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Title:

An exploration of intervention options to enhance the management of supply chain greenhouse gas emissions in the UK

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Abstract:

The management of greenhouse gas emissions (GHGEs) within the supply chains of large organisations is receiving increasing attention as a way to achieve climate mitigation objectives.

Climate mitigation policy for direct GHGEs and organisations' role in managing environmental impacts within supply chains is well covered in the literature. However, the targeting of indirect GHGE from the supply chain, and the intervention options that exist are still underdeveloped, especially in terms of information and informal based interventions, or support and capacity building approaches.

Interview data was collected on the supply chain GHGE management actions of large supply chain leading organisations in the UK such as brand companies and public sector organisations. This is used to construct framework through which an initial and exploratory assessment of the efficacy and likely impacts of a range of interventions, designed to increase levels of supply chain GHGE management by supply chain leading organisations, is conducted.

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It is demonstrated that the management of indirect GHGs could form an additional strategy for climate mitigation objectives, with information based options representing a good option for policymakers.

Research Highlights

- Policy interventions on managing GHG emissions in supply chains are designed.
- These are evaluated using qualitative data collected from a range of stakeholders.
- It develops an 'Emission Reduction Intervention Options' (ERINO) supply chain approach.
- Information based interventions are recommended as a 'middle way'.

Key Words:

Climate Change Mitigation Policy; Environmental Supply Chain Management; Intervention Framework; Supply Chain Leading Organisations

1. Introduction

Climate change mitigation involves the reduction of greenhouse gas emissions (GHGE) to reduce risks posed by anthropogenic climate change (Füssel, 2007; Yohe and Strzepek, 2007). Supply chains can contain between 60-80% of the GHGs associated with the production and consumption of goods and services (CDP, 2008; Huang et al., 2009); meaning, the greatest climate impacts come from indirect processes within supply chains, such as GHGs associated with energy used in the production of raw materials (Scipioni et al., 2010).

Embodied GHGs, or the sum of all emissions involved in the production of a good or service, pose corporate responsibility and future regulatory risks to organisations that lead and control supply chains. Such organisations, known as supply chain leading organisations or focal organisations,

(Kovács, 2008; Seuring and Müller, 2008) are often multi-national consumer brand manufacturers, retailers or key public sector institutions with large procurement responsibilities.

Whilst supply chain GHGs pose risks environmentally and to supply chain leading organisations, a survey of executives found that less than a quarter had acted (Brickman and Ungerman, 2008). This demonstrates that current engagement with this area of supply chain management is restricted (Ihlen, 2009).

There is evidence that supply chain leading organisations are attempting to manage their supply chain GHGs, through programs such as 'Carbon Disclosure Project Supply Chain programme' (CDP, 2010, 2011) and the Courtauld Commitment (WRAP, 2013). The management of these GHGs potentially forms an additional way to achieve climate mitigation objectives. Consequently, supply chain leading organisations and governments require an understanding of supply chain GHGs and how they are managed (Downie and Stubbs, 2013; Matthews et al., 2008).

Whilst economic and some information based interventions have previously been identified in relation to supply chain GHGs (Abdallah et al., 2010; Bojarski et al., 2009; Chaabane et al., 2012; Davis et al., 2011; Diabat and Simchi-Levi, 2009), these efforts fail to examine wider intervention options. The same criticism is open to alternative perspectives, such as research on product-choice editing² (Bocken and Allwood, 2012). Whilst previous frameworks are too generic and do not consider the impacts or implications of interventions (Aivazidou et al., 2013). This research will contribute by identifying key drivers, barriers and management activities within the context of the management of supply GHGs, and examine previously unexplored options, such as information and informal regulatory options as well as support and capacity building approaches.

² 'Product Choice Editing' is the limiting the choices available to consumers towards a predefined end-goals; in this case towards more sustainable or low GHGE products Sustainable Consumption Roundtable, 2006. Looking back, looking forward: Lessons in choice editing for sustainability. Sustainable Development Commission and National Consumer Council, London, UK..

1.1 Business and Organisational Responses to Climate Change and Environmental/Green Supply Chain Management

Increasing numbers of practitioners and scholars see organisations at the centre of the challenge to mitigate GHGEs (Downie and Stubbs, 2013; Gouldson and Sullivan, 2013; Jeswani et al., 2008; Voss and Clegg, 2010). Some highlight that organisations have a central role in reducing the GHGEs associated with products and services, through product choice editing and marketing campaigns (Bocken and Allwood, 2012). By attributing GHGEs to organisations that lead and control supply chains, policy and regulation can target these organisations to affect a larger proportion of GHGEs (Móznér, 2013).

The management of supply chain GHGEs, through and by supply chain leading organisations more closely aligns GHGEs with consumption, following concepts such as consumer responsibility (Munksgaard and Pedersen, 2001; Proops et al., 1993) and ecological footprinting (Wackernagel and Rees, 1996). These approaches allow environmental management of the product, meaning emissions are localised, allowing responsibility to be assigned for their management (Bastianoni et al., 2004).

The management of GHGEs within organisational supply chains is noted in relation to voluntary corporate action on climate change, including product development and process and supply improvements (Boiral, 2006; Dunn, 2002; Hoffman, 2005; Jeswani et al., 2008; Kolk and Pinkse, 2005; Schultz and Williamson, 2005; Sprengel and Busch, 2010; Weinhofer and Hoffman, 2010). Key activities previously identified include the development of specific systems (both internal and external) to develop and control supplier engagement and collaboration (Jeswani et al., 2008), design changes (Donnelly et al., 2006), supplier enabling and capacity development (Ciliberti et al., 2008; Lamming and Hampson, 1996), supplier requirements such as codes of conduct, auditing and questionnaires (Ciliberti et al., 2008; Lamming and Hampson, 1996; Preuss, 2010) and supplier forums (Keating et al., 2008).

A range of driving factors are responsible for businesses engagement with this area, including competitive pressures, fluctuating energy prices, market shifts and stakeholder demands (Jeswani et al., 2008; Kolk and Pinkse, 2008; Okereke, 2007; Sullivan, 2010). Barriers include uncertainty, high costs, lack of technological development, low levels of awareness and little government pressure (Jeswani et al., 2008; Lee, 2012; Pinkse, 2007; Sullivan, 2010).

This area of climate change action overlaps in its scope with concepts of environmental supply chain management (ESCM) and green supply chain management (GSCM). Environmental supply chain management (ESCM) can be considered as “integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to consumers as well as end-of-life management of the product” (Srivastava, 2007: 53-54). Whilst GSCM is the integration of “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”. As such, the management of supply chain GHGEs is linked to ESCM and GSCM, however this literature has focussed upon management of energy consumption or gaseous emissions to a lesser degree (Lee, 2011). Existing efforts have either focused upon GHGE management within small and medium sized enterprise (SME) supply chains (Côté et al., 2008), or in terms of supplier selection (Hsu et al., 2013), providing an opportunity for this research to contribute.

1.2 Environmental Policy and Climate Change Mitigation Regulation

Legislation is identified as a key driver of pro-environmental behaviour in organisations (Green, McMeekin and Irwin 1994). A range of policy responses are available to tackle climate mitigation objectives, including command and control regulations, taxes, tradable permits, information-based instruments and voluntary approaches (IPCC, 2007).

Economic mechanisms include taxes and emission trading (Bailey, 2007; Jordan et al., 2005; Tews et al., 2003), which alter benefits and costs associated with specific actions (Ekins, 1999), are seen as central to climate policy (Stern, 2008), due to their cost effectiveness and flexibility (Labatt and White, 2011). A widely advocated approach is the use of 'cap and trade' systems, where overall GHGs are limited, and emitting agents are required to buy or trade permits, which represent the right to emit a predefined level of GHGs; this approach is able to limit overall GHGs, whilst allowing the creation of a market for permits, which identifies efficient abatement opportunities (Avi-Yonah and Uhlmann, 2009). Research has focused upon effectiveness (Meehl et al., 2007) or advantages over other methods (Chameides and Oppenheimer, 2007; Murray et al., 2009). Supply chain impacts have been modelled under carbon taxes (Davis et al., 2011) and emission trading (Abdallah et al., 2010; Bojarski et al., 2009; Chaabane et al., 2012; Diabat and Simchi-Levi, 2009).

Information based interventions, such as eco-labels and mandatory reporting, are also identified (Taylor et al., 2012), and operate by impacting decision-making and raising the spectre of reputational damage (Mackenzie, 2010). 'Naming and shaming' has been shown to impact share value, indicating the existence of enforcement mechanisms (Hamilton, 1995). A further category of intervention is the provision of support and capacity building (Gouldson et al., 2008), and the rise of 'governance' mechanisms emanating from non-state actors (Bevir and Rhodes, 2003).

Whilst some research has been conducted on economic mechanisms and their application to supply chain GHGs (Abdallah et al., 2010; Bojarski et al., 2009; Chaabane et al., 2012; Diabat and Simchi-Levi, 2009), little research is available on the efficacy or impact of information or support and capacity building approaches. One area where this research will add value, is by providing an exploration of a wider set of possible interventions.

1.3 UK Institutional Context

Supply chain leading organisations in the UK operate within a specific institutional structure. Supra-nationally, the United Nations Framework Convention on Climate Change (UNFCCC) Kyoto Protocol

commits signatory industrialised nations into GHGE reductions, over the period 2008-2020. Three mechanisms operate including emission trading, the clean development mechanism and joint implementation (UNFCCC, 2013). Below this, is the European Union Emissions Trading System (EU-ETS) which caps and trades GHGE allowances across more than 11,000 energy intensive organisations (European Commission, 2005).

At the national level, relevant institutions 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 leads on climate mitigation policy (DECC 2012). Defra controls several related policy areas, including land management, waste or water treatment (Defra, 2013a). Finally, the CCC provides independent advice to government on its carbon budgets and the likelihood of meeting targets (CCC, 2013).

There is no legislation aimed at supply chain GHGEs; however the Climate Change Act requires the UK government to introduce mandatory (statutory) GHGE reporting, in contrast to voluntary corporate reporting through organisational Sustainability Reports. A consultation was launched outlining several options, including the addition of supply chain (or Scope Three) GHGEs (Defra, 2011). However, these were excluded from new reporting requirements, which cover Scopes One and Two (Defra, 2013b).

In terms of non-governmental organisations (NGOs), the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) developed the GHG Protocol standards, the primary international GHG accounting and management tool (GHG Protocol, 2012). The Carbon Disclosure Project (CDP) and Global Reporting Initiative (GRI) use the GHG Protocols and allow organisations to report their GHGE, including those embodied within their supply chains (CDP, 2011; GRI, 2013).

1.4 Research Problem and Design

This paper identifies, explores and considers interventions that will enhance the management of supply chain GHGEs by supply chain leading organisations in the UK. These interventions include and expand upon previously considered options concerned with supply chain GHGE taxes and trading (Abdallah et al., 2010; Bojarski et al., 2009; Chaabane et al., 2012; Davis et al., 2011; Diabat and Simchi-Levi, 2009), and follows previous papers that have explored the impacts and implications of ranges of policy instruments concerned with direct GHGEs (Gainza-Carmenates et al., 2010; Johansson, 2006; Li and Lin, 2013; Parry and Williams III, 1999). To consider these options, an intervention approach is developed, using a framework constructed from primary qualitative data. This intervention approach is called the 'Emission Reduction INtervention Options' (ERINO) supply chain approach.

An intervention approach is a description and specification of what is required to achieve a desired goal, including how they are to be generated and expected impacts (Chen, 1990). It is a series of 'micro-steps and linkages', identifying causality, from interventions to outcomes (Rogers et al., 2000). The general constituents of such an approach includes the actors involved, the inputs and outputs of the intervention as well as expected outcomes (Mickwitz, 2003). Many methods can be used, including "statistical analyses of data at different levels of aggregation, qualitative analyses of documents, questionnaires and thematic interviews" (Mickwitz, 2003:429); this analysis will be based on the results of thematic interviews.

To develop an intervention approach, a conceptual framework is required, allowing the interventions to be explored. Data on primary driving and hindering factors as well as activities used to manage supply chain GHGEs are needed, so as to examine likely intervention impacts.

2. Methodology and Conceptual Framework Construction

The conceptual framework was constructed using primary qualitative data collected from 34 individuals. At the inception of the research, the authors found that little knowledge was available through desk-based research to fully inform a single research phase. Consequently, an initial exploratory or scoping research phase was launched, Phase One, to identify key factors and actors. Once the results of this phase were processed, a second more focused explanatory phase was launched, Phase Two. These will now be explained in more detail.

2.1.1 Phase One

Phase one aimed to provide an overview of the current state of supply chain GHGE management efforts within the UK. A perspective from participants external to organisations undertaking supply chain GHGE management initiatives was sought, including individuals from academia, business support organisations and NGOs that had engaged with the topic. Within this phase, 'experts' were required to provide an adequate overview, which would inform both the results and the design of phase two. Experts can play an important role in exploratory research, as they shorten the time involved in observations and can be considered 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 et al., 2009).

Participants were primarily recruited via email having been identified through academic and grey literature, via internet searches or through co-nomination; a key source of relevant organisations were members of the Carbon Disclosure Project Supply Chain program. Participants had to have three years' experience in positions relevant to supply chain GHGE management; this acted a validation criteria for the participants and the data they provided.

Participants were interviewed using a semi-structured interview format (please see interview schedules in Appendix A) via telephone or in person. In all but two cases, interviews were recorded and transcribed.

11 respondents provided data (see Table 11, in Appendix B), between December 2010 and March 2011. These participants provided an overview of current initiatives, key organisational actors involved, overarching drivers and barriers and future policy options. This provided a working structure from which to launch Phase Two of data collection, whilst also highlighting possible intervention/policy options; whilst the intervention types have previously been explored in relation to direct GHGEs, this research is concerned with exploring their application and efficacy in relation to supply chain GHGEs. This initial phase identified private sector supply chain leading organisations as most active, but that public sector examples did exist.

2.1.2 Phase Two

As Phase One confirmed that action to manage supply chain GHGEs was voluntary within the UK (consistent with the contextual analysis provided in section 1.2), and that both private and public sector examples exist, Phase Two sought to further examine primary drivers, barriers and management activities. This explanatory phase sought data from individuals within supply chain leading organisations attempting to manage supply chain GHGEs. Included within this phase were three participants from consultancies or third sectors organisations who had worked closely with organisations included within the Phase Two sample. Similarly to Phase One, there were a limited number of examples/sources of data available who had the desired context specific knowledge. As such a non-probabilistic purposive sampling strategy was again undertaken (Bogner et al., 2009). The same participant recruitment and qualification criteria used in Phase One was also applied to Phase Two. In both phases, participant identification and recruitment continued until data saturation was achieved – the point where no new information was being obtained (Green and Thorogood, 2009).

23 participants were interviewed in total, (see Table 12, Appendix B), between September 2011 and February 2012.

The data was analysed by coding typical and frequent elements (using Nvivo 8), alongside information critical to the answering of the research question. The two data collection phases were coded separately. Thematic analysis formed the focus of analysis efforts (Boyatzis, 1998). The categorisation of data involved numerous iterations to ensure internal consistency within categories. The completion of this process produced a range of codes and categories, with a variety of layers, identifying key themes.

3. Results – Conceptual Framework

The results from the data coding are presented below. Driving factors, barriers and key management activities were primarily identified through the Phase Two interviews. Comparable data had been collected through Phase One, which served to provide a source of triangulation; the primary drivers, barriers and management activities identified were consistent across Phases One and Two. Public and private sector supply chain leading organisations in some instances experienced differing drivers and barriers; where this occurred, separate categories were produced. The Emission Reduction INtervention Options' (ERINO) framework (see figure 1) is constructed from data from both Phases One and Two; the exploration of the workings and impacts of potential interventions are conducted using data from Phase Two.

3.1 Private/Public Sector Driving Factors

The driving themes identified comprise of four general driver categories, within which are specific aspects, as outlined in Table 1.

Table 1: Private Sector Drivers

| Overarching Driving Factor | Aspects/examples of Drivers |
|-----------------------------------|------------------------------------|
|-----------------------------------|------------------------------------|

| | |
|--|---|
| Differentiation & Competitiveness | Competitiveness as differentiation. Future proofing (i.e. for legislation). Reputation. |
| Costs & Margins | Efficiency and cost reductions. Future Proofing (i.e. against prices increases). |
| Stakeholders (Compliance) | Stakeholders – general. Investors/ Shareholders. |
| Other (Facilitating Factors – aiding efforts, rather than driving them) | Methodological Standardisation. Increased Saliency of GHGE. |

Those factors reported to be driving public sector supply chain leading organisations to engage with supply chain GHGE are outlined in Table 2.

Table 2: Public Sector Drivers

| Overarching Driving Factor | Examples/Aspects of Drivers |
|--|---|
| Individual Entrepreneurship | Specific Individual Driving from Within |
| Policy & Regulation | Limited context, i.e. HEFCE guidance |
| Organisational Identity & Mission | Organisational Specific Expertise Organisational Mission |
| Costs & Efficiency | Operating (but links weak) |

3.2 Private/Public Sector Barriers

During analysis and coding of the data it became clear that barriers were impacting organisations in two ways: those that were operating internally versus those operating externally. The barriers presented below are split accordingly.

Internal barriers were surmountable through internal actions. External barriers were those that supply chain leading organisations had little control over, requiring remedial actions by external agents, such as government or third sector actors. Barriers effecting the public and private sectors were again separated.

Barriers identified as occurring within private sector supply chain leading organisation examples are illustrated in Table 3 and Table 4.

Table 3: Private Sector Internal Barriers

| Internal Barriers | Explanation/Examples |
|--|---|
| Conflicting Objectives | GHGE a relatively low priority. |
| Costs | Supply Chain measures need to be cost effective. |
| Lack of Understanding & Focus | The complex nature of supply chain GHGE poorly understood. |
| Lack of Systems | GHGE data hard to collect and verify; SCM systems unsuitable for collecting data. |

Table 4: Private Sector External Barriers

| External Barriers | Explanation/Examples |
|---|---|
| Policy Issues & Contradictions | Regulations restricting available options to reduce GHGE. |
| 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 GHGE Inputs | Lack of low GHGE substitutes. |

Those barriers identified as occurring within public sector supply chain leading organisations are illustrated within Table 5 and Table 6.

Table 5: Public Sector Internal Barriers

| Internal Barriers | Explanation/Examples |
|--|--|
| Conflicting Objectives | GHGE low priority/reductions would irrevocably impact essential services. |
| Resource Constraints | Budget cuts etc. |
| Lack of Understanding & Focus | See private sector barrier. |
| Data Issues | Lack of systems, benchmarking difficulties and little methodological guidance. |

Table 6: Public Sector External Barriers

| External Barriers | Explanation/Examples |
|--|---|
| Lack of Policy or Regulation | Public sector reliant on top-down direction in many instances. |
| Supplier Engagement | Lack of 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. |

3.3 Supply Chain GHGE Management Activities

Activities undertaken by supply chain leading organisations were similar in the public and private sectors; however, a ‘✓’ is used in the tables below where only one sector noted an activity. During coding, it was identified that management activities were occurring within different parts of the supply chain. For example, beyond tier one suppliers, within tier one suppliers, in-house within supply chain leading organisations and downstream. The activities presented here were not mutually exclusive – organisations were often active in several areas.

3.3.1 Beyond tier one

These were activities occurring in suppliers of suppliers, where no direct commercial relationship existed with the supply chain leading organisation. These activities included conversation and dialogue with suppliers and the use of management standards; these were only identified within single cases in the public and private sectors (two cases overall).

3.3.2 Tier one

Activities occurring within the first tier of the supply chain concerned those actions with suppliers who had a direct commercial relationship with the supply chain leading organisation. These activities were more numerous and diverse than those occurring upstream, beyond this tier, and are highlighted in Table 7.

Table 7: Tier One Management Activities

| 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 | ✓ | |
| Activities | | |
| Supplier Involvement in Design | ✓ | |
| Supplier Training and Schools | ✓ | ✓ |

3.3.3 In-House to Supply Chain Leading Organisations

A range of activities were identified in the data that occurred within supply chain leading organisations themselves. Although these affected suppliers and the overall supply chain, the activity itself took place within supply chain leading organisations, and did not require supplier engagement. Table 8 provides an overview of these activities.

Table 8: In-house Management Activities

| GHGE Management Activities 'In-house' | Private Sector | Public Sector |
|--|-----------------------|----------------------|
| Supply Chain GHGE Modelling and Assessment | ✓ | ✓ |
| Design Changes | ✓ | |
| Internal Training and Information Provision | ✓ | ✓ |
| Embedding of Supply Chain GHGEs into Commercial Teams | ✓ | ✓ |

3.3.4 Downstream

Although limited, activities downstream of supply chain leading firms were identified; Table 9 provides a summary of these activities.

Table 9: Downstream Management Activities

| GHGE Management Activities 'Downstream' | Private Sector | Public Sector |
|--|-----------------------|----------------------|
| Research and Design on Consumer Use of | ✓ | |

3.4 Intervention Approach Results

Results from the previous sections (and section 3.4.1) will now be used to construct a framework, allowing intervention options to be explored in terms of their efficacy.

3.4.1 Regulatory and Policy Options: Typology of Policy Options

The range of intervention options were developed from Phase One participants responses; several possible policy/intervention options that would increase levels of supply chain GHGE management in the future where noted by Phase One participants, including:

- No expansion of policy, with a continued reliance on the market to provide driving forces.
- Provision of expert support and advice required by both public and private supply chain leading organisations, by government and NGOs, including development of methodologies etc.
- Indirect complimentary policies, such as further decarbonising of power and transport systems.
- Increased mandatory use of management standards and product labelling, in the public and/or private sectors, to drive demand for reductions in GHGEs.
- Mandatory supply chain GHGE reporting for private and/or public supply chain leading organisations.
- Connection of tax liabilities to supply chain GHGEs, or their inclusion in cap and trade scheme.
- The creation of a supply chain GHGE credit scheme: work with suppliers to reduce their GHGEs provides credits that could be used against tax liabilities or brought into existing GHGE trading schemes, i.e. the EU-ETS.

These options are categorised according to their regulatory type in Table 10 (Mickwitz, 2003).

Indirect complimentary policies, such as electricity decarbonisation, are not included because the intervention approach and the ERINO supply chain approach are focused on measures aimed specifically at supply chain leading organisations.

Table 10: Categorisation of reported intervention options reported by Phase One respondents, according to Mickwitz (2003) typology.

| Regulation Type | Identified Intervention Options |
|--|--|
| Command & Control | Nil – not suitable |
| Economic | Supply Chain GHGE Taxation Scheme |
| | Supply Chain GHGE Trading Scheme |
| | Supply Chain GHGE Credit Scheme |
| Information | Management Standards |
| | Product Labelling Schemes |
| | Mandatory Supply Chain GHGE Reporting |
| Co/civic/informal regulation | No Expansion of Current Policy |
| Supporting Mechanisms and Capacity Building | Expert Support and Advice |

3.4.2 Construction of Intervention Approach

An intervention approach is a specification of the actions required to achieve a specific outcome, including the impacts the interventions can be expected to have on supply chain leading organisations (Chen, 1990). For this case, the outcome is the enhancement of supply chain GHGE management efforts. The actors, specifics of the individual interventions, as well as outcomes are seen as general constituents of an intervention theory or approach (Mickwitz, 2003). To introduce more specific criteria relevant to climate change objectives, the policy conditions of the IPCC (2007)

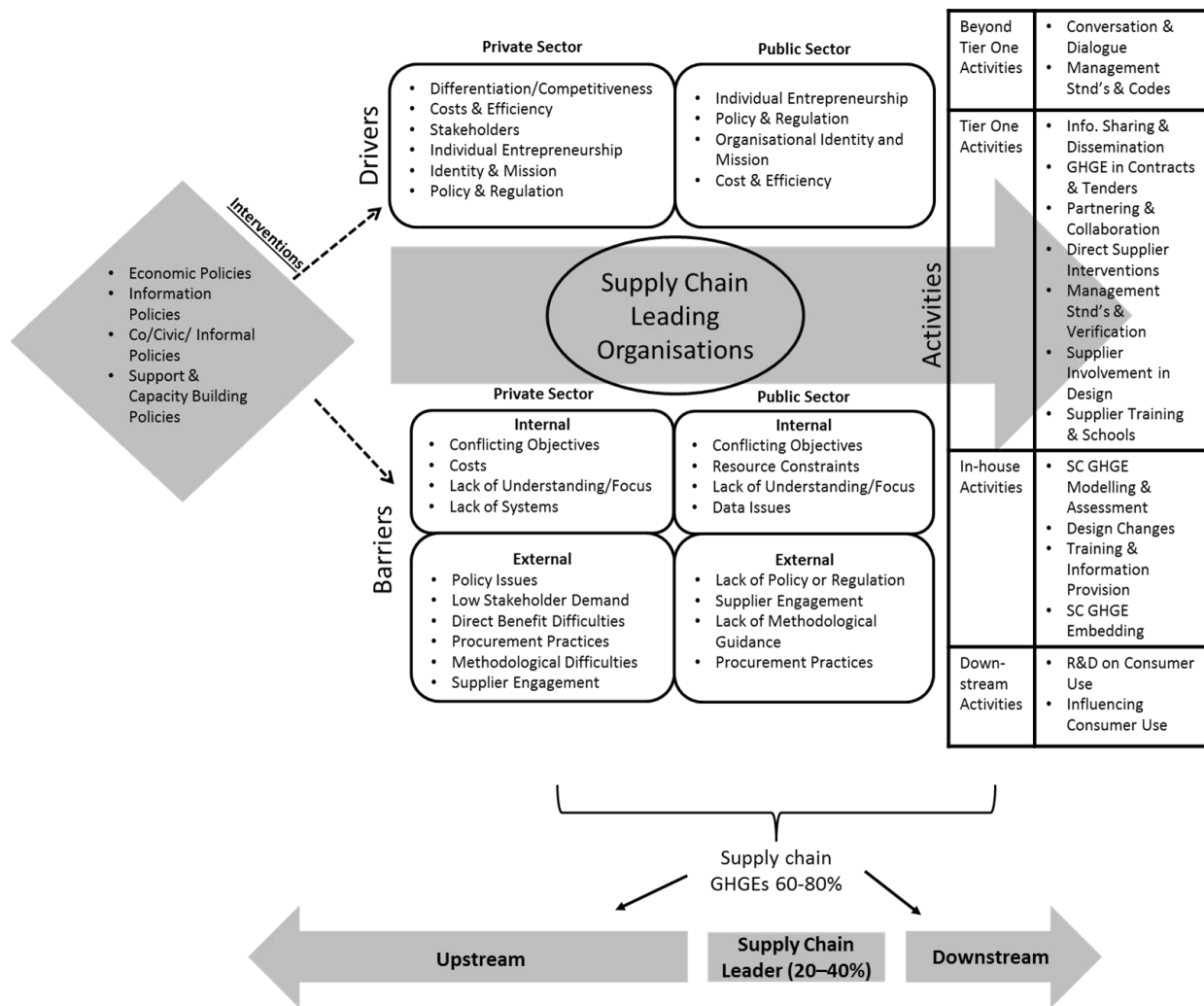
will also be considered, concerning environmental and cost effectiveness, distributional impacts and institutional feasibility.

The interventions are explored using instrumental rationality, which assumes that agents act in their best interests, i.e. to achieve optimal outcomes in any given situation (North, 1993). This method of reasoning will be used to explore and consider how supply chain leading organisations would react to the interventions outlined in Table 10. It should be noted that with such a small sample, and the qualitative nature of the data, that the results of this exercise, and the inferences drawn in the discussion, are exploratory propositions; further research will be required to further validate and enhance their usefulness. In essence, this paper is establishing a point of departure for future research examining the management and regulation of supply chain GHGs.

The driving and hindering factors identified from Phase Two are used as a guide to assess how different intervention options might impact and influence supply chain leading organisations. Those factors identified as drivers can be targeted by interventions to increase efforts; conversely, interventions also operate by reducing barriers. Barriers were split according to their internal or external operation, and although stated that internal barriers could be overcome through internal action, it should be recognised that these hindrances can also be impacted by interventions.

Using results of Phase One and Phase Two, a framework was constructed to explore the efficacy of a range of intervention options. This framework is illustrated in Figure 1.

Figure 1: Emission Reduction Intervention Options' (ERINO) framework.



3.5 Interaction of Interventions with Results Data

This section will develop and outline the ERINO supply chain approach for supply chain GHGE management, using instrumental rationality/logic, which assumes agents take a course of action that will optimally achieve their desired goals in any given scenario, such as profit maximisation or service delivery. This will allow Phase Two data and analysis to be used to explore likely actions by supply chain leading organisations in response to the interventions outlined Table 10.

Command and control policies were highlighted as inappropriate for supply chain interventions by the Phase One participants due to their complex, opaque and heterogeneous nature. Such policies

would lead to suboptimal outcomes, or would be unworkable from administrative or practical perspectives. They will not be considered further here.



3.6 Economic Policies

Economic regulations operate by moderating financial costs or benefits (Ekins, 1999). Taxes, cap and trade/permit schemes and supply chain credit schemes are included within this category; we limit our description and analysis here as some previous research has been conducted on supply chains and these types of climate mitigation policies - please see Abdallah et al. (2010); Bojarski et al. (2009); Chaabane et al. (2012); Davis et al. (2011); Diabat and Simchi-Levi (2009).

3.6.1 Taxation and Cap and Trade Interventions

Taxation schemes would link a tax liability to supply chain GHGEs associated with a supply chain leading organisation. A cap and trade or permit scheme would require supply chain leading organisations to be allocated, or purchase, GHGE permits, which could be traded. Both these interventions would levy a cost on GHGEs, stimulating cost drivers. This would decrease the relative cost of mitigation measures, and reduce difficulties in obtaining direct benefits from GHGE reductions within suppliers. Figure 2 illustrates how tax or cap and trade schemes operate.

Figure 2: Operation of tax/cap and trade interventions.

| | |
|--|--|
| <p>Drivers</p>  <ul style="list-style-type: none"> • <i>Increases relative costs of inaction.</i> | <p>Barriers</p>  <ul style="list-style-type: none"> • <i>Decreases relative cost of measures.</i> • <i>Reduces direct benefit barrier.</i> |
| <p>Activities</p> <ul style="list-style-type: none"> • <i>Focus on SC GHGE reduction activities.</i> | <p>Implications</p> <ul style="list-style-type: none"> • <i>Inclusion of GHGE performance standards within supplier contracts.</i> • <i>Use of management standards.</i> |



3.6.2 Supply Chain Credit Scheme

The supply chain credit scheme would operate as an ‘add on’ to other economic interventions focussed at direct or supply chain GHGEs, such as the EU-ETS. Supply chain leading organisations

who conducted work within a supplier to reduce GHGEs would gain credits, which could be used to offset linked tax liabilities, or as additional credits within existing cap and trade schemes. This approach would be advantageous where government wished supply chain leading organisations to exert their influence, power and expertise to the benefit of less able suppliers.

This intervention would stimulate cost drivers and reduce barriers by decreasing the relative cost of interventions within suppliers, and tackles the direct benefit barrier by providing a benefit specifically for work with suppliers. Figure 3 illustrates how the supply chain credit scheme would operate.

Figure 3: Operation of supply chain credit intervention.

| | |
|--|---|
| <p>Drivers</p>  <ul style="list-style-type: none"> • <i>Increases relative costs of inaction.</i> | <p>Barriers</p>  <ul style="list-style-type: none"> • <i>Decreases relative cost of measures.</i> • <i>Reduces direct benefit barrier.</i> |
| <p>Activities</p> <ul style="list-style-type: none"> • <i>Focus on supply chain GHG emission reduction activities within suppliers.</i> • <i>Increased supplier engagement.</i> | <p>Implications</p> <ul style="list-style-type: none"> • <i>Greater demands placed upon suppliers.</i> • <i>Increases supplier focal organisation relationship requirements.</i> |

3.7 Information Policies



Interventions such as the imposition of product carbon-labels, Environmental Management Systems (EMS) and mandatory reporting operate by providing information, improving decision-making within organisations and externally. They operate through reputational drivers, or by reducing barriers associated with poor information and awareness.

3.7.1 Carbon Labels

The use of carbon product labels is designed to alter consumer demand, and so change the dimensions through which organisations compete, by allowing comparisons of embodied GHGEs within products. The operation of this intervention is illustrated in Figure 4.

As this intervention is designed to increase consumer demand for low GHGE products, it is reliant on latent demand existing. It is also designed to drive supply chain leading organisations internally, by increasing levels of awareness.



Figure 4: Operation of carbon product-label intervention.

| | |
|--|--|
| <p>Drivers</p>  <ul style="list-style-type: none"> • Stakeholder demand (informs consumers). • Internal awareness. | <p>Barriers</p>  <ul style="list-style-type: none"> • Methodological issues. • Poor levels of understanding. |
| <p>Activities</p> <ul style="list-style-type: none"> • Focus on per product measurement and assessment. | <p>Implications</p> <ul style="list-style-type: none"> • Reliant on stakeholder demand. • Little public sector application. |

3.7.2 Mandatory Supply Chain GHG Reporting

Mandatory reporting, consulted on by Defra in 2011, would impel organisations to report and disclose their supply chain GHGEs. It would operate similarly to product labels, although on an organisational, rather than product based scale, as illustrated in Figure 5. Organisations could be ranked within a league table, via stock market indexes or sectors. This intervention would operate by enhancing reputational and differentiation drivers. Barriers associated with methodological issues and levels of understanding would be reduced, as participation would require a standard methodology provided by government or third sector actors.


Figure 5: Operation of mandatory supply chain GHGEs reporting intervention.

| | |
|---|--|
| <p>Drivers</p>  <ul style="list-style-type: none"> • Reputational drivers. • Differentiation drivers. | <p>Barriers</p>  <ul style="list-style-type: none"> • Methodological issues. • Levels of poor understanding. |
| <p>Activities</p> <ul style="list-style-type: none"> • Increases focus on management procedures and measurement. • Focus on reductions. | <p>Implications</p> <ul style="list-style-type: none"> • Little impact on public sector. |

3.7.3 Environmental Management Systems

The imposition of EMS forms a different type of information based policy, operating primarily through internal information provision, as shown in Figure 6. 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. Consequently, this policy would be highly complementary to economic or information based interventions.

Figure 6: Operation of mandatory Environmental Management System intervention.


| | |
|---|--|
| <p>Drivers</p> <ul style="list-style-type: none"> • <i>No impact on drivers.</i> | <p>Barriers</p>  <ul style="list-style-type: none"> • <i>Methodological issues.</i> • <i>Levels of poor understanding.</i> |
| <p>Activities</p> <ul style="list-style-type: none"> • <i>Increases focus on management procedures and measurement.</i> | <p>Implications</p> <ul style="list-style-type: none"> • <i>Reliance on existence of drivers within wider organisational environment.</i> |

3.8 Co/Civic/Informal regulation: Continuation of Current Context

This intervention involves a reduced role for the state and includes a range of possibilities. Such interventions rely on supply chain leading organisations being receptive to factors used to instigate participation in these schemes, including stakeholder pressures or fears that their reputation or competitiveness would be impinged.

This option relies on drivers that exist within the wider business environment and the role played by NGOs, such as the CDP, which has used investor pressure to encourage participation. These methods hold the advantage that they require few government resources, but have low predictability and control. This type of intervention would operate through existing stakeholder pressures, reputation and differentiation, as shown in Figure 7, with no specific impact on barriers.


Figure 7: Operation of informal/private/self-regulatory interventions.

| | |
|--|---|
| Drivers  <ul style="list-style-type: none"> • Stakeholder pressures (esp. investors). • Reputation. • Differentiation. | Barriers <ul style="list-style-type: none"> • No impact. |
| Activities <ul style="list-style-type: none"> • See results. | Implications <ul style="list-style-type: none"> • Uneven levels of engagement. • Reliant on stakeholders and 3rd sector actions. • Low predictability and control. |

3.9 Supporting Mechanisms and Capacity Building

Support and capacity building is the final intervention (Gouldson et al., 2008), including the provision of expert support, methodologies, calculation tools and organisational strategies. They impact barriers being experienced in both public and private sectors, including methodological difficulties and standardisation issues; this is illustrated in Figure 8.

Figure 8: Operation of supporting mechanisms and capacity building interventions.

| | |
|--|---|
| Drivers <ul style="list-style-type: none"> • No impact. | Barriers  <ul style="list-style-type: none"> • Methodological understanding. • Poor understanding (incl. EU Procurement in public sector). |
| Activities <ul style="list-style-type: none"> • Enhancement of measurement and reduction activities. | Implications <ul style="list-style-type: none"> • Focus on barriers, leaving drivers untouched. • Greater impact on public sector. |

4. Discussion

4.1 Drivers, Barriers and Management Activities in the Literature

The results from Phase two, concerning drivers, barriers and management activities, were used to construct the framework through which the intervention options were explored. To assess the validity of this framework, the drivers, barriers and activities identified will be compared with literature on corporate climate change engagement and ESCM.

The private sector drivers derived from the Phase Two data coding fit well with drivers identified within the ESCM/GSCM literature, including stakeholders (Hoffman, 1999; Jennings and Zandbergen,

1995; Walker et al., 2008), cost pressures (Walker et al., 2008), the desire for improved reputation and associated competitive advantage (Seuring and Müller, 2008; Walker et al., 2008). The same is true in terms of corporate climate change literature, covering efficiency/costs (Jeswani et al., 2008; Ramus, 2002), stakeholders (Sullivan, 2010), and for competitive advantage and the effects of market changes (Okereke, 2007; Sullivan, 2010). Regulation, although heavily advanced in both the ESCM (Croom et al., 2009; Walker et al., 2008) and corporate climate change literatures (Jeswani et al., 2008), was not reported by research participants.

The literature concerning drivers of corporate climate change engagement does not consider the role of public organisations; however, several public sector drivers are identified in the ESCM literature, including legal compliance and the effects of regulation (Morgan, 2008; New et al., 2002), which were introduced into public procurement in the UK in 2004, for products such as paper. Agency factors, such as individual expertise and entrepreneurship are also noted (New et al., 2002).

The barriers identified through the interviews also fit well with those in the literature. Within the ESCM/GSCM literature, this includes the lack of financial resources, awareness or expertise (Luthra et al., 2011; Min and Galle, 2001), low levels commitment or interest (Handfield et al., 2005; Ravi and Shankar, 2005), little support or government policy (Porter and van der Linde, 1995; Zhu and Sarkis, 2006), low customer demand (Lamming and Hampson, 1996), a lack of systems (Hervani et al., 2005) and supplier difficulties (Luthra et al., 2011; Srivastava, 2007; Wycherley, 1999).

The coding results fit well with barriers identified in relation to corporate engagement with climate change, including financial restraints, low awareness or expertise (Jeswani et al., 2008), the absence of policy and regulatory uncertainty, (Jeswani et al., 2008; Okereke, 2007; Pinkse, 2007) and poor training (Hsu and Hu, 2008; Lee, 2012).

Literature concerning ESCM/GSCM public sector barriers agree with the results, including an overly bureaucratic culture and the poor sharing of best practice (Morgan, 2008), which correlates with the

impact of procurement practices and data issue categories respectively. The impact of poor project management skills, not identified in the results is also noted (Morgan, 2008). The effect of negative perceptions of EU Procurement Rules is emphasised in both the results and the literature (Preuss and Walker, 2011). The premium of cost in decisions, over environmental objectives is further area of agreement (National Audit Office, 2005; Preuss, 2007; Preuss, 2009).

Management activities identified through the analysis are broadly consistent with those noted in the corporate climate change and ESCM/GSCM literatures. The corporate climate change strategies literature noted businesses would be active within the supply chain (Kolk and Pinkse, 2005; Lee, 2012), and that measures would be both internal, such as developing systems, and external, including supplier collaboration (Jeswani et al., 2008); both of these corroborated results that fed into the framework. Further agreement, in relation to ESCM/GCM literature, is found for design changes (Donnelly et al., 2006), supplier enabling and capacity development (Ciliberti et al., 2008; Lamming and Hampson, 1996), supplier requirements including codes of conduct, auditing and questionnaires (Ciliberti et al., 2008; Lamming and Hampson, 1996; Preuss, 2010) 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 supply chains (Weil and Mallo, 2007), but does confirm their use within a new context. The use of formal agreements in supplier 'partnerships', are found within the literature, which notes the introduction of competition into the supply base and supplier evaluations (Krause, 1997). Further agreement is found in training and education efforts and direct investment within suppliers (Krause, 1997).

The drivers, barriers and management activities identified through the interviews and coding match well with those in the literature. Whilst these results do not identify new factors, they do confirm the validity of existing knowledge to supply chain GHGE management. The validity and usefulness of the framework that was developed to test the interventions, is also strengthened by the confirmation

that these factors are well established in relation to corporate climate change engagement and ESCM.

4.2 Assessment of Approach and Implications for Policymakers and Organisations

It is important to note that the analysis conducted here is based upon a small sample and qualitative data. It aimed to provide an initial assessment of the efficacy of these approaches, an exploration of how they could operate and the initial and tentative indications of the impacts. The results, and implications, should be seen within these limits.

The advantages of managing GHGs through supply chains were articulated at the start of this paper, and these reasons hold through this analysis. This includes the ability to target and regulate a larger proportion of GHGs, as compared with approaches targeting direct organisational emissions. Supply chain leading organisations, as the target of driving factors, pass these pressures up the supply chain, to suppliers. This finds many similarities to the process of environmental supply chain dynamics, which described the diffusion of environmental management capabilities from customer to supplier firms (Hall, 2000). This allows the management of a larger amount of GHGs to be placed into the hands of a single actor, the supply chain leading organisation, requiring fewer governmental resources and is simpler than attempting to manage the GHGs within all supply chain members separately.

4.2.1 Assessment of Interventions

Tax or cap and trade interventions could prove environmentally effective where financial incentives and costs were sufficient. The administration of a tax, or cap and trade scheme would likely be a substantial administrative undertaking, with implications for the verification of GHGs. This administrative burden could be somewhat offset, through increased certainty of these interventions stimulating action. Distributional implications are harder to judge, as the cheapest abatement options may be in the supply chain or internally within supply chain leading organisations; however

this intervention is designed impact both public and private sectors. Similar approaches already exist with regards to direct GHGEs, such as the EU-ETS in Europe, or California's Cap and Trade programme; such programmes could feasibly expand to include supply chain GHGEs.

The supplier credit scheme, by specifically targeting emissions within suppliers, operates on a narrower basis than a tax or cap and trade intervention. The administration and verification of actions undertaken within suppliers (i.e. whether they successfully reduced supplier GHGEs) would present an administrative challenge, requiring a robust verification process. As this intervention is designed to be used in conjunction with other GHGE policies, the institutions used in their administration could potentially be used within the supplier credit scheme. Costs could be limited through the use of management standards and clear calculation methodologies. This intervention would be expected to impact both public and private sectors.

Product carbon labels environmental effectiveness may be limited, as previous research has indicated price is consistently the critical consideration in purchasing decisions (Mainieri et al., 1997). This issue could be reduced if economic interventions were also used that increased product prices, based on their GHGE content. Ensuring product labels were accurate could involve high administrative costs. The use of product eco-labels has been met with confusion by consumers; a survey by Boots Plc., in 2008, found that 44% of consumers confused carbon labels with fair trade issues (Deans, 2008). Product-labels have proved successful within other contexts, such as those that highlight the nutritional content of food (Deans, 2008; McKinnon, 2009). Product labels would have limited impact on public sector organisations, as the products and services offered are not subject to competition. However, the identification of product or service GHGE levels would still present the opportunity to identify inefficiencies. The existence of energy performance labels, such as the EU Energy Label scheme, provides institutions to administer such policies. A methodology applicable across all products, allowing comparability would be required, provided by government or trade bodies for specific sectors.

Mandatory reporting relies on supply chain leading organisations wishing to be seen positively with regards to GHGEs and the competition this creates; where not the case, the intervention would likely prove limited. Administratively, this intervention could be included within existing plans by the UK government, including requirements for companies to report on their internal GHGEs (Defra, 2011). Mandatory reporting would fail to impact public organisations, due to its reliance on reputational and competitive drivers.

EMS would likely aid the identification of inefficiencies, but may not stimulate further innovative changes within production systems, reducing its relative environmental impact. It would involve lower administrative costs than economic interventions. This scheme should impact public and private sectors equally, due to the focus on increasing internal awareness. EMS exist currently, such as through the British Standards Institute, and if this intervention were enacted, similar actors could be utilised by government.

Co, civic or informal interventions would provide little certainty environmentally, likely resulting in outcomes reported currently, such as sporadic and uneven levels of engagement. These interventions are cheap; however when considered against outcomes, may not represent a cost-effective solution. Distributional impacts are hard to predict, due to the uneven nature of engagement under this regime, but public sector organisations are left largely unmotivated.

Administratively, such an approach relies heavily on non-governmental actors. Overall, although requiring little government action, this approach is highly unpredictable in terms of its impacts.

Support and capacity building efforts allow state and non-state actors to influence the barriers faced by supply chain leading organisations, such as methodological and strategy difficulties. This approach would have little impact independently, being effective only in conjunction with other interventions.

4.2.2 Implications for Policymakers

Many of the interventions outlined are complimentary, and if enacted together, could have increased effectiveness. For example, economic interventions require timely and accurate information, which could be provided through the imposition of EMS. This information could be conveyed publically through mandatory reporting, creating financial and reputational drivers, impacting public and private sectors. Mandatory reporting, through effective EMS, would provide information to stakeholders to pressure supply chain leading organisations (Hamilton, 1995; Mackenzie, 2010). The provision of support and capacity building would ease organisations compliance with the interventions, providing further complimentary benefits. Several interventions outlined are also consistent with, and could complement existing regulatory arrangements. For instance, the introduction of a supplier credit scheme could provide organisations with permits for use within the EU-ETS.

However, the range of interventions explored are not without difficulties. The scale and scope of specific interventions could prove troublesome if imposed nationally, in the absence of a global agreement. Economic interventions that tied global supply chain GHGE levels to financial liabilities, may lead to organisations shifting operations out of the intervening territory. Consequently, such an approach would only be appropriate at global, or minimally, at supranational level, for instance through the EU.

Information based schemes are unlikely to suffer similar concerns. Since October 1st, 2013, all UK incorporated companies have been required to report their global direct GHGEs, which is expected to save four million tons of CO₂e by 2021 (Carbon Trust, 2013; Defra, 2013c). The jump from reporting global direct GHGEs to those also associated with the supply chain is not too great, and as with current requirements, would be unlikely to lead to organisations shifting operations. The expected GHGE reduction would be larger, due to the greater proportion of emissions targeted.

One remaining difficulty identify is that many barriers experienced by supply chain leading organisations are left untargeted through the interventions explored here, such as a lack of consumer demand, which has been identified in research on the management of lifecycle GHGEs (Bocken and Allwood, 2012). Methodological difficulties concerning the accuracy of GHGE accounting should be tackled by governments, alongside those NGOs that have released standards to date.

4.2.3 Implications for Organisations

As cap and trade or tax interventions place a direct emphasis on GHGE reductions, such as through product design changes, supply chain leading organisations would be likely to attempt to gain control over their supply chain GHGEs through supplier contracts stipulating GHGE levels. These policies would require accurate measurement of GHGEs in supply chains, leading to greater use of voluntary EMS.

The supplier credit scheme may increase supplier engagement efforts and stimulate the measurement of supplier GHGE performance, identifying cost effective abatement options. GHGE performance standards could be introduced into supplier contracts and supply chain leading organisations may attempt to motivate suppliers to reduce GHGEs independently, minimising their own involvement. Supplier selection may be influenced by the possibility of credits, negatively impacting the working of supply markets, and disadvantaging those suppliers who had independently reduced their GHGEs. Consequently, over burdensome demands could be place onto some suppliers. An element of the verification process should seek to ensure that supply chain leading organisations only receive credits where work and support had been provided to suppliers. Supply chain leading organisations subject to EU procurement directives may experience difficulties in identifying appropriate actions.

Product carbon labels have been trailed by several organisations, including Tesco's and PepsiCo (PepsiCo, 2013; Tesco's, 2011). Such an intervention could include substantial initial costs per

product labelled, would require a common methodology and as noted above are to-date questionable in effectiveness.

Mandatory reporting would require organisations to measure their supply chain GHGs, but would be less costly than per product measures. Organisations who failed to reduce their emissions relative to competitors may see their reputation and competitive position diminished.

EMS systems represent a cost to supply chain leading organisations, however, once installed would highlight inefficiencies, and present organisations with opportunities to reduce supply chain GHGs levels, reducing demand for energy and lowering costs.

Under co, civic or informal regulation, supply chain leading organisations would be stimulated by drivers within the wider business environment. Currently, NGOs such as the CDP utilise investor pressure. Those organisations lacking these drivers would be unlikely to include themselves in such schemes, resulting in few impacts and little action to manage supply chain GHGs.

Supply chain leading organisations and their supply chains will experience difficulties in measuring and managing these GHGs, as illustrated through Tables 5, 6, 7 and 8. Support and capacity building interventions are aimed solely at these factors. Public sector organisations, struggling with constraining perceptions of EU Procurement Directives and the role of procurement consortia, should be targeted with support. The introduction of supply chain GHG management aims into procurement consortia could enable their purchasing power (the reason they exist) to be utilised. Private sector organisations would benefit through improved methodologies and greater general awareness and knowledge.

An inherent difficulty for organisations is the need to work with suppliers. The threat exists that suppliers will be unwilling to act, or will demand higher prices to do so, reducing drivers and potential economic gains. Those organisations that successfully managed and reduced their emissions would experience benefits. These are likely to include reduced energy costs (and their

impact on product prices), through more efficient supply chain processes, the potential for improved supply chain relations, an environmentally enhanced brand and improved competitive positioning.

5. Conclusions

This paper presents and develops a supply chain management framework that we term the ERINO supply chain approach. This framework attempts to provide an initial, exploratory assessment of the efficacy and likely impacts of a range of interventions designed to improve the quality of greenhouse gas emissions (GHGE) management by supply chain leading organisations. These interventions were explored using instrumental logic and reasoning and a conceptual framework. The framework was constructed from drivers, barriers and management activities using empirical data collected through 34 interviews with participants associated with organisations leading UK supply chains.

The ERINO supply chain framework was designed to be relevant within current policy thinking including policy recommendations of the Intergovernmental Panel on Climate Change (IPCC). This paper evaluated the application of different types of interventions into supply chain management such as mandatory reporting of supply chain GHGEs or economic support based mechanisms.

Although the British government has consulted on the use of mandatory supply chain GHGE reporting (Defra, 2011), existing literature has failed to complete an assessment of how different interventions could operate when targeted at supply chains. Notable exceptions are emission taxes or product choice editing (Abdallah et al., 2010; Bojarski et al., 2009; Chaabane et al., 2012; Davis et al., 2011; Diabat and Simchi-Levi, 2009). As such, this paper builds on existing frameworks including Aivazidou et al. (2013) producing intervention assessments with possible impacts, mechanisms and implications.

This paper identifies that information based intervention could offer the best option and a 'middle way' for enhancing the management of supply chain GHGEs. By targeting reputational drivers, information based interventions could avoid the political difficulties associated with economic based

mechanisms and the uncertainty (and likely lack of action) of informal regulation or support and capacity building interventions.

A key contribution of this paper is the implication of the interventions on the mechanisms of SCM within supply chain leading organisations. As corporate responsibility has spread to include supply chain impacts (Kovács, 2008), so too could future regulatory approaches by governments wishing to tackle other sustainability issues. This provides a new setting within which to explore the workings of environmental interventions and policies. The approach developed in this paper can support the design of future interventions by the inclusion of more generic workings of the management of supply chains by leading organisation.

This research included data from a limited range of industries and relied on data of a qualitative nature; in this sense, it offered a point of departure for future analysis and research. Future research could overcome these limitation by including data from a wider set of industries and through the use of published quantitative data. Future research could test the ERINO supply chain approach through the examination of scenarios with senior managers and strategists from supply chain leading organisations, or be submitted to more formal policy analysis and modelling methods via quantitative data.

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Appendix A Interview Schedules

Interview Schedule Phase One – Government Policy Options

Introducing Statements

Read out the following:

Your answers will be treated with confidentiality and all responses will remain anonymous.

You (*the respondent*) 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 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 |
| <ul style="list-style-type: none">• Respondent's position and experience to be clarified (initial information already gained in participant identification regarding their qualifications).<ul style="list-style-type: none">○ 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 the de-carbonisation of supply chains? |
| Main Interview Questions & Topics: Current situation & near future (i.e. next 2 years): |
| 1. Who is leading current supply chain decarbonisation efforts and how? <ul style="list-style-type: none">a. What are the characteristics they hold that mean they are leading?b. What are the key drivers and barriers?c. How are they doing this? |

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| 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 (if applicable)? |
| 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)? |
| a. Why? |
| 2. How do you see the policy agenda/environment evolving over the next decade with regards to the de-carbonisation of supply chains (<i>i.e. those policies that may impact on firms operating in/throughout supply chains</i>)? |
| a. Why? |
| 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. <i>Make arrangements for checking and approval of interview transcript.</i> |

Interview close

Interview Schedule Phase Two – MNE Business Strategy and Policy

Options

Interview Reference Number:

Introducing Statements

Read out the following

You (*the respondent*) 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 agreed to the interview being recorded.

(If they decline, discontinue the interview and thank them.)

This interview will follow a semi-structured format comprising of 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 |
| <ul style="list-style-type: none">• Respondent’s position and experience to be clarified (initial information already gained in participant identification regarding their qualifications).<ul style="list-style-type: none">○ Job title:○ Specific responsibilities:○ 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? |
| Current situation & near future (Current - next 2 years): |
| <ul style="list-style-type: none">• The Company (internal):<ul style="list-style-type: none">○ Is the management and reduction of Greenhouse Gases (GHG) a corporate objective?<ul style="list-style-type: none">▪ How long has your company been engaged with this issue?▪ Have reductions targets been set and over what period?▪ Is progress being measured?▪ How is your organisation doing this (if applicable)?○ Which emissions are included (i.e. those within the company, or also those emissions associated with the business, but that fall outside its boundaries)? |

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| <ul style="list-style-type: none"> ▪ What strategies, procedures and personnel have been employed towards these ends? |
| <ul style="list-style-type: none"> • Barriers and Drivers to Engagement with supply chain decarbonisation: |
| <ul style="list-style-type: none"> ○ What drivers exist to reduce GHG emissions in your supply chain? <ul style="list-style-type: none"> ▪ Internally and externally? |
| <ul style="list-style-type: none"> ○ What barriers exist to your efforts to reduce GHG emissions in your supply chain? <ul style="list-style-type: none"> ▪ Internally and externally? |
| <ul style="list-style-type: none"> ○ How do these drivers and barriers operate? |
| <ul style="list-style-type: none"> • Inter-Organisational Relationships (environmental focus, moving to more generally): |
| <ul style="list-style-type: none"> ○ Suppliers: <ul style="list-style-type: none"> ▪ How best can you describe the relationship that your company has with its suppliers (<i>i.e. market exchange to vertical integration</i>)? ▪ Are you able to work/collaborate with suppliers? <ul style="list-style-type: none"> • Who within you company would lead/be involved in these efforts? ▪ What information is shared between your suppliers and yourself? ▪ How are suppliers selected? Are Climate Change criteria are used? ▪ Extent to which contract renegotiation/changing suppliers is easy? Is there substitutability with suppliers? ▪ Are GHG emissions and their management a factor in this regard? |
| <ul style="list-style-type: none"> ○ Other organisations: <ul style="list-style-type: none"> ▪ Are there any other organisation with which you share information on GHG emissions and their management? <i>i.e. the government, other industry partners, 3rd sector organisations.</i> |
| <p>Impact of Government Policy & Strategies (Current & Future):</p> |
| <ul style="list-style-type: none"> • Now: |
| <ul style="list-style-type: none"> ○ Can you think of a recent example of where government policy has impacted on your company's objectives or strategy? |
| <ul style="list-style-type: none"> ○ Do you feel that government is playing a leading role with regards to reducing GHG emission in supply chains? |
| <ul style="list-style-type: none"> • Future (Next decade): i.e. options/ policy briefing that has come out of Phase One of interviews |
| <ul style="list-style-type: none"> ○ How would the following policies and strategies affect your company's objectives and efforts? |
| <ul style="list-style-type: none"> ○ Would they encourage you to be more pro-active with regards to de-carbonising your supply chain? |
| <p>Future MNE Strategy & Policy Options:</p> |
| <ul style="list-style-type: none"> • Future drivers leading to MNE supply chain de-carbonisation pro-activity: |
| <ul style="list-style-type: none"> ○ Can you list the changes required contextually for your company to engage further in de-carbonisation of their supply chain? (<i>i.e. making it a strategic objective of the corporation</i>). |
| <ul style="list-style-type: none"> ▪ Internally? |

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| <ul style="list-style-type: none"> ▪ Externally? |
| <ul style="list-style-type: none"> • Potential Business Policies and Strategies that the MNE could employ? |
| <ul style="list-style-type: none"> ○ Have you thought about what policies and strategies could be employed to GHG emissions in your supply chain? What control mechanisms does the company have at its disposal? |
| <ul style="list-style-type: none"> ○ Which aspects of your company's operations would be most crucial in instigating and following through these policies and strategies? |
| <ul style="list-style-type: none"> ○ What policies are available to influence supply chain member with whom you have no direct commercial relationship? |
| <ul style="list-style-type: none"> • Changes to supplier relations: |
| <ul style="list-style-type: none"> ○ With regards to your current supply chain partners, what factors will make managing GHG emissions easier, or more challenging? (<i>i.e. type of relationship, length of time relationship has existed etc.</i>) |
| <ul style="list-style-type: none"> ○ What supply chain management activities will be most crucial in achieving a reduction in GHG emissions in your supply chain? Will any of these activities be problematic to your business? |
| <p>Closing comments</p> |
| <p>Thank you for your time and attention. <i>Make arrangements for checking and approval of interview transcript.</i></p> |
| <p>Interview close</p> |

Appendix B Research Participant Information

Table 11: Phase one participant information.

| Participant Job Title | Organisation Type | Interview Type & Length |
|---|--|-------------------------|
| Senior Policy Advisor (Environment & Energy) | Business Representation Organisation | In person (57 Minutes) |
| Head of Corporate Relations (brief included Business & Climate Change) | Local Business Support and Representation Organisation | In person (36 Minutes) |
| Operations Director | Local Ethical Investment Advisory | In person (58 Minutes) |
| Senior Account Manager | Solution Based NGO specialising in supply chain GHGE | In person (44 Minutes) |
| Program Manager - Sustainability | Regional Intelligence Network | In person (36 Minutes) |
| Research Fellow – Energy & Sustainability | Policy Think Tank | Telephone (34 Minutes) |
| Environmental Campaign Organiser | Regional Business Support Organisation | In person (42 Minutes) |
| Corporate Strategy Consultant | Global Sustainability Management Consultancy | In person (28 Minutes) |
| Post-Doctoral Researcher (Sustainability Policy Research, including SME GHGE management) | Academic Institution | In person (50 Minutes) |
| Senior Strategy Manager | National Low Carbon Business Support Organisation | Telephone (29 Minutes) |

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| Senior Sustainability Manager | Sustainability Think Tank | Telephone (32 Minutes) |
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Appendix C

Appendix D **Table 12: Phase two participant information.**

| Participant Job Title | Organisation Type | Interview Type & Length |
|---|--|------------------------------------|
| (2x Participants) Head of CSR Strategy & Policy for Procurement; Climate Change & Sustainability Officer | Multinational Telecoms Service Provider | Telephone (29 Minutes) |
| Associate Director of Brownfield and Sustainability | British House Building Company | Telephone (37 Minutes) |
| Science & Technology Leader | Multinational Consumer Goods Company | Telephone (45 Minutes) |
| Vice President of Sustainability | Multinational Pharmaceutical and Consumer Healthcare Goods Company | Telephone (32 Minutes) |
| Executive Director | Regional Social Enterprise Engaged with Supply Chain GHGE Management | Telephone (41 Minutes) |
| Capability Manager | British Water Utility Company | In person (44 Minutes) |
| Group Environment Health and Safety Manager (for UK | Dairy Products Company | In person (55 Minutes) |

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|---|---|--|
| subsidiary) | | |
| Head of Sustainability | Construction, Property & Housing Company | Telephone (42 Minutes) |
| Senior Sustainability Manager | Multinational Construction & Development Company | In Person (1 Hour, 5 Minutes) |
| Regional Manager, North of England | Multidisciplinary Consultancy Company Working on Supply Chain GHGE Management | Telephone (18 Minutes) |
| Head of Supply Chain Carbon Reduction | Multinational Grocery and General Merchandise Retailer | Telephone (37 Minutes) |
| Sustainability Officer | Local Government Organisation | In person (40 Minutes) |
| Low Carbon Consultant | Global Consultancy and Professional Services Firm | Telephone (38 Minutes) |
| Responsible Procurement Manager | Top-tier Regional Administrative Body | In person (49 Minutes) |
| Head of Supply Chain Research | Environmental Consultancy | In person (43 Minutes) |
| (2 x Participants) Environmental Advisor (Construction); Sustainable Procurement Advisor | Government Agency | Telephone (47 Minutes) |
| Climate Change Officer | Local government organisation | Telephone (7 Minutes + extensive email correspondence) |
| (2 x Participants) Environment | University | In person (58 Minutes) |

and Sustainability Officer;

Research Fellow

| | | |
|-------------------------------|------------|------------------------|
| Sustainability Officer | University | In person (33 Minutes) |
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| Operation Director | Sustainability Unit of National | Telephone (26 Minutes) |
|---------------------------|---------------------------------|------------------------|

Public Service Provider
