGE management, highlighting key intervention strategies employable to impact and moderate SCM actions by focal organisations.

6.6.1.2 Supply Chains as Sources of Competitive Advantage

Through the literature review, it was noted that within the SCM literature, ideas concerning the role of the SC in competition had evolved, resulting in many scholars asserting that in order for businesses to be successful and gain competitive advantage that they could no longer compete as individual entities. It was advanced that businesses needed to look beyond their own boundaries to find sources of competitive advantage (Walton, Handfield and Melnyk 1998); for this to occur, organisations needed to gain sufficient control and influence, and attempt to manage the SC (Lummus and Vokurka 1999; Ellram and Cooper 1993). A collaborative paradigm was noted, involving joint working and collaboration with the SC for success, rather than more mandatory approaches to SCM (Ketchen and Hult 2007). Ultimately, this led to conceptions of SC versus SC competition, as the way by which businesses competed (Cox 1999). The results obtained here have implications for this shift in thinking.

The results indicated that SC GHGE management was identified as a source of competitive advantage for focal organisations in the private sector. That the participants believed that engagement with this area of environmental management could provide competitive advantage, and that successful SC GHGE management involves closer management and relations with the SC, has several implications. It provides an indication that SC GHGE management could conform to the collaborative competitive paradigm. Although focal organisations used both more mandatory, competition based strategies versus more collaborative efforts to control and manage suppliers, both can be considered consistent with the idea that the SC was being managed as an extension of the focal organisation, for competitive advantage. Although more competition based approaches, such as selecting suppliers based on environmental performance, or integrating GHGE performance standards into contracts are not by their nature collaborative, they serve the same purpose; that being, ensuring that control is obtained over the SC, so that actions and impacts occurring within this part of the production process contribute to, rather than detract

from, competitiveness. In this way, the results of this thesis conform to and agree with theories concerning SC versus SC competition, as well as the collaborative paradigm.

6.6.1.3 Supplier Management and Supply Chain Competition

The collaborative paradigm of competition is also evident in the supplier management literature, where the majority of previous research has focused on the manufacturing sector and in particular the automotive industry (Stuart 1993). Here, the results obtained with regards to supplier engagement factors and supplier management techniques, as outlined in aspects of the activities categories, such as supplier audits and the inclusion of GHGEs into tendering and contracts provide this literature with a broader application of this existing knowledge in to other sectors beyond manufacturing (including services and the public sector).

Here, the results obtained through the project again confirm existing knowledge, but in new contexts with regards to a specific area of environmental management, SC GHGE management. Previously identified factors include price and quality (Swift 1995), but also historical levels of business with a supplier, levels of communication and the state of the relationship as well as the suppliers attitude (Dickson 1966). These correspond well with engagement factors in the results, such as the levels of spend with a supplier, the suppliers capacity and the state of the supplier-focal organisation relationship, all reported as considered when deciding whether to target suppliers in terms of SC GHGE management activities. Previous literature mainly concerned whether a supplier was selected and taken on, versus the results shown here that are concerned with whether suppliers are engaged in terms of SC GHGE management; this difference represents a further advancement of knowledge, as noted above, due to SC GHGE management being a young and relatively underdeveloped area of management.

6.6.1.4 Supply Chain Management Activities and Corporate Responsibility

Supplier engagement factors were supplemented in the results by the activities undertaken by focal organisations once suppliers were chosen as targets of SC GHGE management efforts. Several of the activities identified, such as including GHGEs into the tendering process and contracts, supplier training and direct interventions, were all previously identified in the literature (Krause 1997), and again represent an area where the thesis has confirmed existing knowledge operating within a new area.

These ideas advanced in this section link to work concerning CR, and the role that impacts occurring beyond the traditional boundaries of organisations can have on reputation (Kovács 2008). That actions and impacts of the SC are considered an aspect of an organisations CR efforts, means that any negative factors occurring within the SC can negatively affect the focal organisation. Linked to the above point regarding competitive advantage and the need for SCs to be managed as an extension of focal firms, CR concerns would also now dictate that SC GHGEs are managed as a strategic risk management concern. Both these views provide a further explanation of the reasons why private sector focal firms are engaging with SC GHGE management, through strategic aims, in the absence of policy, and provide a theoretical rationale for their actions. It should be highlighted however, in terms of environmental effectiveness of these approaches, that previous research has indicated that where organisations attempt to reduce GHGEs out of competitive self-interest, that they do so to a lesser degree that those reducing them out of ethical concerns (Le Menestrel and de Bettignies 2002).

6.6.1.5 Public Sector Environmental Supply Chain Management and its Paradoxes

As noted in the literature review, relatively little research exists concerning public sector organisations and ESCM. However, the literature that does exist on the topic broadly supports the findings presented in the results. For example, work previously noting the paradoxical weakness of UK public sector procurement at achieving objectives such as ESCM, in spite of public sector organisations often forming the largest buyer in the market, increasing leverage over suppliers, fits well with the picture outlined here (Preuss 2009; Morgan 2008; Preuss 2007; New, Green and Morton 2002).

Indeed, explanations such as the more formalised and bureaucratic nature of public sector procurement squeezing out the ability of individuals to pursue more advanced ESCM efforts, could be advanced as an explanation (New, Green and Morton 2002). However, it was also reported within phase one, that the project led nature of work in the public sector, and in phase two, that individual entrepreneurship was a driver within the public sector, seem on the surface to contradict this previous explanation. Deeper consideration shows that they are not contradictory. For instance, overly formalised routines may well inhibit efforts in the public sector, where little top down

pressure is evident, with individual entrepreneurship and the project led nature of work allowing instances of success, such as within the Universities examples examined, whilst hindering efforts more widely. This correlates well with previous work that has highlighted the fragmented and 'patchy' nature of sustainable procurement efforts with the public sector (Preuss 2007).

Previous research has also demonstrated that the failure of public procurement to pursue objectives consistent with sustainable development, may be isolated to environmental issues, with economic and social objectives receiving greater attention and success (Walker and Brammer 2009). This research also lends weight to the explanation presented in the paragraph above, concerning the limiting effects of variability within public sector procurement across and between different public sector organisations (Walker and Brammer 2009; Walker and Preuss 2008). Walker and Brammer (2009) also noted that where top down direction was evident, in areas other than SC GHGE management, that these contextual factors unique to the public sector impacted on the ability of these orders to achieve their aims. Again, the results presented through this research fit well with those present within the literature, but present a new area of ESCM, SC GHGE management, where these previously recognised factors can be seen to be at play.

The impact of negative or constraining perceptions regarding EU Procurement Directives is also worth noting; although several participants note that this constrained their ability in relation to supplier management, other examples were presented where these issues were overcome. Previous research has highlighted that EU Procurement Directives, and the perceptions that surround them, can have a detrimental effect on procurement efforts, and has advocated additional training as a remedy (Walker and Preuss 2008). The results presented through this research would seem to concur and strengthen assertions that increased awareness of the actual impacts of EU Procurement Directives is required with the public sector.

Although the drivers within the public sector appeared less pronounced and the barriers higher, the scale of public procurement in the UK was identified as being able to advance SC GHGE management; indeed, examples of public sector SC GHGE management were shown to exist. The paradox of government control over the power

of procurement resulting in little action, either due to low levels of political will or to a lack of coordination, finds agreement with previous work, in terms of the relatively poor outcomes of environmental and more general sustainability efforts in public procurement (Preuss 2009; Walker and Brammer 2009; Morgan 2008; New, Green and Morton 2002).

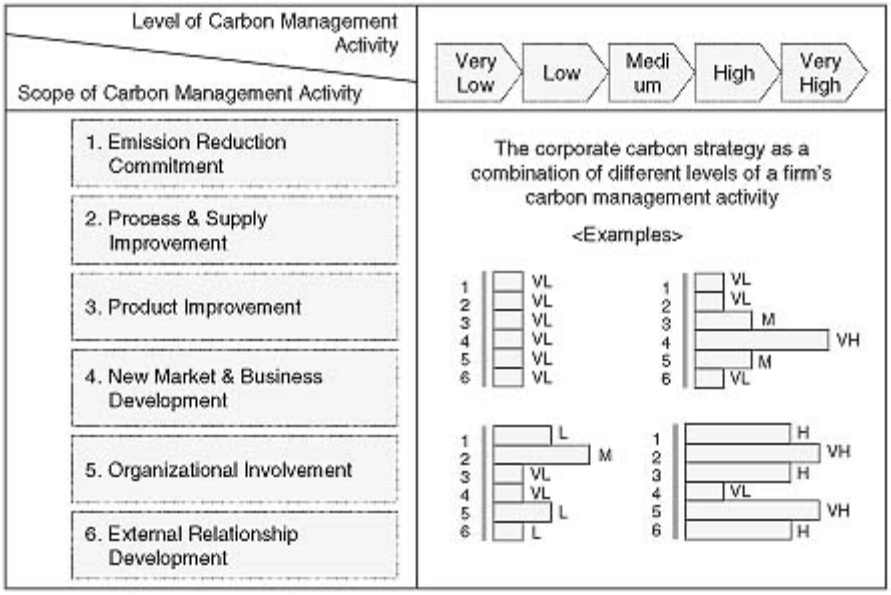
So although both the scale and potential levels of control available through public sector procurement would be able to amplify the benefits accruable through SC GHGE management efforts, for focal organisations, the SC and in wider terms with regards climate change mitigation objectives, current levels of activity mean this potential is unfulfilled. The public sector can be seen as a key area where the advancement of SC GHGE management efforts would be most beneficial, both due to the relatively low starting point and due to the scale of procurement that occurs. Many suppliers could be impacted through such schemes, without the commercial imperatives present within the private sector that may restrict aid and help being offered to suppliers.

6.6.2 Organisational Climate Change Strategies

Theoretical and practical knowledge regarding corporate efforts to engage with climate change objectives more generally was highlighted through the introduction as relevant to SC GHGE management. This was due to SC GHGE management forming an aspect of this area of business strategy and its relationship with the environment. The impact and contribution of the findings to this area will be discussed below.

As was established within the introduction, corporate climate change scholars have asserted and provided models as to the options and strategies available to corporations, or private sector focal organisations. For example, Lee (2012) (see Figure 6-10) identifies six areas of action from commitments to reductions, through to external relationship development. The second area of action identified, process and supply improvements would include actions to manage and reduce SC GHGEs. Although such efforts identify the range of options available to corporations to tackle their GHGEs, these models lack specificity with regards to the actions required within each stage.

Figure 6-10: Lee (2012 p.37) typology/continuum model for business engagement with climate change objectives.



The results presented here, with regards to research question two, concerning the activities undertaken to manage SC GHGEs are able to provide greater depth and understanding in relation to carbon management activity two, in Figure 6-10. The same contribution is able to be made to work by Kolk and Pinkse (2005) and their 'vertical compensation strategy' and both Jeswani, Wehrmeyer and Mulugetta (2008) and Okereke (2007), although the models and categories that they propose as forming the basket of strategies available to corporations is less explicit with regards to the SC being a focus of efforts. Indeed, it is research by Kolk and Pinkse (2005) that identifies that approximately 10% of the organisations they studied were attempting actions within the SC, as 'vertical explorers'.

Efforts to develop a matrix exploring and charting the relationship between the activities undertaken to manage SC GHGEs by focal organisations and the core and additional outcomes achievable (outlined in section 6.1), relate well to this area of previous knowledge. The models advanced by scholars exploring corporate engagement with climate change objectives, such as Lee (2012) and Kolk and Pinkse (2005), operate at a higher level, looking at internal and external GHGEs, as well as the development of new 'climate friendly' products, and the competitive opportunities these bring. These models lacked specificity with regards to SC GHGEs. The FOSCAO matrix developed in 6.1, provides a lower level view of actions available for the achievement of climate change objectives in the SC, specifically reporting and

disclosure and reductions, and can be considered as an extension to models such as those developed by Lee (2012).

For example, Lee (2012) identifies ‘process and supply improvements’, whilst Kolk and Pinkse (2005) identify ‘vertical explorers’. The FOSCAO matrix developed by this thesis demonstrates the activities that are undertaken by corporations (and public sector organisations) that have chosen this line of climate change engagement and action and deepens knowledge within this specific category of action. Further, it illustrates the activities necessary for a range of outcomes related to climate change objectives, such as reporting and disclosure, whilst also highlighting available additional benefits.

The SCHEME framework illustrated within Figure 6-9 provides further perspectives in this regard by also integrating the drivers, barriers and variables considered to be impacting upon organisations engaging with SC GHGEs, as many of the drivers and barriers inherent within SC GHGE management are also relevant to wider engagement with climate change mitigation efforts by organisations. This SCHEME framework could be conceived as an advancement in terms of understanding the specific corporate strategies noted by scholars such as Lee (2012) and Kolk and Pinkse (2005) in relation to the SC, providing greater detail on a previously recognised, but under developed area of corporate engagement with climate change mitigation objectives.

Further, the frameworks and other results presented within this thesis, such as the drivers and barriers, and activities, broaden previous knowledge in this area, by being partly based on the experiences of public sector organisations, rather than being purely focused on the actions of private sector corporate actors.

6.6.3 The Control and Motivation of Supply Chain Greenhouse Gas Emissions Management

Existing knowledge regarding policy and regulation was covered through the contextual aspects of the introduction due to its relevance with regards to enhancing SC GHGE management efforts. The findings of this research will now be discussed in terms of their contribution, theoretically and practically.

6.6.3.1 ERINO Supply Chain Approach: Implications for Climate Change Mitigation and Policy

Although the British government has consulted on the use of mandatory reporting (Defra 2011), an assessment and theory of how different interventions could operate was absent. The ERINO SC approach developed within section 6.2 provides such an analysis and identifies a range of interventions available for the motivation of SC GHGE management, including their various 'pros and cons'. By analysing and operationalising these options through the data obtained on focal organisations in the UK, and in terms of the IPCCs policy considerations, such as environmental effectiveness, the ERINO SC approach was designed to be relevant within current policy and regulatory thinking on climate change in the UK. The development of this theory represents, at least, a moving of intervention ideas, such as mandatory reporting of SC GHGEs, or alternative economic, information or supporting based mechanisms, into the ESCM sphere.

The ERINO SC approach can also be viewed as a contribution more widely, in terms of the impacts of various interventions on the workings of SCM within focal organisations. As CR has spread to include SC impacts, so too could future regulatory approaches by governments wishing to tackle other sustainability related issues, including other environmental impacts, or those that rest within the social sphere. The theory developed through the ERINO SC approach could support these future efforts, by highlighting more generic workings of focal organisational SCM efforts and the likely impacts that a range of interventions would have on these management efforts. The theory also indicates that focal organisations can be used as policy conduits, where governments or other actors wish to utilise the power and capabilities encompassed by focal organisations, for the advancement of policy goals for SC members, including SME suppliers. This can be illustrated using the overview schematic outlined in Figure 6-9, where interventions, represented by the shaded diamond, impact focal organisations in such a way so as to achieve preconceived policy goals.

6.6.3.2 Greenhouse Gas Emission Management and Informal/Private/Self-Regulation

In the preceding sections, explanations were advanced that provided a deeper understanding of the way that focal organisations obtained competitive advantage through SC GHGE management, in terms of SC versus SC competition and the collaborative paradigm and how focal organisations interact and relate to their SCs.

Ideas and theories concerning governance, including its privatisation, offer a further alternative explanation as to the results obtained. In this instance, these theories focus on where the pressures acting on focal organisations are originating and can be seen to include some of the driving factors, such as stakeholder demands, illustrated in Figure 6-9.

One alternative method of control for the state is that of 'steering' or 'signalling' how and where organisations should be acting (Kettl 2000). Backed by ideas of responsive regulation, where government action should initially be minimal and only indicate behaviour, involving no explicit regulatory mechanism (Foley 2004), it is intended that organisations regulate themselves and act accordingly. The recent Defra consultation on the possibility of introducing mandatory Scope Three GHGE reporting to large organisations in the UK could be seen as such an effort (Defra 2011); this measure was not enacted, with only Scope One and Two proposals proceeding, however the impact of the consultation and other similar statements by government, concerning climate change regulation more generally, can be considered a signal to organisations to take climate change objectives in to account with regards to their future strategy (more recent government statements however reduce the validity of this view). The possibility of future regulation and policy, targeted at SC GHGEs, was noted by participants B06, B08 and B09. Participant B08 noted specifically that it was their belief that regulation would come in the future, and as a result they would be at an advantage if, as an organisation, they engaged now.

Within ideas of governance, where the state fails to act directly, several authors have proposed that non-state actors, including the third sector, as well as private organisations, can act to fill the gap and create and implement structures akin to regulation (Taylor et al. 2012; Bevir and Rhodes 2003). Organisations, such as the CDP and the GRI, offer mechanisms that allow focal organisations to disclose and report their GHGEs. These are information based policies, forming a type of private or civic-regulation, where non-state, third sector actors administer regulation (Bevir and Rhodes 2003). Such phenomena however, require a form of enforcement; in the above example this was achieved through the threat of future regulation and a fear of a loss of competitive advantage. In terms of GHGE reporting, such pressure stems from societal factors, and their successful harnessing by these third sector actors. Such

societal pressures manifest themselves through stakeholder demands (Hutter 2006; Cashore 2002), either from customers, consumers or financial stakeholders, such as investors and shareholders. Financial stakeholders, in particular, were highlighted by participants as stakeholders who clearly articulated their demands in relation to the management of SC GHGEs, such as the case with B02.

That financial stakeholders are making such demands demonstrates clearly the CDPs ability to harness these pressures to encourage or enforce compliance with their programme, and allow it to be seen as a type of private or civic-regulation. There is little state involvement, with several non-state actors coming together to firstly, create a mechanism for the reporting of SC GHGEs, in the case of the CDP, and secondly, the creation of pressure for organisations to join. Within this example, pressure comes from the investor community, who ask organisations to submit data in order for their climate change mitigation risks to be disclosed, to allow their inclusion in the pricing of assets. This disclosure is able to highlight the potential future liability, in the event of future regulation being applied, that such organisations would face from their SC GHGEs. Other notable stakeholders include customers and consumers, as well as regulators themselves (Henriques and Sadorsky 1999).

Other types of action, which were highlighted through the data, include the use of standards in the SC. Standards, such as ISO 14001 or CEMARS Achilles, are noted through the governance literature as another example of non-state regulation, where professional organisations, such as trade or professional bodies, administer such programmes (Taylor et al. 2012). The use of these standards, by the focal organisations, was then promoted to suppliers throughout their SCs. The use of these standards follows similar pressure to those advanced above, and allows focal organisations to assert that they are using the appropriate systems and methods for measuring and managing their SC GHGEs, in turn providing assurance to their stakeholders, and the administers of the private/civic-regulation. In this way, these regulatory approaches are able to penetrate the SCs of these organisations and effect changes within their suppliers, in turn making focal organisation a type of private regulator within their own SCs. For example, utilising supplier contracts to mandate GHGE reductions could be seen to be consistent with command and control or economic based polices used by government.

Where the Water Utility participant, B06, noted that their organisation ranked their suppliers into a league table, based on a mixture of factors, including GHGE performance can be seen to be consistent with information based policies used by the state. Such assertions can also draw parallels with research in relation to the outsourcing of regulation in relation to labour standards in the SC (O'Rourke 2003). The SCHEME framework developed includes these conceptions and is able to illustrate how pressure emanating from informal or private regulation can motivate focal organisations to act in relation to their SC GHGEs.

6.6.4 Benefits and Reasons for Managing Greenhouse Gas Emissions in Supply Chains: A Case of Derived Benefits?

The results have demonstrated that focal organisations are engaging with SC GHGE management due to a range of drivers and in order to achieve a range of objectives and outcomes. Although key differences existed between those focal organisations in the public and private sectors, both sets of participants' reported that SC GHGE management was pursued in order to improve the position of their organisation, partly due to a lack of regulation mandating action. These outcomes where primarily illustrated through the FOSCAO matrix presented through section 6.1, and illustrated in Figure 6-9, showing the SCHEME framework.

Focal organisations were engaging with SC GHGE management primarily to achieve one or both of two aims. These included the disclosure and reporting of SC GHGEs, through initiatives such as the CDP, or in order to achieve SC GHGE reductions. The pursuit and fulfilment of these objectives were reported to provide benefits to focal organisations, which can be seen to be as a response to driving factors, or due to the additional benefits outlined in the results section 5.4 and through Figure 6-9. Although a range of additional outcomes were identified, alongside the primary aims of SC GHGE management, the driving factors identified can also be seen in terms of benefits available to focal organisations.

Due to the differing driving factors reported between the public and private sectors, they will be discussed independently, before discussing more generally the additional reported benefits of SC GHGE management.

6.6.4.1 Specific Private Sector Benefits

Focal organisations in the private sector were engaging with SC GHGE management due to stakeholder demands, in order to differentiate themselves from their competitors, to improve their reputation or as a response to cost pressures in the present or expected in the future. The driving factors identified through the results can themselves be seen to represent a range of positive outcomes.

The drivers identified through the results point towards benefits available to focal organisations, both in terms of the fulfilment of the driving pressure itself, and the benefits that lie behind them. For example, reporting SC GHGEs satisfies investor demands and could improve focal organisation reputation with other stakeholders and in relation to its competitors, both crucial to the focal organisations future commercial success.

On this level, responding to stakeholder pressures is aimed at these pressures ceasing. It is in this way that focal organisations are able to derive a further benefit, the satisfaction of stakeholder demands, through their efforts to measure and report their SC GHGEs. Indeed, many of the driving factors noted by the participants in the private sector act in a similar way, and demonstrate an alternative level of benefit through SC GHGE management, that being, the elimination of driving pressure present within the wider business environment.

Within the private sector examples, many of these factors allowed focal organisations to gain competitive advantage, improving their commercial position and increasing their chances of success in the future. Within the private sector, drivers were identified to be operating primarily through the market and wider business environment. Participants reported that they felt it was in the interests of their businesses to be engaging with SC GHGEs, and that this was able to provide benefits, such as differentiation, increased competiveness and reduced SC costs. These results helped to provide an answer as to why focal organisations in the private sector were engaging with SC GHGE management in the absence of regulation, a key driver in the ESCM literature.

6.6.4.2 Specific Public Sector Benefits

The public sector examples studied provided a more complex picture, as the participants reported context specific policy impacts, such as in the higher education (B18 and B19) example, and other organisational specific factors, such as individual entrepreneurship, as primary drivers. Overall, drivers within the public sector were reported to be less widespread, and more dependent on directives from above, such as policy and regulation. The barriers operating also contributed to the situation of the private sector being more advanced, as the public sector was constrained by factors such as a lack of top down direction/regulation and less methodological clarity in comparison to the private sector.

Due to a narrower set of drivers, reflecting the different context within which these organisations operated, it is possible to consider that public sector organisations have less benefit to derive from engagement with SC GHGE management. As these focal organisations do not operate within competitive markets, they are not affected by differentiation pressures or competitive advantage concerns. It was noted that organisational reputation and identity were factors in some engagement efforts in the public sector, such as noted by the University participants B18 and the benefits available by responding to these pressures were noted to include the opportunity for more funding.

Although a broad view across public sector focal organisations does indicate a non-competitive context, one example could be seen to be operating within a competitive setting. The higher education industry examples, illustrated with data provided by participants from the two Universities canvassed (B18 and B19), could in some ways be considered to be operating competitively, for example in terms of attracting students, a key source of funding. These participants also noted the possibility of a reputational boost from leading initial engagement efforts within their sector, and additional benefits such as forming closer ties with suppliers who could provide inputs into their academic endeavours. In this sense, the Universities canvassed were competing for both students and future research funding, and although not explicitly linked to either, engagement with SC GHGE management would raise the profile of the University, potentially contributing towards these goals. Considering this point in a wider sense, public sector focal organisations, like those in the private sector, compete to attract

talented employees, and efforts such as SC GHGE management could provide positive views of organisations, contributing towards these goals.

The government agency example, B16, noted that their efforts were due in part to their organisational identity and engagement as a response to this driver could be seen as beneficial in terms of staff moral and reinforcing reasons behind why such a public sector focal organisation exists. Drivers, such as individual entrepreneurship, are not so easily explained through the reasoning advanced above, but could include more moralistic and ethical desires to do the 'right thing'; indeed, B20, from the sustainability unit of a national public service provider noted that their engagement efforts were in part due to such concerns.

So although the public sector was less driven, and therefore in a position where fewer benefits represented by driving forces were available, due to their non-competitive context, elements of a competitive situation or the dynamics that operate with them, can be conceived. So, although relatively less able according to the data, public sector focal organisations can still be considered able to derive benefits through SC GHGE management, as illustrated through Figure 6-9.

6.6.4.3 Additional Benefits

In addition to the benefits available to focal organisations, considered through the driving pressures reported, a range of additional benefits were identified as also available, not included within the outcomes of reporting and disclosing SC GHGEs, or through GHGE reductions; these were considered in section 5.4. These included the possibility of cost savings and efficiency gains, improved supplier relations and increased supplier resilience, as well as context specific considerations.

As illustrated through the FOSCAO matrix, improved supplier relations were identified as available through SC management activities such as direct supplier interventions, or efforts to increase information sharing and provision in the SC (see Appendix H). By investing resources in the SC in this way, interactions with the SC were going beyond those associated with standard commercial arrangements, potentially increasing trust in the supplier buyer relationship (a key determinant in the literature, see section 2.1.2) and ensuring greater levels of communication and interaction. Although these do not by default lead to improved supplier relations, participants noted that

suppliers were often positive to such changes. This could be due to suppliers perceiving such investments as likely to lead to closer business ties and increased likelihood of future contracts. The closer working pursued due to SC GHGE management efforts could spill-over into other areas, and reduce transaction costs in the future associated with communication difficulties or other complications inherent within buyer-supplier relationships. This is one example of how efforts to manage SC GHGE management efforts created additional benefits to focal organisations.

The chance of improved supplier-buyer relations through SC GHGE management efforts also draws our attention to the mandatory versus collaboratory dichotomy identified in section 4.3.2.2. Improved supplier relations are likely to be obtained primarily through collaboratory SC GHGE management techniques, rather than through mandatory efforts. However, mandatory efforts could enhance SC performance, through the introduction of competition into the supply base. So although this would seem to rule out the chances of improving supplier relations, it could enhance principle efforts towards the reduction of SC GHGEs, improving focal organisation reputation and competitive position. Further, they are not true alternatives, as mandatory efforts could be employed across the majority of suppliers, whilst strategically important suppliers could be brought in closer to the focal organisations through more collaborative arrangements.

Other additional benefits identified included increasing the financial resilience of suppliers and improving the stability of the supply base. Indeed, this point regarding the possibility of increasing the financial resilience of supplier deserves greater attention concerning efforts to increase understanding of why focal organisations engage with SC GHGE management. It was noted that passing benefits of reduced GHGEs within suppliers to the focal organisations was a barrier, as it reduced the direct benefits available to the focal organisation. As such, the central benefits of SC GHGE management may actually be an improved reputation and competitive positioning within a market, rather than financial costs savings, which would be the principle driver, beyond regulation, in the public sector. This point further illustrates the contextual differences between the public and private sectors.

It was highlighted in the previous section however that although public sector organisations do not operate within a classic competitive setting, they can still be considered to be competing for the best employees and for future funding from government or other public agencies, or in the case of Universities, for students. Although these reasons were not reported widely by participants within the public sector, it does not mean that the benefits of their engaging with SC GHGE management efforts cannot produce these advantages. In addition, the public sector participants noted the chance to improve the local economy and business capabilities, where the public sector organisation had a regional or local remit, such as with local authorities.

6.6.4.4 Summary of Elements and Factors Involved in Focal Organisational Engagement with Supply Chain Greenhouse Gas Emission Management

The arguments presented above have considered why focal organisations reported that they were engaging with SC GHGEs. This included the primary aims of reporting and disclosing SC GHGEs and their reduction. It was noted however that these could be seen as derived outcomes, in order to pursue other objectives, such as to improve the reputation and competitive position of a focal organisation. It was considered for instance, that due to the difficulties of achieving cost reductions through SC GHGE management efforts, which improved reputation or other benefits such as satisfying stakeholder demands, may be the real reason and benefit of engaging with SC GHGE management. These arguments were advanced in order to seek deeper meaning and understanding of the reason for, and benefits accruable from SC GHGE management.

6.7 Chapter Summary

This chapter has continued the analysis presented in the preceding chapters and developed matrixes, theory and frameworks concerning the management of SC GHGEs. A FOSCAO matrix was developed in order to explore the relationship between the activities undertaken to manage SC GHGEs and the outcomes and objectives available. By establishing these relationships, the specific actions required to achieve desired outcomes or objectives are able to be charted, as well as what additional objectives actions could contribute towards, when undertaken towards the achievement of other objectives.

In addition to the development of the FOSCAO matrix, this chapter has also outlined a range of interventions designed to enhance focal organisational efforts to manage SC GHGEs. The ERINO SC approach charts a range of interventions and their effects on focal organisations, including likely implications and effectiveness. The development of this theory was in response to research question three, concerning the options and changes available that would enhance SC GHGE management efforts.

The FOSCAO matrix and ERINO SC approach where then synthesised, creating the SCHEME overview framework of SC GHGE management. Using the SCHEME framework as a starting point, the chapter then moved on to consider how the constituent parts of the SCHEME framework related to and impacted upon existing knowledge in terms of ESCM, organisational climate change strategies and climate regulation.

Chapter 7. Conclusions

This chapter will attempt to provide conclusions and a close to the thesis. A summary of the journey the research has taken will be provided before conclusions will be presented. Once this is completed, the limitations of the research will be explored, before a brief discussion of the implications of the conclusions in terms of existing knowledge, theory and future research is undertaken.

7.1 Summary of the Story So Far…

The aims of this thesis were to explore and explain the current phenomenon of SC GHGE management by focal organisations, within the context of the UK. It sought to identify the reasons for their engagement, any barriers they were experiencing and the activities they were undertaking to manage SC GHGEs. The objectives and outcomes of these activities were also included in this exploration, as well as the charting of their relationship with SC GHGE management activities.

In addition to these aims, the thesis sought to identify and consider what options were available to enhance or further focal organisation efforts, through the development of an intervention theory. The following chapter will aim to provide conclusions to these aims and the research questions that led the enquiry, which were:

1. What factors are driving or hindering organisations engagement with SC GHGE management, and what are the objectives or outcomes?
2. What activities are organisations undertaking to manage their SC GHGEs?
    a. Including the various SCM (Supply Chain Management) and internal measures taken.
    b. If and how focal organisations are targeting their resources towards particular aspects or parts of the SCs, and why?
    c. What factors moderate focal organisation SC GHGE management strategies?
3. Is a deeper understanding able to be gained with regards to:
    a. Relationships between SC GHGE management activities and outcomes?
    b. The conditions under which SC GHGE management could be expanded and used to a greater extent, to achieve climate change mitigation objectives, including policy options and their implications?

Due to the exploratory nature of the research and in order to structure the enquiry, the research was split into several phases. These included an initial exploratory and scoping phase, phase one, followed by the main data collection and categorisation phase, phase two; this included the identification of factors that influenced and regulated how focal organisations approached SC GHGE management and could be considered strategy or activity variables. Once these phases had been completed, and the data obtained, framework development and theory building began; this sought to establish the relationship between the activities and outcomes reported as achievable through SC GHGE management, through a FOSCAO matrix, which was followed by the charting and operationalising of intervention options, which led to the development of an ERINO SC approach for SC GHGE management.

These phases of the research will be summarised in more detail below and will attempt to illustrate how the research moved forward and reached answers and conclusions to the aims and research questions posed. Firstly however, a summary of the context and literature review will be presented.

7.1.1 Initial Investigations

Initial investigations into SC GHGE management highlighted several key aspects that led to interest being raised in this area. It was primarily established that large businesses were increasingly being held to account with regards to impacts occurring within their SCs. It was highlighted that businesses were engaging with GHGEs within their SCs, and disclosing and reporting these through schemes such as the CDP, or through their own sustainability reports. As initial investigations of the context within which this was occurring highlighted that current policy and regulation in the UK, and wider within the EU, did not target these GHGEs, questions were raised as to why these organisations were undertaking these activities.

Following searches of the literature and consideration of the topic, prior research into the management of environmental impacts through the SC was considered relevant, as GHGEs can be considered to be an environmental impact. In addition, literature was identified that considered the changing stance of large businesses to climate change, charting their path from opposition and denial to one of engagement and the seeking of opportunity, as noted in the introduction. Both these literatures outlined a range of

drivers as responsible for organisational engagement with environmental impacts in the SC, or with climate change more generally. However, both were felt to be insufficiently specific and to have been conducted within different contexts to the current activities with regards to the management of SC GHGEs.

Specifically, it was noted within the ESCM literature that the management of gaseous emissions had received insufficient and inadequate attention, with much focus placed upon other types of waste (Lee 2011). In addition, it was also highlighted that although efforts had been made to provide theories or frameworks of ESCM or SSCM, such as those by Seuring and Müller (2008) and Carter and Rogers (2008), that a lack of overarching theory existed within the discipline, restricting current efforts to provide a more holistic level of understanding.

By contrast, literature concerned with business engagement with climate change mitigation objectives focused on a higher level than SCs, considering overall organisational strategies in relation to climate change; these efforts, by scholars such as Lee (2012) (see Figure 6-10) did however note that the SC was an area where organisations could engage and act, but with few specific details.

7.1.2 The Development of an Empirical Research Agenda

From initial investigations into the context of SC GHGE management and the literature, it was decided that an exploratory approach that sought to identify key factors and seek explanations for any relationships or specific phenomenon found was appropriate, due to the lack of suitable theories that could provide a broad and holistic understanding of the topic. It was felt that as this was a new and burgeoning area of environmental management and organisational action, and that a qualitative approach would allow many factors and impacts to be considered and employed towards the answering of the research questions and aims.

As little information was available through the literature or other secondary sources, primary data from individuals with the necessary knowledge and expertise was sought. Semi-structured interviews were undertaken, initially with individuals external to focal organisations, from consultancies, business support organisations and academia, in order to provide an overview of the current situation and practice. This initial stage, phase one, sought to identify key aspects to study in further depth in phase two; in

total 11 participants provided data. The outputs of phase one, to be highlighted next, indicated that focal organisations in both the public and private sectors would be best placed to provide information for the remainder of the study; 23 interviews were conducted in phase two.

Once the empirical data had been collected, data analysis and framework and theory building was conducted. This involved preliminary attempts to code and categorise the data, according to the research question posed. Once all the data had been coded and checked for consistency, further analysis was conducted. The analysis and results obtained will be descried next.

7.1.3 Phase One: The Identification of Key Actors and Other Initial Empirical Evidence

Phase one of the project sought to explore and scope the current state of SC GHGE management within the UK, so as to identify those actors considered central to efforts to manage SC GHGEs. 11 Individuals with the necessary breadth and detail of knowledge and experience were identified and interviewed. The results from the data obtained indicated that large brand orientated businesses, with large instances of GHGEs within their SCs were leading current efforts. They were engaging due to strategic competitive factors present within the wider business environment and not due to policy, which was identified by participants as not directly impacting SC GHGEs. Although actors within the private sector were identified as leading current efforts, public sector organisations were also identified as playing a role, due to the scope and power of public procurement. It was noted that their efforts lagged behind those of the private sector, but participants did indicate that some examples of public sector SC GHGE management did exist. For this reason, it was decided that both public and private sector focal organisations would be approached for interviews in the second phase of the research.

Phase one also provided data on the options open to government in terms of policy and regulation, as well as factors seen to be constraining the governments and the public sectors ability to act in this regard. Although this area of investigation was not continued through to phase two, the policy options identified aided later attempts to develop an intervention theory. Finally, the data from phase one also identified third sector organisations as playing several, and in some respects critical roles, such as the

provision of research, education and advice, in relation to SC GHGE management. As with the policy options, this area of investigation was not taken forward into subsequent phases. Both these decisions allowed greater resources to be employed towards the investigation into drivers and barriers, and activities of public and private focal organisations. This phase was successful in identifying private sector organisations as leading current efforts, providing achieving research aim one, and providing further focus to the remainder of the research. It provided further indications of the drivers and barriers effecting businesses, and to an extent public sector organisations, and the activities being used to manage SC GHGEs; these indications provided partial evidence for the answering of aspects of research question one and two (a).

7.1.4 Phase Two: The Exploration of Reasons for, Barrier Experience, and Activities Undertaken in the Management of Supply Chain Greenhouse Gas Emissions

Phase Two of the project sought to gain a different perspective to that of phase one, and sought participants with knowledge and experience from within focal organisations. 23 individuals from focal organisations were interviewed, including 8 public sector (including an involved third-sector organisation) and 10 private sector focal organisations, in addition to a further two participants from consultancy organisations. The results from this phase were able to identify a range of drivers and barriers for both public and private sector organisations. A wide range of drivers, including competitive advantage, cost and stakeholders were found to be operating within the private sector examples; these reflected those identified within the literature review by scholars such as Walker, Di Sisto and McBain (2008) and Seuring and Müller (2008) in relation to more general ESCM or SSCM or Jeswani, Wehrmeyer and Mulugetta (2008) and Okereke (2007), in relation to business engagement with climate change. In the public sector however, drivers were less wide ranging, and found only in limited contexts, but this also reflected those found factors noted within contexts close to SC GHGE management (e.g. Walker, Di Sisto and McBain 2008).

Further, public sector barriers were reported to be relatively greater than those in the private sector, including aspects such as a primacy of cost over environmental consideration (Preuss 2007; New, Green and Morton 2002); overall, many of these

drivers were also reflected in the wider sustainable or environmental procurement literature (see Morgan 2008; Walker, Di Sisto and McBain 2008; New, Green and Morton 2002). These results provided a confirmation to answers obtained in phase one regarding the relevant actors and their relative levels of actions, and also aspects of research question one, concerning the reasons for organisations engagement with SC GHGEs, and the difficulties involved.

Phase two also provided results that were able to answer the second aspect research question one, concerning the objectives and outcomes of efforts to manage SC GHGEs. Although only confirming that efforts aimed to report and disclose SC GHGEs, or reduce them, additional beneficial outcomes were also identified, such as improved supplier relations; this indicated that an ability to obtain 'win-win' solutions with regards to SC GHGEs existed, or was at least reported, reflecting environmental 'win-win' aspects of the literature (Pinkse 2007; Hoffman 2005; Dunn 2002; Porter and van der Linde 1995) or those aspects noting the positive spills-overs available through ESM or supplier engagement (e.g. Holt 2004; King 1996).

The specific actions being undertaken to manage SC GHGEs were also identified, providing answers to research question two. It was reported that actions were being taken throughout the SC, including the first tier of suppliers and beyond, within the focal organisations and downstream. That these actions were reported indicated that the barriers identified were surmountable, but that direct financial benefits were troublesome, demonstrating that benefits to the focal organisations went beyond the possibility of achieving cost savings within the SC. Many of the activities identified were similar to those identified in previous research, such as the evaluation and motivating of suppliers or sharing best practice in the SC (e.g. Ciliberti, Pontrandolfo and Scozzi 2008; Keating et al. 2008; Krause 1997).

The final aspect of research question two was also answered, concerning the factors considered when deciding with which suppliers to engage. It was found this was partly related to the objectives being pursued by the focal organisation, such as a desire to minimise risks across the SC, through the use of standards and less 'hands-on' measures, or to target GHGE reductions through collaborations with parts of the SC with high GHGE instances.

Phase two analysis also aided in the identification and development of categories that illustrated key factors that altered or effected how focal organisations engaged with SC GHGE management. These variables included the maturity of focal organisation efforts, both in terms of SC GHGE management and more general environmental management efforts, where in the SC the focal organisations was (i.e. its proximity to consumers), their size, type of business model or product, private versus public stance, the location of their SC GHGEs, their stakeholders and the type and levels of SC power and relations. Although a lack of specificity was found in the literature in relation to such factors, some agreement was found in relation to aspects such as 'business context' and the role of stakeholders (Boiral, Henri and Talbot 2012; Sprengel and Busch 2010; Kolk and Pinkse 2007; Kolk and Pinkse 2005).

In summary, phase two confirmed that businesses were leading current efforts, due to a range of factors, and that the public sector was primarily being constrained by a lack of top down direction to engage with SC GHGEs (although this was context specific, demonstrating that policy from sector specific regulatory agencies was effective within a public sector context). The activities occurring within the SC were also described, as well as supplier engagement factors and variables that moderated focal organisations SC GHGE management actions. This, in total, provided answers to research questions one and two.

7.1.5 Framework Development and Theory Building

Once initial categorisation efforts had been concluded, providing at least partial answers to research questions one and two, there was a desire to attempt to deepen the analysis and knowledge able to be gained through the research. This involved attempting to look at the data in new ways and exploring and developing an understanding of some of the relationships between the factors identified in the initial analysis.

Framework development and theory building, as noted within the methods chapter, started during the data collection process; however it's more formal and structured development was undertaken once the categorisation and analysis described above had been completed. Two frameworks/theories were developed from this data, using different techniques; the ERINO SC approach was developed using inductive reasoning,

whilst the FOSCAO matrix was the product of a matrix analysis between the key SC GHGE management activities and the possible outcomes.

The ERINO SC approach outlined a range of interventions and their workings. It was highlighted that interventions could operate in a number of ways, including the targeting and enhancing of driving factors or the reduction and elimination of barriers; both of which had been identified in prior analysis. Phase one participants had been asked to consider what measures could be taken by government to increase levels of SC GHGE management, and these first responses were used to build the initial list of options. From here, they were considered in more detail and categorised according to their economic, information or capacity enhancing characteristics. Included in this list was the continuation of the current situation, which, as will be considered later in this chapter, can be conceived as a type of private or informal regulation.

The FOSCAO matrix, by contrast, focused to a greater degree on the focal organisations themselves, and identified relationships between the activities undertaken to manage SC GHGEs and the reported outcomes and objectives. By undertaking this analysis, the FOSCAO matrix highlighted the specific actions necessary to achieve a precise outcome, or where activities were already underway, which additional objectives could also be pursued through such activities. This work provided answers to research question three.

An overview framework of SC GHGE management was also constructed, called the SCHEME framework, synthesising the ERINO SC approach and FOSCAO matrix. This SCHEME framework provided a view of SC GHGE management, incorporating its drivers, barriers, variables, activities and outcomes, and how interventions could be targeted. The contributions of these aspects of the project to existing theory and knowledge will be reiterated later within this chapter.

7.2 Wider Implications and Practicalities of the Results: Focal Organisations, their Supply Chains and in terms of Policy

The section aims to consider the results of the research in terms of its wider implications and practicalities. The impacts in terms of focal organisations will be covered first, followed by SCs and the suppliers within them, before considering the policy and regulatory implications.

7.2.1 Focal Organisations

The results and discussion presented through the thesis indicated that focal organisations are increasingly being expected to manage GHGEs embodied in their products and services in the SC. This adds additional pressures and demands onto focal organisations, and as such could be seen as an added strain. As has also been discussed however, are the many positives and benefits reported as available to focal organisations undertaking such activities.

As such, although difficulties and barriers must be overcome whilst engaging, focal organisations should consider deploying the necessary resources, independent of any interventions by the state. Doing so allows potential benefits, such as improved reputation, enhanced supplier relations, supplier resilience and protection against any future regulation targeting these GHGEs. Reported central and additional benefits of SC GHGE management can be seen to conform with ideas on 'win-win' outcomes in relation to engagement with environmental management and strategy in the literature (Pinkse 2007; Hoffman 2005; Dunn 2002; Porter and van der Linde 1995); however, it should be remember that trade-offs exist both in terms of the results of this research and in previous works (Hahn et al. 2010).

Corporations or other organisations developing strategies for engaging with climate change mitigation more generally should note the benefits that were reported as available through SC GHGE management initiatives. However, it can also be noted that many of the benefits could conceivably be available through other actions designed to manage GHGEs, including those internal to organisations. Benefits such as improved reputation and reduced exposure to future regulation would be available from more general engagement with climate change mitigation activities. As such, these organisations should be aware of these benefits and be prepared to mobilise resources towards these aims.

Whether individual focal organisations, in the public or private sectors undertake actions in relation to their SC GHGEs will depend upon their specific contexts. However, this research provides an overview to these organisations of the likely driving factors that they may be experiencing as well as the barriers they can expect to encounter if they engage. In addition, the range of strategies available to them is

noted; the FOSCAO matrix further outlines the activities that can be undertaken in order to reach specific outcomes or objectives.

In addition to this, it is possible to identify a range of key factors and competencies that focal organisations wishing to successfully engage with SC GHGE should consider. These have been identified and constructed using the data collected throughout the research, with specific regard to those focal organisations felt to be the most active and successful in terms of SC GHGE management.

7.2.1.1 Communication and Awareness

Communication and awareness are identified as being required by focal organisations wishing to advance their efforts to manage SC GHGEs. The 'awareness' aspect of this capability is critical in several ways. Awareness is needed regarding the importance and existence of SC GHGEs, as well as in terms of which aspects of the SC to focus on and act within. These aspects of this capability are obtainable through initial scoping and engagement strategies, as outlined in section 4.3.1.

Communication is also seen as a critical ability, both internally and externally. Internal communication is required as many aspects of an organisation are involved in the management of SC GHGEs, such as procurement or SC management departments, sustainability or environmental management departments, as well as design and aspects of overall organisational strategy. Internal communication is essential in order to allow these disparate parts to cooperate and coordinate appropriately.

The SC also needs a level of awareness about the challenges and demands of managing GHGEs between businesses; in this sense, communication and awareness is a 'two-way' process, integral to the supplier-focal organisation relationship. Being an 'educated customer' is important, as many of the changes that can influence SC GHGEs come from the focal organisations, such as changing buying habits and patterns, as well as logistical alterations. Being able to use the information collected by the SC appropriately, further underlines the importance of awareness and communication as capabilities required by any focal organisation wishing to manage their SC GHGEs.

Participant B04 provided a good example of the importance of awareness and of being an 'educated customer', as it was noted that by changing the way that certain inputs were ordered, that embodied GHGEs could be reduced, rather than solely altering

supplier practices. This included buying sugar beet rather than sugar cane, as the former could be sourced more locally.

The importance of communication and awareness was also identified within the literature review in relation to those capabilities and elements required for success in more general environmental management and business performance (Lokshin, Gils and Bauer 2009); that these capabilities are also important in terms of SC GHGE management can be seen to reinforce these previous assertions.

7.2.1.2 Focus and Prioritise

Having the capability to prioritise management efforts and focus on those areas that will return the greatest management gains are highlighted as a capability required by focal organisations. This can be seen in terms of focusing on those areas of the SC with the highest GHGEs. Taking up the second aspect of the focusing and prioritisation capability, namely, focusing on SC GHGEs, it is important to note that this involves enhancing the capabilities of a focal organisation, so as to allow it to engage with GHGEs and the SC. These efforts should include the training and raising of awareness within key departments, such as procurement/SC management and environmental management departments; this relies somewhat on the communication capability described above.

7.2.1.3 Supplier Relations and Incentivising the Supply Chain

Supplier relationship management and the ability to incentivise the SC to act to manage and reduce SC GHGEs also emerged as a core competency. Several methods were noted by participants for motivating, or driving, suppliers to measure and eventually reduce their GHGEs. They include the introduction of competition into the SC by basing supplier selection, at least partly, on GHGE performance, and rewarding suppliers for good performance through appropriate contract management.

These competition based schemes may not be appropriate for all suppliers however, especially where the supply relationship is characterised by high supplier power, where the supplier is able to find alternative business easily, such as in the example of the Dairy, B07. In such cases, a focal organisation may wish to use more collaborative or supportive strategies. Although potentially costly to focal organisations, these

collaborative approaches are likely to improve business relations and can form part of a closer business relationship.

The importance of supplier relations and its ability to improve the environmental performance of SCs was also highlighted within the literature review (Lee and Klassen 2008), and as such is an area where this research agrees with, and confirms, previous research.

7.2.1.4 Embed (including Systems and Infrastructure)

A further capability identified involved the embedding of SC GHGE management efforts into organisations objectives and strategies, as well as into the systems and infrastructure used to manage more general SC and environmental objectives. Embedding SC GHGE management goals into overall strategy was highlighted as allowing greater resources and focus to be placed onto SC GHGE management efforts. Further, their integration into current SCM systems allowed SC GHGE management objectives to be taken on by existing commercial functions within focal organisations.

The development of tools and systems for the collection and measurement of SC GHGEs is also relevant to this capability, and was noted by B06, the water utility focal organisation. In an attempt to ration resources, environmental risks, including GHGEs embodied within the SC, were highlighted at the contract tendering stage and applicant suppliers were assessed. This assessment continues throughout the contract through the use of key performance indicators (KPI's) for the 'top 50' suppliers. The importance of mainstreaming such efforts was noted, including the training of all commercial and procurement teams in terms of GHGEs, and sustainability more widely.

In addition, participant B11, from the multinational grocery and general merchandise retailer, noted that their organisation was in the process of developing their own calculator, due to being disappointed with the work of a consultancy hired to collect and analyse data from suppliers on their behalf. It was hoped that this work would allow suppliers be able to submit self-assessed GHGE data online in the future, enhancing the focal organisations efforts to collect data, and manage and influence SC GHGEs.

The importance of embedding these competencies and skills, as an element of success was highlighted by King, Fowler and Zeithaml (2001), as ensuring those competencies that are gained are employed to maximum effect, is seen as critical; parallels can also be drawn here with the importance of ensuring knowledge transfer (Adam and Lamont 2003) or the spread of best practice (Lokshin, Gils and Bauer 2009), within an organisation.

7.2.1.5 Top Management Support

Several of the capabilities noted above, including the importance of embedding SC GHGE objectives within an organisation and focussing and prioritising efforts are reliant on top management recognising and supporting the need for action. Due to these links, the need for top management support is identified as a key requirement or capability. Having top management support was noted as essential for the successful acquisition of internal resources for programs aimed towards the management of SC GHGEs, allowing SC GHGE management to be embedded within an organisation, and ensuring that this cross-cutting issue gains the necessary cross-organisational support needed.

Once top management support is obtained, several of the factors or capabilities highlighted above will also become easier to achieve. Indeed, the literature also notes the importance of top management support for efforts towards supplier relationship management more generally (Stuart 1993), and specifically within the public sector (Preuss 2009).

7.2.1.6 Collaboration

Collaboration was identified as a factor in highly active focal organisations, both internally and externally. Internally, collaboration holds similarities to the importance of embedding SC GHGE management into organisational systems and infrastructure as well as communication. As noted previously, many areas of an organisation are required to successfully engage with SC GHGE management, and internal collaboration between such departments was a reoccurring theme within the data.

The importance of external collaboration also emerged from the analysis as well as in the literature review (Gascoigne 2002). By collaborating with external organisations or agents, participants noted that extra funding could be obtained. Many SC GHGE

management efforts require the collaboration of the SC, therefore being equipped and capable of collaborating with both internal and external actors is a central element or factor in successful SC GHGE management initiatives.

7.2.1.7 Summary of Implications and Practicalities for Focal Organisations in Relation to Supply Chain Greenhouse Gas Emission Management

It has been discussed above that SC GHGE management presents a new area of environmental management for focal organisations. Initially, such demands seem to present focal organisations with additional tasks and actions, many of which require action outside of their traditional organisational boundaries; in turn, it is possible to conceive that such demands and actions would be viewed negatively. However, as has been asserted, many benefits are reported as available through SC GHGE management efforts.

By reviewing the data obtained in phases one and two, and through the framework development, it was possible to identify and consider a range of factors that emerged as characteristic of those focal organisations engaging with SC GHGE management. Many of these capabilities were enhanced when enacted together; for example, focus and prioritisation, as well as embedding SC GHGE objectives and activities, were boosted and made easier by top management support. The identification of these factors offers a guide to focal organisations wishing to more successfully engage with SC GHGE management. These factors are relevant for organisations in both the public and private sectors.

7.2.2 Suppliers and the Supply Chain

The results of the research present a mixed and uncertain picture for suppliers and supply chains. By taking a negative or pessimistic perspective it is possible to conceive that the new demands placed upon suppliers by focal organisations efforts to measure and manage SC GHGEs will lead to undesirable impacts; this is most pertinent with respect to smaller suppliers further up the SC.

The possibility exists that many suppliers will lack the capabilities required to enact the new demands placed upon them by focal organisations. Suppliers across the SC will no doubt have to gain capabilities concerned with the measurement and assessment of their own GHGEs, and potentially those of their own SC where focal organisations pass on such requirements. In addition, where focal organisations include GHGE reductions

targets within their contracts and tenders, suppliers will be expected to comply. This will create a new competitive dimension within SCs and between competing suppliers. Those suppliers who are able to comply will maintain their competitive positions and their customers, whereas those that fail may lose business.

Those suppliers unable to adapt and improve their GHGE management capabilities may be left behind. Whether this is a negative or positive occurrence is debatable and dependent upon perspective; for those suppliers who potentially lose business, it is an undoubtedly negative situation, however, in order to reduce GHGEs and mitigate climate change, businesses throughout the SC must adapt. Those suppliers left behind, in this case, are those unable or unwilling to manage and reduce their GHGEs and as such, are unable to contribute towards climate change mitigation goals. These casualties can be reduced however where focal organisations engage and offer support and training within their SCs. Research by Du et al. (2013) has highlighted that within an emission restricted SC, under some circumstances supplier bargaining power grows in line with increases in the strictness of GHGE limits.

Some onus, however, remains with suppliers. It would be advisable, with the changes reported to be occurring within some focal organisations, for suppliers to ensure that they communicate with their customer organisations so as to be aware of changing demands as soon as possible. Early warning and a good understanding of the new demands to be placed upon them should allow suppliers to seek the appropriate information and capabilities required for GHGE management.

It is important to note here that SC GHGE management could have positive outcomes for the SC and the suppliers within. For example, it was reported that actions undertaken within the SC to reduce GHGEs would lead to efficiency improvements and potential cost reductions for suppliers. In turn, it was felt that focal organisations could benefit from a SC that was more financially resilient. Where this did occur, the suppliers themselves would undoubtedly benefit from such actions, with lower costs and greater slack within their operations to weather shocks in the market.

This phenomenon would be likely to occur where focal organisations collaborated or engaged with SC members, and specifically where direct interventions were undertaken. However, it could also occur where suppliers had free GHGE assessments

conducted by the focal organisations, allowing suppliers to recognise inefficiencies in their current operations.

This also has implications in terms of the impacts and potential of policy and regulation emanating from government, in terms of the SC being used as a policy conduit. Many SC members are likely to be smaller businesses, such as SMEs. As was shown through some of the examples, focal organisations are in a position to offer support to these businesses; for example, the construction industries setting up of a supplier school, noted by participant B09. That focal organisations could lead efforts to increase the capabilities of SME suppliers within the SC, would also be an attractive factor to government. SC GHGE management allows the potential for the SC to be used as a policy conduit, passing regulations, aimed at a single actor, the focal organisation, to flow or be passed up SCs, affecting all members.

The idea that the SC can be utilised as a policy conduit relates to ideas and theories concerning ESCM. Specifically, several scholars note that SCs, due to their inherent structure and purpose, allow the passage, up and down, of information and pressures. This was seen to form a new paradigm of Green Supply (Hill 1997; Green, Morton and New 1996). This paradigm posited that, as SCs were able to function as channels for information and pressure, that they could be used to spread best practice in terms of environmental management (Green, Morton and New 1996; Lamming and Hampson 1996). These ideas were further advanced into the theory of ESCD, which articulated that pressures could spread up and down the SC that would lead to a reduced environmental impact (Hall 2000). The actions undertaken by focal organisations attempting to manage SC GHGEs can be seen to be consistent with these ideas and theories and could represent an expansion of this previous knowledge into a new context. As the results demonstrated, a range of driving factors, or pressures, including stakeholder demands and strategic competitive concerns can be seen to be resulting in focal organisations passing these pressures up the SC, to their suppliers. These pressures resulted in new demands being placed onto suppliers, such as requirements that they disclose and report their GHGEs, or better manage and reduce them.

That suppliers have to respond to these pressures, alone or with the aid of focal organisations, is enhancing their capacity to manage GHGEs, resulting in potentially

beneficial outcomes for both themselves, through improved efficiency, as well as in terms of overall efforts to reduce GHGEs toward climate change mitigation objectives. In summary, it is important to recognise that SC GHGE management activities offer benefits to the SC and suppliers, including increasing the capacity of suppliers to manage their own GHGEs.

7.2.3 Policy, Regulation and Society

As was shown through section 6.3, a range of options do exist that could enhance focal organisations efforts to manage SC GHGEs, as established through the ERINO SC approach. In addition, the discussion in section 6.6.4 highlighted the myriad benefits available through SC GHGE management for focal organisations, the SC and more widely in terms of climate change mitigation goals. Developing and deploying such interventions would no doubt be politically difficult, however the benefits shown as available should strengthen arguments towards this end.

One area that should receive government focus concerns public procurement, which has been highlighted by the literature and the results of this research as lacking with regards to the management of environmental impacts in the SC. The scale of this procurement, through large public organisation, or through the use of procurement consortia, as in the case of the local authorities canvassed, highlights the potential of this sectors ability to pursue SC GHGE management goals, showing clear links to previous research that has highlighted the potential of public procurement to pursue environmental goals (Preuss 2011; Walker and Brammer 2009). However, a significant driver is lacking more widely, such as an edict emanating from central government, which was considered to be a core reason for the lack of action by public sector focal organisations. This is disappointing, especially within the context of the Climate Change Act.

Public sector focal organisations require greater drivers and actions to tackle perceptions regard EU Procurement Directives. The Utility Industry example, B06, was noted as constrained by the same rules and regulations, and yet had an extensive supplier evaluation and engagement program based partly on GHGEs; this demonstrates that methods are available that circumvent such concerns. As such, it

should be noted that much could be done within the public sector context to advance SC GHGE management, without the need for the interventions outlined in section 6.2.

7.2.3.1 The Advantages of Managing Greenhouse Gas Emissions through Supply Chains

The management of SC GHGEs can also be considered in terms of its impacts on GHGEs more generally, for instance, as a method for controlling GHGEs within a national context as part of efforts to fulfil climate change mitigation objectives. SC GHGE management can be seen to have several advantages over other methods in this regard.

Firstly, as SC GHGE management takes into account the overall GHGE footprint of products and services created by focal organisations, a more substantial amount of GHGEs can be attempted to be managed, versus where just internal GHGEs are the focus, such as with the majority of current regulatory approaches. As SC GHGEs are attributed to one large SC leading focal organisation, their management, or the leading of their management, is placed on to one actor. In this sense, the GHGE footprint of products and services, or much of their life-cycle impact, is attributed to the focal organisation. Although other SC members are required to act, the examples outlined within the results demonstrate that these actions are able to be coordinated and managed by the focal organisation. The focal organisations, as the target of driving factors, pass these pressures up through the SC, to the suppliers; this phenomenon finds many similarities to those described by Hall (2000) through the process of ESCD. The effect of this is that the management of a larger amount of GHGEs is placed into the hands of a single actor, the focal organisation.

This situation, of placing responsibility onto one focal organisation, holds further implications advantageous to GHGE management more generally. Firstly, in terms of policy making and the administration of regulation, governments are able to regulate a single actor, the focal organisation, and compel this actor to at least measure, if not manage, GHGEs within its whole SC. This requires fewer resources from government and is simpler than attempting to manage the GHGEs within all the SC members separately.

Accounting for, and managing GHGEs through the SC is also able to overcome issues concerning productive versus consumptive GHGE accounting. Many criticisms exist with regards to the current focus on national GHGE measurements, due to the pollution havens hypothesis, that theorises that more developed economies can outsource much of their high GHGE industry to countries that export the goods, and embodied GHGEs back (Ghertner and Fripp 2007; Gawande, Berrens and Bohara 2001; Tisdell 2001; Suri and Chapman 1998). This has the effect of shifting GHGEs to other nations, and reducing GHGEs associated with production in the more developed country. Within this situation, the amount of GHGEs produced within a country is reduced, but the embodied GHGEs of products and services, those GHGEs that are consumed, are not reduced. SC GHGE management could overcome these issues, by capturing those elements of the SC that have moved abroad.

7.2.3.2 The Disadvantages of Managing Greenhouse Gas Emissions through Supply Chains

Although SC GHGE management and reduction demonstrates some advantages as a method for the measurement and reduction of GHGEs, in line with climate change mitigation objectives, several factors exist which reduce its efficacy as a method.

Firstly, although a range of interventions were identified, they are not without their difficulties or issues. In order to administer and capture the large amount of GHGEs embodied within SCs, especially those that stretch beyond national boundaries, policy and regulation that extends beyond the nation state would be required. Although a global agreement on climate change has been an area of aspiration and debate for many years, little progress has been made. Were policy to be instigated on a national level, the threat exists that focal organisations would shift operations out of the territory in order to avoid interventions; this is noted as the pollution havens hypothesis, highlighted in the previous section (Ghertner and Fripp 2007; Gawande, Berrens and Bohara 2001; Tisdell 2001; Suri and Chapman 1998).

Several of the barriers reported by the focal organisations in phases one and two are hard to counter by either internal actions or through interventions and supporting governmental actions. For example, low stakeholder demand, especially from consumers, is difficult to resolve, even though it has been signalled in previous research as a method for reducing the lifecycle GHGEs of products (Bocken and

Allwood 2012). Without direct consumer demand for products with reduced embodied GHGEs, overall demand and drivers may be limited, restricting the potential and efficacy of SC GHGE management. However, this could be used as an argument for government action, including regulation, as GHGE reductions more generally, are required in order to mitigate the effects of climate change. Further, other stakeholders, such as institutional and individual shareholders, appear to be beginning to understand that risks do exist for businesses in terms of climate change, and it is their desire to understand these risks that has led members of these groups to call for focal organisations to sign up to schemes such as the CDP.

Methodological difficulties and issues concerning the accuracy of GHGE accounting are also relevant here. It would be likely that such barriers would be reduced as interventions and focal organisations efforts matured, but difficulties would remain due to the complexity inherent within SCs. However, although it would be foolish to expect complete accuracy and all SC GHGEs to be captured by such schemes, those point sources within the SC representing the highest GHGEs would still be able to be targeted and controlled; indeed, focal organisations involved in this research noted that they focussed current efforts on those areas of the SC with proportionality higher GHGEs. As such, boundaries and cut-offs could be incorporated into interventions, below which point specific point sources were not included within schemes.

A further inherent difficulty of SC GHGE management is the need, in most circumstances, to work with suppliers in order to measure and manage GHGEs. The threat exists that suppliers will be unwilling to act, or will demand higher prices to do so, reducing a focal companies motivation and potential gains. Supplier engagement is a central organisational capability with relation to wider SCM objectives; that it forms a barrier to SC GHGE management consequently should not be a surprise. As such, the ability to successfully manage and incentivise suppliers can be considered a key capability when attempting to manage SC GHGEs.

7.2.3.3 An Assessment of the Justification for State Action to Enhance the Management of Supply Chain Greenhouse Gas Emissions

The development of the ERINO SC approach in section 6.2, highlighted and examined a range of interventions that if enacted would enhance the management of SC GHGEs by focal organisations. The role of command and control regulations was discounted due

to their being inappropriate for the regulation of SCs, owing to SCs characteristics, including their diversity and opacity. However, those based on economic and information based motivations were identified, as well as support and capacity building interventions. In addition, a 'governance' intervention was identified, enacted primarily by actors beyond the state, but that could be led by the state through 'signalling'.

Although initial actions have been led by focal organisations through self-interest, either to satisfy stakeholder demands, to enhance reputations or achieve efficiencies, that a range of interventions exist that could lead to enhanced efforts, signals a role for the state. The state's role here can be seen to be twofold. Firstly, with regards to their responsibility in relation to controlling and reducing GHGEs for climate change mitigation objectives; and secondly, in terms of offering support and frameworks for focal organisations undertaking these actions independently of regulation.

That the current situation has seemingly led to this divergence in focal organisation activities could be seen to lead towards arguments that some state intervention could be helpful. Policy and regulation should seek to maximise the potential positives available through SC GHGE management efforts for focal organisations, suppliers and wider communities. As such, regulation or policy should seek to motivate organisations in both the public and private sectors, and where appropriate facilitate the targeting of focal organisation resources into the SC to increase its capability to manage GHGEs, and attempt to ensure that GHGEs managed this way are able to contribute to the reduction and mitigation of climate change.

7.3 Limitations of the Research

This section will investigate and explore some of the limitations of the project, as well as some of the difficulties experienced during its completion.

7.3.1 Methodology

A mix of critical realism and pragmatic philosophies were used to answer the research questions. As little specific literature was available to help in the answering of the research questions, an explorative and explanatory approach was undertaken. In order to ensure a holistic approach to the topic, due to the trans-disciplinary nature, these

methods were felt appropriate. Due to this semi-structured interviews were undertaken, in order to be able to obtain appropriate data from the participants.

7.3.1.1 Validity

Questions concerning the validity of the result must be answered. Validity in qualitative research is a troublesome concept, as it stems from positivist quantitative enquiry (Golafshani 2003). However, the question remains as to whether the results obtained can be seen to be true and certain. Truth pertains to whether the results reflect the real situation, and certainty as to whether they are backed by reliable evidence (Guion 2008).

Participants from both phase one and phase two were chosen for their close proximity to the subject of SC GHGE management, and had to pass the established criteria to be deemed experts. Phase one participants were chosen for their breadth of knowledge and their external perspective, and as such were identified from organisations such as think tanks, business support and consultancy organisations and academia. Phase two participants were chosen in order to provide the internal perspective, and were identified from organisations that had specific experience of engaging with, and attempt to manage, their SC GHGEs. As such, both sets of participants were felt to have sufficient knowledge and opinion on the topic of SC GHGE management, in order to reflect the true situation occurring.

The certainty of the results rests on the consistency of the participants answers. As phase one was seeking to broadly explore the phenomenon of SC GHGE management, any answer was deemed sufficient for it to be categorised and established as an area of interest. This does raise issues of certainty; however a greater burden of evidence was required for phase two. The general categories established through phase two, including drivers and barriers, activities and supplier engagement factors, required at least two participants to have reported associated data for inclusion in the results. Throughout the data collection process however, it was clear that the participants' answers were consistent, both within and between phases one and two. This is demonstrated in the agreement between the two phases, that large private sector focal organisations were leading current efforts. That two perspectives were obtained,

including from focal organisations employees, and from external participants, offers a form of triangulation, increasing the credibility and validity of the results presented.

The threat of social desirability bias (Carter and Easton 2011), meant several actions were undertaken to reduce and limit its potential effects. Firstly, all participants were assured of their anonymity, meaning that any comments and data that they supplied was unable to be traced to themselves or their organisations. Secondly, as demonstrated by the interview schedules, shown in Appendix B and Appendix C, the questions used to enquire about SC GHGE management were neutralised. This was conducted in order to hide any indications of what a 'desirable' answer may be, to ensure to the greatest degree that the responses provided by the participants were their genuine opinion and knowledge. However, as will be discussed in the next sections, the methods used during the project mean that the results must be viewed within specific parameters that limit the knowledge that can be gained from them.

7.3.2 Comparison of Phase One with Phase Two Participants

It is important to consider how the data from phase one and phase two compare, to identify agreement or contradictions, and explore why. As specific results were compared through the results chapters, this section will aim to provide a wider perspective, focussing to a greater degree on the perspectives of the different participants and whether they were correct in their respective assertions. Overall agreement was seen with regards to drivers and barriers for both the public and private sectors, indicating that although data was provided from different perspectives, that they were consistent. This was felt to be true for drivers, barriers and activities. These were the only areas that provided directly comparable areas of data.

7.3.3 Missing Data and Unanswered Questions

Due to the methods used and the questions asked, several questions that arise from the data, and the results more widely, are unable to be answered. For instance, questions over the symbolic versus substantive nature of the actions being undertaken by focal organisations are both intriguing and yet unanswerable. As the project has relied upon self-reporting from participants within focal organisations for a large proportion of the data, questions are raised as to the accuracy of the data and suspicions that the participants would want to ensure that the focal organisations they

represented were portrait in a complimentary light. Although actions were taken to reduce the likelihood of social desirability bias, as outlined above, the chance of this occurring cannot be reduced to zero. However, the aims of the project did not include an assertion to establish the actual levels of SC GHGE management and reduction occurring. Rather, the project sought to identify what participants from focal organisations thought was driving and hindering their efforts in this regard, and how they were managing SC GHGEs. Although the self-reported factors and actions may suffer from biased responses, they are still able to be used to inform policy, provide recommendations and contribute towards wider academic enquiry, as long as this shortcoming in recognised. Further, many of the factors identified from the data do have negative implications, such as the effect on suppliers of using contractually and competitive based supplier management strategies. That actions with potentially negative consequences were reported by the responded lends weight to assertions that the results have avoided biased responses.

Questions over the symbolic versus substantive nature of SC GHGE management efforts also need to be seen in light of data provided during the first phase of the project from participant A04. It was noted that even where focal organisations were providing data to disclosure and reporting schemes, such as the CDP, that verification rates were low. Although questions over the accuracy of the data exist within the real world context of the project, this data is still felt to be valuable by financial stakeholders. As such, any efforts in this regard can be seen as positive, as focal organisations increase their own awareness of the location and scale of their SC GHGEs. As noted at the start of this project, SC GHGE management is a new and young area of environmental management, and as such, these issues can be expected. Yet, that focal organisations are acting at all and voluntarily, should be seen as an encouraging sign for the future of GHGE management and reduction more generally. What is more certain, is that the efforts reported by the private sector focal organisations in terms of driving factors, including reputational and CR benefits, are substantive, with likely genuine reputational and differentiating benefits; however, the data provided for this project is again unable to answer this question definitively.

A further area where this project is unable to provide answers, concerns the impact of focal organisations activities on their SCs and suppliers. The use of a variety of

methods to manage SC GHGEs, including introducing competition based on GHGE performance into supplier selection and management, may have implications for smaller suppliers. Suppliers may have to develop new capabilities, and those suppliers unable to, may suffer competitively. The positives or negatives of this potential situation are hard to establish, as the supplier perspective was unable to be obtained through the research. Although undoubtedly negative for a supplier who is unable to fulfil new demands, overall, those suppliers able to manage GHGEs to the required standard will thrive and survive, benefiting efforts towards climate change mitigation.

The overall contribution that SC GHGE management could make towards climate change mitigation efforts is also an interesting, yet unanswerable question through this project. The benefits of SC GHGE management, as a method for reducing GHGEs has been articulated earlier in this chapter, and include its ability to capture a large proportion of GHGEs involved in the production process, as well as establishing a single actor as responsible for the management of those GHGEs. However, the contribution this could make to overall GHGE reductions, compared to reductions in GHGEs involved in electricity generation and transport networks for example, or through changes to life styles, is hard to establish. The importance of the technical aspects of SC GHGE management, such as calculation methodologies is also worth noting as another potentially important area of research and knowledge, which was unable to be considered during this project.

Several issues encountered during the project, which could have impacted on the results, are also noteworthy. Difficulties in recruiting participants for interviews meant that some stakeholders identified as important sources of information were not interviewed. Although great efforts were taken to include policymakers within the sample in phase one, none contacted agreed to take part. This has implications for the policy options identified during phase one. Although a source of weakness, it should be recognised that many of the participants from phase one, such as participant A01, worked within think tank organisations. Part of their aim is to inform and influence policy making by government; as such, although policymakers with direct influence did not inform the project, individuals involved in the policy making process have.

Further, the size of the sample was restricted by the availability and willingness of individuals to be interviewed. Although extensive efforts were undertaken within both phase one and two, unwillingness by individuals to take part in the project and a relatively small number of organisations actually engaging with their SC GHGEs, due to the young nature of this area of environmental management, meant the sample size was restricted. However, as the interviews advanced, and more data was collected, patterns started to emerge; participant selection efforts continued until it was felt that data saturation had been reached.

7.4 Contributions of the Thesis to Existing Knowledge

This section will provide a summary of the contribution the work undertaken within this thesis has made to existing knowledge, including ESCM, corporate climate change strategies and policy and regulation.

7.4.1 Original Contributions

Several of the outputs of this research provide new and novel knowledge to both the academic literature and stakeholders involved in the practical management and administration of SC GHGEs. These included the development of an intervention theory, the ERINO SC approach, and the FOSCAO matrix, illustrated together in Figure 6-9. This figure demonstrates the various areas of results that were included within each theory and matrix, and how they relate to overall efforts towards focal organisations management of SC GHGEs.

The FOSCAO matrix linked well with existing frameworks and theories developed by scholars on corporate climate change strategies (such as Lee 2012; Kolk and Pinkse 2005). Specifically however, it provided a further depth concerning their assertions regarding the SC as an area of action for corporations engaging with climate change objectives. It illustrated which activities contributed to core and additional objectives and outcomes, providing a map to managers and practitioners as to which activities should be focused upon when attempting to achieve specific goals.

The intervention theory was developed in order to explore the reactions to and implications involved in various intervention options. Although existing governance literature covers the workings of various interventions, including economic, information, informal and supporting options, the intervention theory developed here

applies this previous knowledge, using the empirical data collected through the research, to operationalise and predict expected impacts and implications. This provides a new setting within which to explore the workings of interventions and policies, both in terms of GHGEs, as well as the regulation of SCs, and their associated impacts more generally. In addition, the use of focal organisations as policy conduits was explored, opening new regulatory avenues for the impacting of SC members, for policy makers.

The overview schematic that was developed provides a synopsis of the two discrete contributions, those being the ERINO SC approach and FOSCAO matrix, developed and can also be considered to contribute in several important ways. Firstly, it provides a broader conception of SC GHGE management efforts being undertaken by focal organisations. In this way, similarly to the FOSCAO matrix developed, it builds on previous frameworks and models developed in relation to corporate climate change engagement. For instance, efforts by Lee (2012) and Kolk and Pinkse (2005) both highlighted the range of activities available to corporations wishing to engage with climate change mitigation objectives, ranging from internal efficiency measures to actions that could be undertaken within the SC. Although frameworks identified the SC as an area of action, conceptually they were not concerned with the intricacies of actions within this area of business management. The SCHEME framework developed within this research builds on these initial conceptions by deepening knowledge with regards to actions that could be undertaken within SCs to engage with climate change mitigation objectives.

The SCHEME framework also contributes to literature concerned with ESCM or SSCM. As outlined in the previous chapter, few previous efforts have attempted to develop an overarching theory of ESCM. Frameworks have been provided by scholars such as Seuring and Müller (2008) and Carter and Rogers (2008). Although Carter and Rogers (2008) by integrating sustainability in its triple-bottom line conception into SCM, developing several propositions and highlighting key elements of SSCM, the Seuring and Müller (2008) framework was focused upon, as it was felt more applicable to the research undertaken within this thesis. Their conception of the triggers responsible for SSCM, including the identification of two separate strategies concerning supplier management versus product management, can be seen as a novel contribution.

However, it was asserted that the SCHEME framework illustrated in Figure 6-9, builds and advances Seuring and Müller (2008). Firstly, it agrees with the primary triggers or drivers for action but also integrates key barriers and challenges that must be overcome. In addition to this, variables are also integrated and in doing so, identify those factors that can be seen to moderate and influence the actions undertaken in response to driving pressures. Further, a range of intervention strategies are incorporated, highlighting what options are available to government and other third-party actors wishing to enhance levels of SCM.

Several elements of the frameworks would also be well suited to be tested through research in the future. Although a more general discussion concerning pertinent future research directions is discussed later in this chapter, several aspects of the frameworks developed through this research would suit testing and development. For instance, the FOSCAO matrix could be tested through either qualitative or quantitative means by examining other examples of SC GHGE management. Specifically, organisations that had achieved outcomes or objectives noted within the FOSCAO matrix could be canvassed on the activities they undertook during their efforts. The frameworks applicability to areas of ESCM other than GHGE management could also be investigated.

The ERINO SC approach could be tested through the examination of scenarios with senior managers and strategist from focal organisations likely to be impacted by the interventions, or be submitted to more formal policy analysis methods. Although the SCHEME framework is composed of the ERINO SC approach and the FOSCAO matrix and as such would be applicable to the same testing, the variables outlined within this conception would be suitable for further testing and investigation independently. For example, a review of focal organisations undertaking SC GHGE management, or other forms of ESCM, could be conducted in terms of individual variables to attempt to isolate and examine the impact that these differences had on actual activities and strategies.

The frameworks and theories presented through this research have presented new ways of seeing the world in terms of focal organisations efforts to manage GHGEs within their SCs. It has been demonstrated above that these conceptions can be

compared to, and considered extensions of frameworks developed in the extant literature of both ESCM and business engagement with climate change. Finally, it was briefly highlighted how these frameworks could be tested and examined in terms of their accuracy and usefulness in terms of future research.

7.4.2 Areas of Validation and Confirmation of Existing Knowledge

As noted above, the results and discussion presented in the preceding chapters has found agreement and strengthened current knowledge, including through its confirmation within a new context and setting, in several areas. The identification of a range of driving factors and those acting as barriers for focal organisations engaging with SC GHGEs found broad agreement with both ESCM and corporate climate change strategies literature. That the factors identified within the empirical data matched those within the existing literature, demonstrated that this existing knowledge is valid within the new context of SC GHGE management, and allows this existing knowledge to be used and applied in future studies in this area. In particular, drivers and barriers for public sector focal organisations ESCM efforts were identified in the existing literature, but only to a limited degree. Their confirmation within this context can be seen to strengthen the claims of the existing literature concerning public sector focal organisations.

The activities identified as being undertaken by the focal organisations within the sample were also found to be in agreement with those noted in the literature; again here, this existing knowledge can be seen to be relevant and valid within this new context. However, with regards to existing knowledge regarding corporate climate change strategies, this research has provided new depth and understanding; this claim is made, as hitherto, scholars had identified the SC as an area of corporate action on climate change, but provided little detail. That this research also included public sector focal organisations, in addition to corporations, indicates that much of this previous research could be applied to public sector organisations in terms of how they are able to engage with climate change objectives, excluding where activities are reliant on competitive drivers (which were found to fail to operate within these public sector examples).

Supplier engagement factors identified within the data were consistent with those identified in the literature concerning the selection of suppliers more generally, again providing a contribution in terms of confirming the validity and relevance of existing knowledge in this new context and area of study. Finally, the key elements and factors for success, although somewhat generic in nature, and mirrored in more general management literature, provide a practical guide to managers wishing to enhance and improve their focal organisations ability in terms of SC GHGE management. In addition, the variables identified as impacting focal organisational approaches to SC GHGE management confirmed the importance of stakeholders within this context.

7.4.3 Overview of Contributions

In addition to the points made above, the approach this research took can be seen to have contributed towards knowledge around ESCM, corporate climate change strategies and governance. The nature of the research was qualitative and inductive, and sought to capture as many relevant factors and phenomena, in a variety of contexts, both public and private, to the research area in a holistic way. As a result, both a wide and rich picture of SC GHGE management by focal organisations in the UK was built. This in itself is felt to provide a contribution, as previous literature concerning ESCM efforts has often been narrow in scope, concerned with highly focussed contexts and situations. This is despite the literatures acknowledgement that ESCM is a wide and varied discipline. Although this is often inevitable given the constraints inherent in publishing in refereed journals, wider contexts and factors can be missed. It is felt that the approach taken here has provided a broad and detailed view of SC GHGE management efforts in the UK, including the drivers and barriers, activities, supplier engagement factors, key variables, key elements and factors for success, the workings of various interventions, as well as which activities contribute towards specific outcomes. The breadth of the results and knowledge gained through the methods provides value for a range of stakeholders including those in academia, managers within focal organisations, policymakers and SC members.

Managers and practitioners within focal organisations will be able to use the activities for SC GHGE management identified as a guide as to what could be undertaken to manage SC GHGEs, and specifically which activities should be undertaken to achieve specific outcomes with the use of the FOSCAO matrix. In addition, a range of factors

are shown in terms of supplier engagement, which can be considered by managers, and applied in their own specific contexts. The key elements and factors for success can be used by managers as areas of internal development, for those wishing to advance and improve their organisations efforts. Policymakers will also be able to use these elements and factors for success, as well as the drivers and barriers that were identified, in targeting interventions; the ERINO SC approach that was developed also provides value, as it illustrates the various workings and impacts of a range of interventions.

Finally, the activities identified as undertaken by focal organisations and the participants assertions regarding the likely increase in SC GHGE management efforts in the future, provide an indication to the suppliers of such focal organisations that they should prepare and equip themselves accordingly. Much was made in the data of providing early warning to the SC that GHGEs were becoming increasingly important to focal organisations, and results obtained through this research provide more detail to those suppliers wishing to get an early start on their competitors and prepare themselves for new demands from their focal organisation customers.

The diversity of the participants used, in terms of public and private sectors, as well as different industries, also contributes towards the breadth of the research and the relevance of the results. Although this diversity can raise questions of validity, explored in section 7.3, it was felt necessary in order to develop frameworks and theories that were applicable to a wide variety of cases.

7.5 Implications and Future research

The conclusions presented above raise a range of questions that could be considered in future research. Two areas of future research will be considered here, including a quantitative enquiry into to the level of SC GHGE management occurring and the impact of SC GHGE management activities on suppliers.

As acknowledged above, this thesis and the research that supports it undertook a qualitative approach, due to a range of factors. One weakness of such a method is its inability to answer questions of ‘how much’ SC GHGE management is occurring. Although schemes such as the CDP provide an illustration as to SC GHGE management levels, several of the participants interviewed noted that their efforts were for internal

use and not for reporting purposes or other CR related concerns. Due to this phenomenon, current levels of engagement with SC GHGEs are hard to judge, and would be an important consideration in future decisions regarding policy and regulation.

These questions could be answered through the use of a quantitative survey of large focal organisations. If such an investigation took place, questions such as the specific benefits and their levels experienced by focal organisations could also be included, as well as drivers and barriers experienced. Indeed, such an approach seems like a natural extension of the exploratory approach taken here, which has highlighted the key factors involved in SC GHGEs. This research would be able to inform the shape and scope of any future quantitative inquiry.

Another fertile area of future research concerns the impacts of focal organisation activities on the SC, and in particular on SME suppliers. At the start of the research an aspiration to include the impact of SC GHGE management activities on SMEs existed. Due to time and resources constraints, and difficulties in obtaining access to SMEs impacted by such activities this aspirations was not fulfilled. However, initial investigations highlighted that new demands generated by focal organisations may have profound impacts on SMEs. Although this research has asserted that suppliers may benefit from SC GHGE management efforts, the possibility also exists that some suppliers may be impacted adversely.

These are important questions, as SMEs make up large numbers of business, contribute extensively to economies and employ many scores of individuals. If SC GHGE management does grow as an area of CR concern and environmental management, the impacts of such measures will be important to understand. Such an area of investigation could take both qualitative and quantitative forms. Quantitative enquiries could investigate the number of suppliers impacted by SC GHGE management efforts, whilst qualitative aspects could seek to provide a deeper understanding of impacts.

Future research could also explore the impacts of a wider set of interventions, as highlighted by the difference between the options noted in section 1.6 and Table 6-4. For example, sector specific subsidies or technology deployment support could impact

embodied SC GHGEs, but would have to be considered in terms of particular contexts. The efficacy of the use of voluntary agreements could also be examined as an alternative or precursor to the expansion of economic interventions to SC GHGEs.

7.6 Final Thoughts

Taking a more cynical view of organisational claims in relation to SC GHGE management efforts, it is easy to feel that current efforts merely scratch the surface of the potential of SC GHGE management, as a method for advancing climate change mitigation goals, or in relation to wider sustainability objectives. Large public or private sector organisations control substantial amounts of resources, and are able to influence numerous actors and many elements of the systems central to modern production and consumption. The charge that organisations, chiefly commercial entities, are merely making symbolic gestures in order to further their own profit-making aims holds true in many cases.

The management of embodied SC GHGEs is however undoubtedly in its infancy, and as such, many of the actions reported by the participants are likely to constitute initial engagement efforts or pilot schemes. SC GHGE management was reported to involve numerous difficulties, challenges and complexities; these include issues with obtaining direct benefits, the opacity and complexities inherent to SCs and indeed many environmental and sustainability issues. In this sense, any engagement and effort by an organisation to increase understanding of the embodied environmental impacts within its SC can be considered at least an incremental advancement.

Critical to these final thoughts is the idea that large organisations, in both the public and private spheres are able to make a positive contribution towards climate change mitigation and wider sustainability goals. This research, it is hoped, has demonstrated the potential of large organisations to contribute positively to these contemporary problems; their potential contribution, when considered in terms of embodied environmental impacts through SCs, increases significantly. Where SC GHGE management is practised by large organisations, the benefits were reported to be broad, acting throughout the SC, from SME suppliers through to end users, including consumers.

A central question then, is how to motivate actions that utilise the power and resources of large organisations towards the provision of positive outcomes. This research has outlined several options. Although a somewhat cynical perspective is often required in academic research, the potential presented through the management of environmental impacts through SCs allows a more positive perspective to be considered. The outcomes of this research will, it is hoped, present an area where large organisations can make a positive impact.

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Appendices

Appendix A Drivers and Barriers of Business Engagement with Climate Change Mitigation Objectives

Factors Identified as Driving Business Engagement with Climate Change		
Sources		**Drivers**
(Jeswani, Wehrmeyer and Mulugetta 2008): Survey of 72 companies from Pakistan and 108 from the UK.		Managerial Commitment
		Corporate Targets
		Regulatory Compliance
		Cost savings
(Kolk, Levy and Pinkse 2008): Analysis of corporate disclosures to the CDP.		Regulatory Risks (i.e. new legislation)
		Competitive Risks (i.e. costs & market)
(Hoffman 2005): General analysis.		Short term cost reductions
		Long term future proofing against expected regulations
(Okereke 2007): analysis of FTSE 100 companies.	**Motivations:**	Profit
		Credibility
		Fiduciary obligations
		To guard against risk of losses to business
		Ethical considerations
	Drivers:	Energy prices
		Market shift
		Government regulation
		Investor awareness and pressure
		Technological changes
(Sullivan 2010): literature review.		High emissions
		Regulatory risk
		Competitive pressures
		Stakeholder expectations
		Management perception

Factors Identified as Barriers to Business Engagement with Climate Change	
Sources	**Barriers**
(Jeswani, Wehrmeyer and Mulugetta 2008): as above.	High Costs/Lack of Financial Resources
	Lack of Awareness/Knowledge
	Non-availability of Technologies
	Lack of Expertise
	Lack of Government Support or Policies
(Pinkse 2007): Examination of 136 questionnaire responses investigating corporate intentions to participate in emission trading and offsetting projects.	Regulatory Uncertainty
	Lack of Industry Leaders
	Uncertainty of Competitor Plans
	Lack of integration into Strategy
	Young Policy Mechanism/Lack of Experience
(Kolk and Pinkse 2005): Examination of 136 questionnaire responses.	Lack of Policy Framework
(Okereke 2007): Content analysis of documentation relating to climate change activities of FTSE 100 firms.	Lack of Policy Framework
	High Cost of Investment
	Uncertainty of Future Policy
	Uncertainty of Marketplace
	Lack of Consumer Demand
(Lee 2012): Cluster analysis of 241 Korean companies for the identification of strategy types.	Lack of Experience
	Organisational Change Issues
	Lack of Awareness and Information
	Lack of Financial Resources
	Lack of Human Resources
(Sullivan 2010): Investigation of European firm climate change policies and performance.	Lack of Integration into Strategy
	Lack of Policy Certainty
	Ineffective Policies (i.e. Carbon prices too low).

Appendix B Phase One Interview Schedule/Protocol

(Description: Example of the interview schedule/protocol used during interviews of phase one participants).

Start

Italicised notes for interviewer. All other content (questions) is to be read out for participant.

Introducing Statements

Read out the following: This project is seeking to explore and analyse the impacts, both current and future, of low carbon business policies and strategies on SME suppliers. In this first phase of the project, the research is seeking to explore and identify the options available to government with regards to encouraging multinational enterprises/ SC leaders to play a more central and proactive role in the creation of low carbon SCs.

Your answers will be treated with confidentiality and all responses will remain anonymous.

You (*the participant*) have read the provided information sheet, and signed the accompanying consent form, and are fully informed of your rights and responsibilities as a research participant and agree to the interview being recorded.

(*If they decline, discontinue the interview and thank them.*)

This interview will follow a semi-structured format comprising of mainly open-ended questions; these are seeking full and descriptive answers with no restrictions. The questions are seeking both your knowledge and opinion, in your capacity as a professional. The sequence of the questions is subject to change.

Background Variables & Warm-up

- Participant's position and experience to be clarified (initial information already gained in participant identification regarding their qualifications).

- Job title:
- Specific responsibilities (publications if academic):
- Time in position:
- Time in relevant related position:

- In your professional opinion, what is the best way of dealing with the issue of de-carbonisation of supply chains?

Main Interview Questions & Topics: Current situation & near future (next 2 years):

1. Who is leading current supply chain decarbonisation efforts?
    a. What are the characteristics they hold that mean they are leading?
2. How would you describe the current policy position of the government with regards to the creation of low carbon supply chains?
    a. What do you see government's role being in this regard?
    b. Which businesses are being targeted by these policies?
    c. How effective do you think this policy position is at achieving its aim?
    d. What is your view on the balance between regulatory and non-regulatory policy instruments?
    e. Are there any disadvantages involved in the current approach?
3. What actions are the government taking with regards the de-carbonisation of public organisations supply chains?

Policy Evolution and the Future (up to 2020)?

1. Who will lead work on supply chain decarbonisation over the next decade (i.e. which actor)?
2. How do you see the policy agenda/environment evolving over the next decade with regards to the de-carbonisation of supply chains (*i.e. those policies that may impact on firms operating in/throughout supply chains*)?
3. How do you see the government's role, and associated policies, changing during this period?
    a. Would a wider spectrum of businesses be targeted in the future (i.e. SMEs)?

   b. What actions (set of policies) could government take to enable/encourage a situation where MNEs/supply chain leaders to play a more central and proactive role in de-carbonising their supply chains?
4. What role do you think non-regulatory policy instruments could play in this area of policy in the future?
5. How do you see the role of other actors/organisations evolving over this period?
   a. Third sector organisations?
6. How do you see the role of public sector organisations, with regards to the de-carbonisation of their own supply chains, evolving? (in their capacity of purchasing organisations)

Closing comments

Thank you for your time and attention. *Make arrangements for checking and approval of interview transcript.*

Interview close

Appendix C Phase Two Interview Schedule/Protocol

(Description: Example of the interview schedule/protocol used during interviews of phase two participants).

Start

Italicised notes for interviewer. All other content (questions) is to be read out for participant.

Introducing Statements

Read out the following: This project is seeking to deepen understanding around supply chain decarbonisation strategies including their development, implementation and administration. A further objective is to establish the impact of these strategies upon SME suppliers.

This interview will follow a semi-structured format comprising of mainly open-ended questions; these are seeking full and descriptive answers with no restrictions. The questions are seeking both your knowledge and opinion, in your capacity as a professional.

Your answers will be treated with confidentiality and all responses will remain anonymous.

You (*the participant*) have read the provided information sheet, and signed the accompanying consent form, and are fully informed of your rights and responsibilities as a research participant and agree to the interview being recorded.

(*If they decline, discontinue the interview and thank them.*)

Introductory and background questions (some initial information already gained from secondary sources)

- Participants position and areas of responsibility to be clarified:
    - Organisation:
    - Job title:
    - Areas of responsibility:

- Time in position:

- Background information on organisation:
  - Sector:
  - Size (i.e. turnover, number of staff etc.):
  - Main products:

Supply chain decarbonisation strategy

1. How would you describe current trends in Scope Three/supply chain emissions management?
2. How would you describe your organisation's supply chain decarbonisation/Scope Three emissions management strategy?
   a. Reporting versus reductions?
   b. Data for reporting – estimated/modelled first and then quantified?
3. Why did you decide to engage with supply chain decarbonisation? What prompted the organisation to start?
4. What departments within the organisation, and actors outside, were involved in the development of the strategy?
   a. Execution of strategy?
5. What obstacles and challenges were encountered & how were they overcome?

Relationship with existing supply chain management efforts

6. To what extent did existing supply chain management efforts inform or support the decarbonisation strategy?
7. Has the supply chain decarbonisation strategy been integrated into wider supply chain management efforts?

Supplier impacts and relations

8. Is the strategy applied to all suppliers? If not, why?
   a. What factors were taken into consideration when making this decision? (i.e. levels of communication, cooperation and collaboration, length of trading relationship etc.)?
   b. Has it reached the SME level?

9. How was the strategy introduced/applied to the suppliers (i.e. how was it start/initiated etc.)?
    a. Were they offered any support?
10. Do you think the programme has altered the trading relationship with any of the suppliers?
11. What impact do you think the strategy has had on the suppliers?

Outcomes

12. What do you think the strengths and weaknesses of the strategy have been?
13. How do you think organisations can capture a direct benefit from such activities?

Future and evolution of the strategy

14. How do you see (organisations name) strategy evolving in the future?
15. How do you see the future of supply chain decarbonisation more widely?

Closing comments

Thank you for your time and attention. *Make arrangements for checking and approval of interview transcript.*

Interview close

Appendix D Participant Recruitment Correspondence Examples

(Description: Example of correspondence email sent to individuals identified as holding appropriate knowledge and experience. Correspondence sent in order to recruit individuals and encourage their participation.)

Dear [redacted],

I am writing to you as I am seeking participants for research interviews, either face-to-face or via the telephone lasting from 30-60 minutes. These interviews are being used to collect data for a PhD project I am working on concerning the activities undertaken by supply chain leading organisations in order to manage their Scope Three/supply chain emissions.

From initial research I understand that the [redacted] has engaged with its supply chain in order to measure and manage the associated carbon emissions, resulting in signification reductions; consequently I feel you may be able to add a unique insight to the project through your role at the organisation and the expertise and knowledge you hold. I have already canvassed opinion from one UK [redacted] business and feel that your and [redacted] inclusion would add significantly to the project.

As such I would be interested in discussing the possibility of canvassing your professional knowledge and expertise on these issues through an interview. I have attached an information sheet which further outlines both the project, and my request.

I look forward to your reply.

Kind regards

Tom Long

Appendix E Phase One and Two Participant Information Sheet Examples

(Description: Examples of the information sheet sent as attachments during the participant recruitment process. Information sheet was designed to provide an overview of the project and guide to the interview procedures used, in the event the individual agreed to participate).

PhD Researcher Seeking Individuals with Knowledge or Experience of Scope Three/Supply Chain Emissions Management

Supply chains are increasingly recognised as an avenue through which to pursue the management and reduction of Greenhouse Gas (GHG) emissions, as they can contain in excess of 70% of the emissions associated with an organisation's operations.

This poses risks and challenges as these emissions fall outside the boundaries of organisations, requiring the cooperation and action of suppliers.

This research is seeking to examine and deepen understanding around the strategies undertaken by supply chain leading organisations in order to engage with their Scope Three emissions, as well as the impacts of these strategies on their SME suppliers.

The project is seeking individuals who have developed, led or been involved in initiatives aimed at reducing and managing carbon within supply chains.

As a research participant, you will be asked to:

- Submit to an interview, either in person or via telephone, taking no more than one hour.

  *All information provided will be stored **securely** and presented **anonymously**.

By taking part, your organisation will:

- Be able to aid in deepening understanding around Scope Three emissions strategies and their impact on SMEs, an area critical to the future success and health of both organisations and the environment.
- Be presented with all research findings, intelligence held on Scope Three emissions strategies, their impact on SME suppliers and the likely future direction of such efforts.

For further information and to discuss your potential involvement, please contact:

Mr Thomas Long, Sustainability Research Institute, Room 9.124, Earth & Environment Building, University of Leeds, Leeds, LS2 9JT; Telephone: 07766 993100; Email: eetbl@leeds.ac.uk

Research is being conducted for a University of Leeds PhD project, in affiliation with the 'Centre for Climate Change Economics and Policy'.

Appendix F Participant Consent Form

(Description: Examples of the consent forms presented to participants prior to the semi-structured interviews, as part of procedures in line with ethical considerations. The same consent forms were used in data collection phases one and two).

Participant Consent Form

Title of Research Project: Low Carbon Supply Chain Policies and their Impact on Small and Medium Sized Suppliers

Name of Researcher: Mr Thomas Benjamin Long

Initial the box if you agree with the statement to the left

1 I confirm that I have read and understand the information sheet explaining the above research project and I have had the opportunity to ask questions about the project. ☐

2 I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. *Contact details for researcher: eetbl@leeds.ac.uk, 07766 993100* ☐

3 I understand that my responses will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research. ☐

4 I agree for the data collected from me to be used in future research. ☐

5 I agree to take part in the above research project and will inform the principal investigator should my contact details change. ☐

6. I agree to the recording of this interview, and understand that the audio recordings will be stored securely and anonymously, and that my anonymity will be protected at all times. ☐

_____	_____	_____
Name of participant	Date	Signature
(*or legal representative*)		
___Thomas B. Long__	_____	_____
Lead researcher	Date	Signature

To be signed and dated in presence of the participant

Copies:

Once this has been signed by all parties the participant should receive a copy of the signed and dated participant consent form, the letter/pre-written script/information sheet and any other written information provided to the participants. A copy of the signed and dated consent form should be kept with the project's main documents which must be kept in a secure location.

Appendix G Research Participant Information Table

(Description: Table below provides information on the individuals interviewed during the data collection process. This includes the codes they were assigned and which were used during the writing of the thesis. Participant job title, the type of organisation they were employed by or represented, as well as the date, length and type of interview conducted are all noted).

Participant List & Codes – Phase One and Two

Interview Code/ Number	Participant Job Title	Organisation Type	Date	Type & Length
A01	Senior Policy Advisor	Business Representation Organisations	10th December 2010	57 Minutes/In Person
A02	Head of Corporate Relations	Local Business Support and Representation Organisation	18th January 2011	36 Minutes/ In Person
A03	Operations Director	Regional Business Support Organisation	1st February 2011	58 Minutes/ In Person
A04	Senior Account Manager	Solution Based NGO	4th February 2011	44 Minutes/ In Person
A05	Program Manager	Regional Intelligence Network	07th February 2011	36 Minutes/ In Person
A06	Research Fellow	Policy Think Tank	11th February 2011	34 Minutes/ Telephone
A07	Environmental Campaign Organiser	Regional Business Support Organisation	21st February 2011	42 Minutes/ In Person
A08	Corporate Strategy Consultant	Global Management Consultancy	25th February 2011	28 Minutes/ In Person
A09	Post-Doctoral Researcher	Academic Institution	1st March 2011	50 Minutes/ In Person

				(Notes only)
A10	Senior Strategy Manager	National Low Carbon Business Support Organisation	9th March 2011	28 Minutes/ Telephone
A11	Senior Sustainability Manager	Sustainability Think Tank	18th March 2011	32 Minutes/ Telephone
Interview Code/ Number	**Participant Job Title**	**Organisation Type**	**Date**	**Type & Length**
B01	(2x Participants) Head of CSR Strategy & Policy for Procurement; Climate Change & Sustainability Officer	Multinational Telecoms Service Provider	23rd of Sept. 2011	29 Minutes/ Telephone
B02	Associate Director of Brownfield and Sustainability	British House building Company	24th of Oct. 2011	37 Minutes/ Telephone
B03	Science & Technology Leader	Multinational Consumer Goods Company	25th Oct. 2011	45 Minutes/ Telephone
B04	VP of Sustainability	Multinational Pharmaceutical and Consumer Healthcare Goods Company	1st Nov. 2011	32 Minutes/ Telephone
B05	Executive Director	Regional Social Enterprise	7th Nov. 2011 Telephone	41 Minutes/ Telephone
B06	Capability Manager	British Water Utility Company	8th Nov. 2011	44 Minutes/ In Person
B07	Group environment health and safety manager for the UK business	Dairy Products Company	9th Nov. 2011	55 Minutes/ In Person

B08	Head of Sustainability	Construction, Property & Housing Company	9th Nov. 2011	42 Minutes/ Telephone
B09	Senior Sustainability Manager	Multinational Construction & Development Company	11th Nov. 2011	1 Hour 04 Minutes/ In Person
B10	Regional Manager, North of England	Multidisciplinary Consultancy Company	14th Nov. 2011 Telephone	18 Minutes/ Telephone
B11	Head of Supply Chain Carbon Reduction	Multinational Grocery and General Merchandise Retailer	18th Nov. 2011 Telephone	37 Minutes/ Telephone
B12	Sustainability Officer	County Council	21st Nov. 2011	40 Minutes/ In Person (Notes only)
B13	Low Carbon Consultant	Global Consultancy and Professional Services Firm	2nd Dec. 2011	38 Minutes/ Telephone
B14	Responsible Procurement Manager	Top-tier Regional Administrative Body	7th Dec. 2011	49 Minutes/ In Person
B15	Head of Supply Chain Research	Environmental Consultancy	7th Dec. 2011	43 Minutes/ In Person
B16	(2x Participants) Environmental Advisor (Construction); Sustainable Procurement Advisor	Government Agency	19th Dec. 2011	47 Minutes/ Telephone
B17	Climate Change Officer	County Council	27th Jan. 2012 Telephone	07 Minutes/ Telephone + Initial Email Correspondence

B18	(2x Participants) Environment and Sustainability Officer; Research Fellow	University	1st February 2012	58 Minutes/ In Person
B19	Sustainability Officer	University	7th February 2012	33 Minutes/ In Person
B20	Operations Director	Sustainability Unit of National Public Service Provider	24th February 2012	26 Minutes/ Telephone

Average Interview Time:

Phase One: 40 Minutes

Phase Two: 39 Minutes

Appendix H FOSCAO Matrix

(Description: Full matrix analysis of activities and objectives and additional outcomes available from engagement with SC GHGE management).

Introduction

The following analysis illustrates the matrixes produced by plotting SC GHGE activities against SC GHGE management objectives and the additional benefits reported to be available. The relationships illustrated within the matrixes include those that are:

- “Direct” = activity is central to the fulfilment of the objective or outcome.
- “Contribute” = activity contributes towards an objective or outcome, but in isolation would be unable to fulfil objective or outcome.
- “Conditional Contribution/Direct” = where activity could, if designed and applied appropriately, directly fulfil objective/contribute to fulfilment of objective.
- “None” = no relationship between activity and outcome/objective

Appendix H.1 FOSCAO Matrix: Activities Beyond Tier One Suppliers

Objectives or Outcome Impacted →	**Reporting & Disclosure** **(Activity that help the focal organisation to collect and collate information).**	**GHGE Reduction & Management** **(Activities that help focal organisation to reduce SC GHGEs).**	**Efficiency and Cost Reductions** **(Activities that also lead to cost savings and increased efficiency).**	**Increased Financial Resilience of SC** **(Activities that lead to suppliers saving money and being more financial resilience).**	**Improving SC Relationships** **(Activities that improve relationships within the supply chain).**	**Enhancing Reputation** **(Activities that enhance the reputation of the focal organisation).**
Conversation & Dialogue (Informal communication such as information sharing or to establish likely future expectations).	Conditional Contribution (where focal organisation dialogue is aimed at encouraging reporting and disclosure by SC).	Conditional Contribution (where focal organisation aim is to encourage better management of GHGEs by SC).	Conditional Contribution (where focal organisation aim is to encourage better management of GHGEs by suppliers, which leads to efficiency gains).	Conditional Contribution (where focal organisation activities lead to efficiency gains).	Conditional Direct (where conversation and dialogue improves SC relationship with focal organisation).	Conditional Contribution (where such efforts are publicised and well received).
Management Standards (used to ensure certain management standards by the suppliers of suppliers).	Direct (i.e. B06 and their use of CEMARS with suppliers).	Conditional Contribute (improves the management of GHGEs within SC).	Conditional Contribution (where efforts to improve the management of GHGEs within SC increase efficiency).	Conditional Contribution (where efforts to improve the management of GHGEs within SC increase efficiency).	No (no direct focal organisation relationship required).	Conditional Direct (where their use is publicised as efforts to better manage SC GHGEs).

Appendix H.2 FOSCAO Matrix: Activities within Tier One Suppliers

Objectives or Outcome Impacted →	**Reporting & Disclosure** **(Activity that help the focal organisation to collect and collate information).**	**GHGE Reduction & Management** **(Activities that help focal organisation to reduce SC GHGEs).**	**Efficiency and Cost Reductions** **(Activities that also lead to cost savings and increased efficiency).**	**Increased Financial Resilience of SC** **(Activities that lead to suppliers saving money and being more financial resilience).**	**Improving SC Relationships** **(Activities that improve relationships within the supply chain).**	**Enhancing Reputation** **(Activities that enhance the reputation of the focal organisation).**
Information Sharing & Dissemination **(Both formal, such as questionnaire surveys and information sheets, and informal efforts, such as conversation).**	Direct (GHGE information provided by suppliers required for reporting and disclosure).	Conditional Contribution (where information provided by suppliers is used to enable GHGEs reductions).	Conditional Contribution (where information provided by suppliers is used to enable GHGEs reductions).	Conditional Contribution (where information provided by focal organisation, leads to supplier actions that reduce their costs).	Contribution (communication central to good supply relations).	Conditional Contribution (GHGE reporting and disclosure demonstrates transparency and action on SC GHGEs)
GHGE Inclusion in Tenders and Contract **(Requirements to report GHGEs, to reduction targets included in selection criteria or contracts).**	Conditional Direct (where GHGE reporting and disclosure specified).	Conditional Direct (where GHGE reductions stipulated).	Conditional Contribution (where contract stipulates GHGE reductions, which increase efficiency).	Conditional Contribution (where supplier is able to achieve costs savings).	None (requirements introduced as condition of business).	Conditional Contribution (where it is a demonstration of action to manage SC GHGEs).
Collaboration and Partnering Agreements **(Closer, more collaborative relations, leading to, and enabling enhanced SC GHGE management efforts).**	Conditional Direct (where agreement includes reporting and disclosure requirements).	Conditional Direct (where agreements includes reduction requirements).	Conditional Contribution (where GHGE reductions specified in agreement lead to cost savings).	Conditional Contribution (where it contributes to supplier efficiency).	Direct (closer working between supplier and focal organisation).	Conditional Contribution (can be used to signify focal organisation efforts within suppliers).
Direct Supplier Interventions **(Such as free GHGE**	Conditional Direct (with interventions such as free GHGE assessments, which	Conditional Direct (where focal organisation funds contribute to capital	Conditional Direct (where funds that reduce GHGEs, also increase efficiency).	Conditional Direct (capital works increase efficiency and reduce costs).	Conditional Direct (where such finding improves relationship).	Conditional Contributing (where scheme is used within CR

assessment or supplier funding).	provide GHGE data from suppliers).	works that reduce GHGEs).				efforts).
Management Standards & Verification Activities (To ensure standardised management and data accuracy).	Direct (i.e. B06 and their use of CEMARS with suppliers).	Contribution (improves the management of GHGEs within SC).	Conditional Contribution (where efforts to improve the management of GHGEs within SC increase efficiency).	Conditional Contribution (where efforts to improve the management of GHGEs within SC increase efficiency).	Conditional Contribution (where expected supplier actions are clarified, reducing uncertainty).	Conditional Direct (focal organisation able to demonstrate SC action).
Supplier Involvement in Design (Where supplier provide input into design process to reduce embodied GHGEs).	None	Contribution (supplier input able to reduce GHGE of SC).	Conditional Contribution (where supplier input able to reduce GHGE, which increase efficiency).	None	Conditional Direct (closer working likely to lead to improved business relations).	Conditional Contribution (if efforts can be advertised as such).
Supplier Schools & other Training (Focal organisation provides training to SC).	Conditional Direct (if SC trained in how to conduct GHGE assessment and report data).	Conditional Direct (if supplier trained in reducing GHGEs).	Conditional Contribution (if supplier reduces GHGEs as results of training).	Conditional Contribution (suppliers reduce GHGEs as results of training).	Conditional Direct (is supplier perception of training efforts is positive).	Conditional Direct (if scheme is used to advance CR).

Appendix H.3 FOSCAO Matrix: Activities within Focal Organisation

Objectives or Outcome Impacted →	**Reporting & Disclosure (Activity that help the focal organisation to collect and collate information).**	**GHGE Reduction & Management (Activities that help focal organisation to reduce SC GHGEs).**	**Efficiency and Cost Reductions (Activities that also lead to cost savings and increased efficiency).**	**Increased Financial Resilience of SC (Activities that lead to suppliers saving money and being more financial resilience).**	**Improving SC Relationships (Activities that improve relationships within the supply chain).**	**Enhancing Reputation (Activities that enhance the reputation of the focal organisation).**
SC GHGE Modelling & Assessment (ID of GHGE hotpots using models and financial information)	Direct (Provides unverified SC GHGE information, suitable for some reporting requirements).	Conditional Contribution (where modelling used to ID hotspots and enable reduction actions).	Conditional Contribution (where modelling used to ID inefficiencies).	Conditional Contribution (where SC inefficiencies identified within specific suppliers).	None	Conditional Contribution (if used towards CR efforts).
Design Changes to Reduce SC GHGEs (changes to design of product or service result in reduced SC GHGEs).	None	Direct	Conditional Direct (f design changes also increase efficiency).	None	None	Conditional Contribution (where changes reduce GHGE, and used towards CR).
Internal Training and Information Provision (ensuring all relevant departments have required knowledge and skills).	Conditional Direct (where information needs to be shared internally).	Conditional Contribution (where information needs to be shared internally).	Conditional Contribution (where information needs to be shared internally).	Conditional Contribution (where information for suppliers is held by none-appropriate internal department).	Conditional Contribution (where training and information improve supplier management).	None
Embedding of SC GHGE into Commercial Teams (where SC GHGE management functions transferred into commercial teams).	Conditional Contribution (where this mainstreaming improves collection of information from SC).	Contribution (eases efforts to engage with, and influence, suppliers towards these aims).	Contribution (eases efforts to engage with, and influence, suppliers towards these aims).	None	Conditional Contribution (where mainstreaming improves supplier management efforts).	Conditional Contribution (if integration of efforts used towards CR aims).

Appendix H.4 FOSCAO Matrix: Activities Downstream in Supply Chains

Objectives or Outcome Impacted →	**Reporting & Disclosure** **(Activity that help the focal organisation to collect and collate information).**	**GHGE Reduction & Management** **(Activities that help focal organisation to reduce SC GHGEs).**	**Efficiency and Cost Reductions** **(Activities that also lead to cost savings and increased efficiency).**	**Increased Financial Resilience of SC** **(Activities that lead to suppliers saving money and being more financial resilience).**	**Improving SC Relationships** **(Activities that improve relationships within the supply chain).**	**Enhancing Reputation** **(Activities that enhance the reputation of the focal organisation).**
Influencing Customer Use of Products for GHGE Reductions (incl. product labelling).	Conditional Contribution (only in relation to product labelling efforts, which could involve data collection from suppliers).	None	None	None	None	Conditional Direct (where efforts used towards CR aims).
Research on Consumers Use of Products	Conditional Contribution (where focal organisation includes downstream GHGEs within its reporting).	Conditional Contribution (where consumer use highlights changes that can reduce SC GHGEs).	Conditional Contribution (where consumer use highlights changes that can reduce GHGEs).	None	None	Conditional Contribution (where efforts used towards CR aims).

Appendix H.5 Activities in Relation to Outcomes

This tables that follow illustrate which activities to undertake for a given objectives or outcome. For example, activities that are required, or contribute to disclosure and reporting objectives are illustrated first.

Appendix H5.1 Activities for Disclosure and Reporting:

- See Table 6-2: FOSCAO matrix relationships for reporting and disclosure. Page 205.

Activities for GHGE Reductions:

- See Table 6-3: FOSCAO matrix relationships for greenhouse gas emission reductions. Page 208.

Appendix H5.2 Activities for Efficiency Increases and Cost Reductions:

Activities for Increased Financial Resilience of Suppliers and the Supply Chain		
Relationship	**SC Stage**	**Activities**
Direct	Beyond Tier One	
	Tier One	
	In-house	
	Downstream	
Contribution	Beyond Tier One	
	Tier One	
	In-house	
	Downstream	
Conditional Direct	Beyond Tier One	
	Tier One	Direct Supplier Interventions
	In-house	
	Downstream	
Conditional Contribution	Beyond Tier One	Conversation and Dialogue, Management Standards.
	Tier One	Information Sharing and Dissemination, GHGE Inclusion in Tendering and Contracts, Collaboration and Partnering Agreements, Management Standards and Verification Activities, Supplier Schools and Training.
	In-house	SC GHGE Modelling and Assessment, Internal Training and Information Provision.
	Downstream	

Appendix H5.3 Activities for Increased Financial Resilience of Suppliers

Activities for Increased Financial Resilience of Suppliers and the Supply Chain		
Relationship	**SC Stage**	**Activities**
Direct	Beyond Tier One	
	Tier One	
	In-house	
	Downstream	
Contribution	Beyond Tier One	
	Tier One	
	In-house	
	Downstream	
Conditional Direct	Beyond Tier One	
	Tier One	Direct Supplier Interventions
	In-house	
	Downstream	
Conditional Contribution	Beyond Tier One	Conversation and Dialogue, Management Standards.
	Tier One	Information Sharing and Dissemination, GHGE Inclusion in Tendering and Contracts, Collaboration and Partnering Agreements, Management Standards and Verification Activities, Supplier Schools and Training.
	In-house	SC GHGE Modelling and Assessment, Internal Training and Information Provision.
	Downstream	

Appendix H5.4 Activities for Improving Supply Chain Relationships:

Activities for Improving Supply Chain Relationships		
Relationship	**SC Stage**	**Activities**
Direct	Beyond Tier One	
	Tier One	Collaboration and Partnering Agreements.
	In-house	
	Downstream	
Contribution	Beyond Tier One	
	Tier One	Information Sharing and Dissemination.
	In-house	
	Downstream	
Conditional Direct	Beyond Tier One	Conversation and dialogue.
	Tier One	Direct Supplier Interventions, Supplier Involvement in Design, Supplier Schools and Training.
	In-house	
	Downstream	
Conditional Contribution	Beyond Tier One	
	Tier One	Management Standards and Verification Activities.
	In-house	Internal Training and Information Provision, Embedding of GHGE into Commercial Teams.
	Downstream	

Appendix H5.5 Activities for Enhancing Focal Organisation Reputation:

Activities for Enhancing Focal Organisation Reputation		
Relationship	**SC Stage**	**Activities**
Direct	Beyond Tier One	
	Tier One	
	In-house	
	Downstream	
Contribution	Beyond Tier One	
	Tier One	
	In-house	
	Downstream	
Conditional Direct	Beyond Tier One	Management Standards.
	Tier One	Management Standards and Verification Activities, Supplier Schools and Training.
	In-house	
	Downstream	Influencing Consumer Use of Products.
Conditional Contribution	Beyond Tier One	Conversation and Dialogue.
	Tier One	Information Sharing and Dissemination, GHGE Inclusion in Tenders and Contracts, Collaboration and Partnering Agreements, Direct Supplier Interventions, Supplier Involvement in Design.
	In-house	SC GHGE Modelling and Assessment, Design Changes, Embedding of GHGE into Commercial Teams
	Downstream	Research on Consumer Use of Products.

Appendix H.6 Outcomes in Relation to Activities

The following tables illustrate which outcomes and objectives which activities contribute towards. For instance, the initial list highlights which outcomes and objectives 'conversation and dialogue' carried out beyond the first tier of the supply will help achieve.

Appendix H6.1 Beyond Tier One Activity:

Beyond Tier One Activities		
Activity	**Relationship**	**Objective/Outcome**
Conversation and Dialogue	Direct	
	Contribution	
	Conditional Direct	Improving SC Relationships
	Conditional Contribution	Reporting and Disclosure, GHGE Reductions and Management, Efficiency and Cost Reductions, Enhancing Reputation.
Management Standards	Direct	Reporting and Disclosure.
	Contribution	
	Conditional Direct	GHGE Reduction and Management, Enhancing Reputation.
	Conditional Contribution	GHGE Reduction and Management, Efficiency and Cost Reductions, Increased Financial Resilience of SC.

Appendix H6.2 Tier One Activity:

Tier One Activities		
Activity	**Relationship**	**Objective/Outcome**
Information Sharing and Dissemination	Direct	Reporting and Disclosure.
	Contribution	Improving SC Relationships
	Conditional Direct	
	Conditional Contribution	GHGE Reductions and Management, Efficiency and Cost Reductions, Increased Financial Resilience of SC, Enhancing Reputation.
GHGE Inclusion in Tenders and Contracts	Direct	
	Contribution	
	Conditional Direct	Reporting and Disclosure, GHGE Reductions and Management.
	Conditional Contribution	Efficiency and Cost Reduction, Increased Financial Resilience of SC, Enhancing Reputation.
Collaboration and Partnering Agreements	Direct	Improving SC Relationships.
	Contribution	
	Conditional Direct	Reporting and Disclosure, GHGE Reduction and Management.
	Conditional Contribution	Efficiency and Cost Reductions, Increased Financial Resilience of SC, Enhancing Reputation.
Direct Supplier Interventions	Direct	
	Contribution	
	Conditional Direct	Reporting and Disclosure, GHGE Reduction and Management, Efficiency and Cost Reductions, Increased Financial Resilience of SC.
	Conditional	Improved SC Relationships.

	Contribution	
Management Standards and Verification Activities	Direct	Reporting and Disclosure.
	Contribution	GHGE Reduction and Management.
	Conditional Direct	Enhancing Reputation.
	Conditional Contribution	Efficiency and Cost Reductions, Increased Financial Resilience of SC, Enhancing Reputation.
Supplier Involvement in Design	Direct	
	Contribution	GHGE Reduction and Management.
	Conditional Direct	Improving SC Relationships.
	Conditional Contribution	Efficiency and Cost Reductions, Enhancing Reputation.
Supplier Schools and Training	Direct	
	Contribution	
	Conditional Direct	Reporting and Disclosure, GHGE Reduction and Management, Improving SC Relationships, Enhancing Reputation.
	Conditional Contribution	Efficiency and Cost Reductions, Increased Financial Resilience of SC.

Appendix H6.3 In-house Activities:

In-house Activities		
Activity	**Relationship**	**Objective/Outcome**
SC GHGE Modelling and Assessment	Direct	Reporting and Disclosure.
	Contribution	
	Conditional Direct	
	Conditional Contribution	GHGE Reduction and Management, Efficiency and Cost Reductions, Increased Financial Resilience of SC, Enhancing Reputation.
Design Changes	Direct	GHGE Reduction and Management.
	Contribution	
	Conditional Direct	Efficiency and Cost Reductions.
	Conditional Contribution	Enhancing Reputation.
Internal Training and Information Provision	Direct	
	Contribution	
	Conditional Direct	Reporting and Disclosure, GHGE Reductions and Management.
	Conditional Contribution	Efficiency and Cost Reductions, Increased Financial Resilience of SC, Enhancing Reputation.
Embedding of SC GHGE into Commercial Teams	Direct	
	Contribution	GHGE Reduction and Management, Efficiency and Cost Reductions.
	Conditional Direct	
	Conditional Contribution	Reporting and Disclosure, Improving SC Relationships, Enhancing Reputation.

Appendix H6.4 Downstream Activities:

Downstream Activities		
Activity	**Relationship**	**Objective/Outcome**
Influencing Customer Use of Products for GHGE Reductions	Direct	
	Contribution	
	Conditional Direct	Enhancing reputation.
	Conditional Contribution	Reporting and Disclosure.
Research on Consumers Use of Products	Direct	
	Contribution	
	Conditional Direct	
	Conditional Contribution	Reporting and Disclosure, GHGE Reduction and Management, Efficiency and Cost Reduction, Enhancing Reputation.