

# UK company strategies in reducing carbon dioxide emissions

Yongmei Bentley

University of Bedfordshire, United Kingdom

## Key words

CO<sub>2</sub> emissions, reduction, logistics, strategies

## Abstract

*This study investigated a number of large UK companies' strategies in reducing emissions of carbon dioxide (CO<sub>2</sub>) in their supply chain operations. In-depth interviews were conducted with logistics/supply chain (SC) managers across different sectors. The research identified the main CO<sub>2</sub> reduction strategies, and examined these in the light of existing literature in the research domain. One of the key findings was that there was a strong tension between cost reduction (identified as the major driver for reducing CO<sub>2</sub>) and lack of resources (the main barrier). It was also found that most CO<sub>2</sub> reduction strategies had started only fairly recently, and so far, were mainly operational and tactical in nature. This study makes an empirical contribution to a better understanding of how companies form their CO<sub>2</sub> reduction strategies in response to environmental pressures. It has implications for policy makers in terms of how to motivate logistics/SC managers to implement strategies to reduce the environmental impact of CO<sub>2</sub> emissions in their business operations. Therefore, it is recommended that logistics/SC managers develop and implement practical initiatives and strategies to reduce CO<sub>2</sub> emissions, and to embed these into corporate strategy.*

## 1. Introduction

The distribution of goods contributes significantly to global warming, and this presents 'a much greater and more immediate threat than previously thought' (McKinnon, 2001:4). Freight transport, as a key part of logistics, is a substantial contributor to CO<sub>2</sub> emissions. The 1997 Kyoto Protocol agreement set targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions (UNFCCC, 1997). Since then there has been an increasing public and government concern for the environment, and companies have been under mounting pressure to reduce the environmental impact of CO<sub>2</sub> generated by their activities, including logistics activities. This research mainly focuses on two questions: What strategies are currently being implemented in selected UK companies to reduce carbon dioxide (CO<sub>2</sub>) emissions in their supply chain (SC) activities? And what are the main drivers and barriers affecting the implementation of these strategies? Data were collected from in-depth interviews that were carried out with senior SC managers from 15 large UK companies with significant SC activities. Key findings are analysed in the light of the relevant literature review.

## 2. Background and Literature review

### a) Research background

As mentioned above, the distribution of goods contributes significantly to global warming (McKinnon, 2001). For example, emissions of CO<sub>2</sub> from logistics activities in the UK for 2004 were 34 million tonnes, about 6% of the total UK emissions (McKinnon, 2007). Findings from Kahn-Ribeiro and Kobayashi (2007) and the World Economic Forum (Doherty and Hoyle, 2009) are consistent with these UK findings, and show that total world emissions from the freight transport sector are between 6% and 8% of global emissions. Another study from Kahn-Ribeiro and Kobayashi (2007) estimates that just the freight transport share of energy related CO<sub>2</sub> emissions worldwide is in the region of 8%. This means that with the inclusion of warehousing and handling, logistics accounts for 10%-11% of the worldwide total (McKinnon, 2010a).

In terms of economic activity, a report from DHL (Ehrhart, 2010) estimated that the logistics industry generates about 9% of the world's GDP, while in Europe it accounts for about 10% of GDP. As the pressure mounts on global supply chains to produce enough food, goods and services to meet the needs of growing population, the logistics industry is expected to continue to grow, and so will its energy consumption and CO<sub>2</sub> emissions unless change is introduced (Beamon, 2008). With the forecasted growing rates of the shipping industry and with reduction of emissions by the rest of the national economies by an average of 50%, the total emissions from the logistics and shipping industry are expected to be around 15-30% of the CO<sub>2</sub> total world emissions by 2050 (McKinnon, 2010b). These are worrying figures and for this reason many authors (e.g. Aronsson and Brodin, 2006; EUROSTAT, 2010) have emphasized the need for decoupling the growing rates of transportation volumes and the emission this produces.

In the light of these facts, a variety of strategies to reduce CO<sub>2</sub> emissions are being currently used or actively considered in UK SC operations, especially by the larger firms which have the available resources and capability. There are now a number of studies regarding such strategies, and in the UK useful reports on these have been produced by the Department of Energy and Climate Change, the Department for Environment, Food and Rural Affairs, the Carbon Trust, the Chartered Institute of Logistics and Transport, and the Social Research Council.

#### **b) Studies on environmental impact of SC activities**

There has been an increasing number of studies that look at the environmental impacts of SC activities. Topics studied included: CO<sub>2</sub> auditing (Piecyk, 2010); environmental impacts of freight transport (Cullinane and Edwards, 2010); the environmental impact of warehousing and distribution (Marchant, 2010); reverse logistics and waste management (Cherrett et al., 2010); and the environmental costs of logistics (Piecyk et al., 2010). Specific practices that have an impact on CO<sub>2</sub> emissions include: the use of 'green' criteria to choose suppliers and transporters (Edwards et al., 2010); consolidation of shipments and selection of cleaner transport modes (Eglese and Black, 2010, McKinnon, 2010d, McKinnon and Edwards, 2010); the use of environmentally friendly packaging, recuperation of materials for reuse, and the disposal of waste (Cherrett et al., 2010). Mollenkopf et al. (2010), for example, examined the relationship among three SC strategies - green, lean and global, through an in-depth review of literature which revealed that these SC strategies had many barriers as well as drivers but with converging and contradictory points. Doherty and Hoyle (2009) identify some of the more significant and commercially-feasible opportunities for the decarbonisation of logistics and transport. These include the use of 'clean' vehicle technologies; de-speeding the supply chain; enabling low-carbon sourcing; optimised logistics networks; energy efficient logistics buildings; packaging design initiatives; training and communication; modal switches; reverse logistics; increased home delivery; and reducing congestion. These initiatives in combination, according to the authors, can have the potential to reduce global logistics and freight transport emissions by 1,400 million tonnes of CO<sub>2</sub> in the medium term, i.e. 50% down from current levels. However, many companies find it is not so easy to those initiatives in practice because there are all sorts of barriers.

#### **c) Significance of the study**

While there are some signs of development in the understanding of the firms responses towards environmental issues such as CO<sub>2</sub> emissions, especially since 1997 after the Kyoto Protocol agreement, there is little understanding of the individual SC managers' behaviour and perceptions, and their decision-making process (Carter and Easton, 2011). This is surprising considering the importance and urgency in developing strategies for achieving lower emissions

(Wu and Dunn, 1995, Ehrhart, 2010). Moreover, several authors have pointed out the need for the academic research to stay close to SC practices in order to identify the new perspectives and address the industry's mainstream strategic concerns, including CO<sub>2</sub> emissions (McGinnis and Kohn, 1990; Eisenhardt and Zbaracki, 1992; McKinnon, 2007; CCC, 2008; McKinnon, 2010b & 2010c). This led to the start of the research presented here which mainly focused on examining the two questions: What strategies are currently being implemented in selected UK companies to reduce CO<sub>2</sub> emissions in their SC activities? And what are the main drivers and barriers affecting the implementation of these strategies? The findings from the responses were analysed in the light of relevant literature reviewed for this study.

### 3. Research methodology

To achieve the objectives of this research, a number of research methods were considered, including questionnaire survey, case study, and qualitative interview. Interviewing, one of the most important sources of qualitative research, was judged as the method most likely to yield the information required. In this technique, although the research would pursue 'a consistent line of inquiry', the actual stream of questions in an interview was 'fluid rather than rigid' (Rubin and Rubin, 1995). Throughout the interview process, the researcher had two main jobs - 'to follow the line of inquiry ...' and 'to ask the questions in an unbiased manner that also serves the needs of the line of inquiry' (Yin, 2003: 90).

A key criterion for selecting the UK companies to interview was that they had significant logistics operations. Contacts were established primarily via the Chartered Institute of Logistics and Transport (CILT-UK), where this included personal contacts at CILT events, direct e-mails, and a general e-mail requiring collaboration in the research sent to the selected members on the CILT membership database. In practice, it required quite a lot of effort to get in touch with logistics and SC managers at a suitable level who were willing to be interviewed for this research, and whose companies were willing for the interviews to take place, even with a guarantee of anonymity. In the end over 20 large UK companies agreed to take part in the interviews, but a total of 18 logistics managers from 15 large UK companies were finally interviewed. These including five food manufacturers, three logistics operators, three transport infrastructures, one essentials manufacturer, one fluid equipment manufacture, one retail, and one hospitality company.

A questionnaire with 16 questions was sent to the respondents about two weeks before the agreed date for interview to allow time for thought-out responses. The interviews lasted up to an hour and were taped with the interviewee's agreement, and subsequently transcribed. All companies were guaranteed anonymity to help yield more meaningful replies. The interviews were semi-structured, and based around the questionnaire, but were deliberately 'open-ended' to allow interviewees to elaborate on issues that seemed to them particularly important.

The transcribed interviews were analysed using NVivo. Eight themes were chosen from the interview questions, and the quotations extracted from the interviews related to these themes, with each relevant sentence or phase tagged according to the theme or sub-theme judged most appropriate. These were then reviewed by the research team, and some responses were also subsequently cross-checked with the interviewees to check accuracy. The result was thus a detailed thematic qualitative analysis of these interviews.

### 4. Discussion of findings

#### a) Company awareness of CO<sub>2</sub> reduction issues

Interviewees were asked if their companies were aware of the need to reduce CO<sub>2</sub> emissions. Given the initial selection of companies involved, all the 15 companies investigated were aware in general terms of the need to reduce CO<sub>2</sub> emissions from their logistics operations.

In particular, the managers from the three logistics operators showed a high degree of awareness. They mentioned that logistics is the core of their business and as their activities involve an extensive use of fuel and energy so they are 'in the spotlight' when dealing with the topic with customers and other stakeholders. The logistics managers at the six different manufacturing companies indicated that CO<sub>2</sub> reduction in logistics activities are included as part of the corporate commitment to reduce their total emissions within their environmental agenda. However, they said that the majority of the resources assigned to reduce their emissions were invested in their core manufacturing operations. The two logistics practitioners from the retailer investigated were clear that the majority of the CO<sub>2</sub> their company generates is based on their transport and distribution activities. They were also very aware of the need to reduce the emissions of logistics if the company wanted to achieve its environmental targets. The two logistics participants working for infrastructure facilities associated with shipping also agreed that in addition to the need to reduce the emissions of their own operations, an important issue for them was to assist their customers in reducing their emissions in turn, either through modal shift or through improving their inbound and outbound supply chains. The participant at another infrastructure operator was also keen to emphasize to their customers the importance of facilitating low-carbon means of transportation such as use of electric trains. The interviewee from the hospitality company said that their company had just started to be aware of CO<sub>2</sub> reduction issues and they would be incorporating more initiatives in the future years.

**b) CO<sub>2</sub> reduction strategies in logistics and SC activities**

The interview questions then examined current and planned strategies undertaken by the participant companies to reduce CO<sub>2</sub> emissions, specifically in logistics and SC activities. All the respondents stated that their companies have already started to make, or planned to make, changes in their logistics and SC activities in order to reduce their CO<sub>2</sub> emissions. However, the changes and initiatives aimed at reducing emissions in logistics and SC operations were mainly implemented at the operational and tactical levels, with less focus on large and expensive strategic changes such as network optimisation, centralisation, localisation, change in information systems, or changing a large proportion of the fleet to greener vehicles. However, it is worth mentioning that there had been a general increase in the use of multimodal transportation, changing to rail or waterways when the infrastructure and capacities were appropriate for such change.

Another important change at the strategic level was the increased number of cases of collaboration between companies, even when they are direct competitors. An example of such collaboration could be seen between two food manufacturers which have been sharing units for transporting goods with similar characteristics. And, as mentioned above, the three companies which are managing transport infrastructure are implementing not only initiatives to reduce their own emissions, but also making infrastructural changes to facilitate greener means of transportation for their customers.

There were examples from the interviews to illustrate some of the key logistics and SC initiatives implemented by the respondents' companies to reduce CO<sub>2</sub> emissions. These cover a wide range of actions, and show a considerable degree of forward thinking and commitment. However, an important finding from these interviews was that even in these large companies, with significant resources and capacity, the issue of CO<sub>2</sub> reduction in logistics and SC operations had not been embraced as extensively as might be the case, particularly in the important area of monitoring and reporting CO<sub>2</sub> reductions achieved. Moreover, despite a long-standing awareness of the issue by the logistics managers and by the companies themselves, most initiatives to reduce CO<sub>2</sub> emissions specifically in logistics had started only in the last 4/5 years.



A number of the initiatives of the companies investigated for this study are similar to those suggested by Doherty and Hoyle (2009) that were discussed in the literature review section. For example, this study has confirmed that the above authors' promotion of 'optimised logistics networks' and 'modal switches' (or 'multimodal transportation' used for this study) are the initiatives that have already been used by some of the UK companies to reduce carbon emissions and improve energy efficiency in logistics/SC activities.

**c) Drivers for implementing CO<sub>2</sub> reduction initiatives**

An important area explored were the factors that are influencing companies in their decisions for taking CO<sub>2</sub> reduction actions. *A priori*, one can speculate as to a wide variety of drivers, and it is important to know which are predominant. Drivers can include, for instance, a concern over the risks posed by climate change; the need for compliance with existing legislation; anticipation of new government legislation; cost and benefit considerations; requirements imposed by suppliers or customers; or simply a wish by the company to appear green. The interviewees were asked therefore about the drivers of the change towards low CO<sub>2</sub> logistics operations. Answers from participants were very diverse as their companies were also diverse in nature and with different operational characteristics. Nevertheless, they agreed on one fundamental driver: CO<sub>2</sub> reduction is frequently linked with cost reduction. For this reason, cost benefits were mentioned by all the interviewees as a driver for implementing CO<sub>2</sub> reduction initiatives, with some differences between the levels of importance they gave to this. The other main driver highlighted by the majority of the interviewees was corporate social responsibility, which was engrained in the values and principles of most of the companies interviewed. But they suggested that any effort to reduce emissions in logistics had to balance financial, social and environmental factors, in order to guarantee the sustainability of their businesses.

**d) Barriers for implementing CO<sub>2</sub> reduction initiatives**

When analysing the interviews, it was noted that according to the nature of their business, companies face a wide variety of barriers, reflecting the differing function of logistics in their operations. However, the most frequently mentioned barrier was lack of resources. Many respondents mentioned that capital had been an issue, especially since the start of the economic crisis in 2008, and companies had prioritised investments in activities that added more value to their products. Three of the food manufacturers indicated that because logistics is a support function and not the core of their business, it had not received the same attention, and it had been difficult to channel additional resources to implement initiatives. Since logistics is not their biggest CO<sub>2</sub> emitter it had also been lower on their priority list for potential CO<sub>2</sub> reduction. Not only the lack of financial resources has been an issue, but time resources had also affected and delayed the implementation of CO<sub>2</sub> reduction initiatives in logistics. The interviewee at one food manufacturer revealed that they are on a tight timescale and 'sometimes... little things ... won't get done, just because there just isn't the time to actually do them'. Respondents at another food manufacturer, and at the essentials manufacturer, also had similar statements and agreed that an important barrier is people's time to actually make these changes in logistics happen.

Despite of the barriers discussed above, surprisingly one of the most frequent responses was that there were 'no major barriers for implementing initiatives to reduce emissions in logistics'. This is an encouraging finding for those wishing to see CO<sub>2</sub> reductions continue to be taken forward. Almost a third of the respondents agreed that because all of these initiatives come together with logistics efficiency and cost benefits, everybody is on board from top management to the lower levels of management.

**e) Strategic changes in logistics and SC due to CO<sub>2</sub> emissions concerns**

We also examined the extent that CO<sub>2</sub> reduction has led to *strategic* changes in companies' logistics activities. The general response from the companies was that there had been no *major* strategic changes in logistics due to CO<sub>2</sub> concerns. However, most respondents admitted that a more strategic approach will be needed in order to tackle this issue. Strategic changes in logistics and SC usually require structural changes which at the moment are not widely adopted. Multi-modal transportation, which in the context of CO<sub>2</sub> reductions means moving to a fuel-efficient combination of transport modes, and the use of new vehicle technologies (such as hybrids or electric units), were the main structural changes mentioned by the majority of the companies interviewed, and these initiatives were just at the beginning of their development. The companies that showed the most significant structural and strategic changes were the ones providing transport infrastructure, as they have to facilitate an increased use of rail and water modes of transport by their customers. Operational and tactical strategies to reduce CO<sub>2</sub> emissions have started more recently and structural ones mainly at an even earlier stages. For these strategic changes to happen, participants in the retail company and two of the infrastructure companies said that changes at a national level coming from the government are needed. These changes will need to focus on improving the rail, water and road networks. Another strategic change that will need to occur in the next few years is that companies will need to increase collaboration within their own supply chain, and even with competitors from other supply chains, in order to reduce their tonne-kilometres. Some of the companies interviewed, such as the food manufacturers, have already started already with this, and will be including further in their logistics strategic planning in the near future.

**f) Emergence of CO<sub>2</sub> reduction initiatives through the organisational structure**

How CO<sub>2</sub> reduction initiatives within logistics and SC activities develop within company management structures? Are these mainly driven top-down from senior management or are they mainly initiated by the logistics managers themselves? An interesting finding was that companies where logistics is a core function, such as the logistics operators and the infrastructure operators, there was a strong influence from top management, with the drive mainly a top-down process. Perhaps this was due to the more structural type of initiatives these companies were implementing. This was the case, for example, with the port and the rail operators, as they require a significant amount of investment and strategic thinking in connection with any proposed initiatives. For the three logistics operators in particular, any initiative to reduce CO<sub>2</sub> emissions will affect their core operations, and also directly affect revenues. Apart from these participants, the two respondents from the hospitality company and the industrial manufacture also indicated that the top-management was the main initiator of their CO<sub>2</sub> emissions initiatives in logistics. However, as these two companies were the ones with the fewer initiatives already in place, one might speculate that this top-down approach was in fact holding them back.

For the organisations where logistics is a core function, strategic change requires a top management who are very familiar with the new logistics concepts and technologies. This does not have to be the case for companies where logistics is only a support function, and here the middle logistics management stated they were the most knowledgeable when it came to the formation, evaluation and implementation of changes and solutions for their logistics operations. Nevertheless, these managers pointed out also that such changes would not be possible without the engagement of all levels of management. The respondent from a food manufacturer summed this up when he declared: '...aspirations to beat environmental problems come from the top, but actually the ideas are generally generated within the middle and further

down'. Other key statements from the interviews stressed the importance of logistics middle managers in setting the targets of CO<sub>2</sub> reduction for the logistics operations, as they are the ones that knows what is feasible.

## 5. Summary and Conclusions

This paper reports the findings from an investigation of 15 large UK companies having significant supply chain activities of the following factors: the company awareness of the environmental impact of CO<sub>2</sub> emissions from their logistics and SC activities; initiatives taken to tackle these emissions; the drivers and barriers within the company affecting these initiatives; the extent of strategic changes in logistics and SC practices with the company due to CO<sub>2</sub> emissions concerns; and how CO<sub>2</sub> reduction initiatives for logistics and SC activities have developed within company management structures. Key findings of this research include:

- Despite a long-standing awareness of the CO<sub>2</sub> issues by the companies, and the logistics managers within the companies, most CO<sub>2</sub> reduction initiatives only started in the last three to four years, and have been mainly operational and tactical rather than strategic.
- There is a positive correlation between most CO<sub>2</sub> reduction initiatives and cost reduction, and this link has been a major driver for the adoption of CO<sub>2</sub> reduction in the companies investigated.
- A key barrier cited for the adoption of CO<sub>2</sub> reduction initiatives in logistics and SC has been the lack of resources to carry out identified changes. Other barriers include the countervailing pressures from new business demand, such as online retailing, and the fact that CO<sub>2</sub> reduction technologies are not yet settled, so investment is still considered risky. This is supported by the view that SC strategies had both barriers and drivers that have converging but contradictory points (Mollenkopf et al. 2010).
- In the companies surveyed, there had been no significant *strategic* changes in logistics and SC activities within the companies due to CO<sub>2</sub> concerns, but most respondents felt that a more strategic approach will be needed in order to tackle the issue.
- CO<sub>2</sub> reduction initiatives were mainly driven top-down from senior management for companies where logistics/SC is a core function, but the role of logistics/SC middle managers is very important in setting the targets of CO<sub>2</sub> reduction for the logistics and SC operations.

The study has confirmed the awareness by UK companies of the need to reduce CO<sub>2</sub> emissions in logistics activities and thus has led to a wide range of autonomous logistics initiatives being adopted, or being considered for adoption. The findings have also confirmed the statement that the need to implement logistics initiatives to reduce CO<sub>2</sub> emissions has led to an increased role for logistics managers, especially in companies where logistics is a support function, as opposed to companies where logistics is a core business. However, the adoption of those more structural/strategic changes has not yet happened to a major degree, at least in the major companies studied here, although this is expected in the years to come. Nevertheless, it is hoped that this study can assist logistics managers in the development and implementation of initiatives and strategies to reduce CO<sub>2</sub> emissions, and to embed these into corporate strategy.

## 6. Research Limitations & Direction for Further Research

This section highlights some of the limitations:

- It is recognised that the 15 companies interviewed do not statistically represent UK large companies as a whole. However, they were all large companies with significant logistics activities, covered a range of industries, and included companies where logistics was a core business, as well as those where it was a support function.

- By contrast, the 18 interviews were judged the right number for the resources available. Each interview took a significant amount of time to set up and considerably more to transcribe and analyse. While additional data is usually a desirable goal, obtaining further interviews would have reduced the degree of analysis possible.
- A questionnaire survey might have been able to reach out to more companies and hence to collect more sizeable sample data.

Therefore, further research can be conducted using semi-structured questionnaire survey to reach more respondents, cover more companies and include a wider range of industries.

### Acknowledgement

The authors of this paper would like to acknowledge the contribution of Mr J. C. Boluarte who helped with the data collection for this research.

### References

- Aronsson, H. and Brodin, M. H. (2006). The environmental impact of changing logistics structures. *International Journal of Logistics Management*, 17 (3), 394-415.
- Beamon, B. M. (2008). Sustainability and the Future of Supply Chain Management. *Operations and Supply Chain Management*, 1 (1), 4-18.
- Carter, C.R. and Easton, P.L. (2011), "Sustainable supply chain management: evolution and future directions", *International Journal of Physical Distribution & Logistics Management*, Vol. 41 No. 1, pp. 46-62.
- CCC (2008). *Building a Low Carbon Economy: the UK's Contribution to Tackling Climate Change*. Committee of Climate Change. Available from: <http://www.theccc.org.uk/reports/building-a-low-carbon-economy> [Accessed 6 April 2015].
- Cherrett, T., S. Maynard, McLeod, F. and Hickford, A. (2010). Reverse logistics for the management of waste. In: McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (eds.) *Green Logistics: Improving the environmental sustainability of logistics*. London: Kogan Page Limited.
- Cullinane, S. L. and Edwards, J. B. (2010). Assessing the Environmental Impacts of Freight Transport. In: McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (eds.) *Green Logistics: Improving the environmental sustainability of logistics*. London: Kogan Page Limited.
- Doherty, S. and Hoyle, S (2009). *Supply Chain Decarbonization: The Role of Logistics and Transport in Reducing Supply Chain Carbon Emissions*. World Economic Forum.
- Edwards, J. B., Wang, Y., Potter, A. and Cullinane, S. (2010). E-commerce, E-logistics and the Environment. In: McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (eds.) *Green Logistics: Improving the environmental sustainability of logistics*. London: Kogan Page Limited.
- Eglese, R. and Black, D. (2010). Optimizing the routing of vehicles. In: McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (eds.) *Green Logistics: Improving the environmental sustainability of logistics*. London: Kogan Page Limited.
- Ehrhart, C. E. (2010). *Delivering Tomorrow: Towards Sustainable Logistics*. Bonn: Deutsche Post AG.
- Eisenhardt, K. M. and Zbaracki, J. J. (1992). Strategic Decision Making. *Strategic Management Journal*, 13, 17-37.
- EUROSTAT (2010). *Freight transport statistics*. Available from: [http://ec.europa.eu/eurostat/statistics-explained/index.php/Main\\_Page](http://ec.europa.eu/eurostat/statistics-explained/index.php/Main_Page). [Accessed 4 Feb 2016].
- Khan-Ribeiro, S. and Kobayashi, S. (2007). Transport and its infrastructure. In: Change, I.-g. P. o. C. (ed.) *Fourth Assessment Report: Climate change 2007 - mitigation of climate change*. Geneva.



- Marchant, C. (2010). Reducing the Environmental Impact of Warehousing. In: McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (eds.) *Green Logistics: Improving the environmental sustainability of logistics*. London: Kogan Page Limited.
- McGinnis, M. A. and Kohn, J. W. (1990). A Factor Analytic Study of Logistics Strategy. *Journal of Business Logistics*, 11 (2), 41-63.
- McKinnon, A. (2001). Integrated Logistics Strategy. In: Brewer, A., Button, K. J. and Hensher, D. A. (eds.) *Handbook of Logistics and Supply Chain Management*. Elsevier Science Ltd.
- McKinnon, A. (2007). *CO2 Emissions from Freight Transport in the UK*. Edinburgh: Climate Change Working Group of the Commission for Integrated Transport.
- McKinnon, A. (2010a). Environmental sustainability. A new priority for logistics managers In: McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (eds.) *Green Logistics. Improving the environmental sustainability of logistics*. London: Kogan Page Limited.
- McKinnon, A. (2010b). Environmental Sustainability: A new priority for logistics managers. In: McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (eds.) *Green Logistics: Improving the environmental sustainability of logistics*. London: Kogan Page Limited.
- McKinnon, A. (2010c). Green Logistics: The Carbon Agenda. *LogForum*, 6 (3), 1-9.
- McKinnon, A. (2010d). Increasing fuel efficiency in the road freight sector. In: McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (eds.) *Green Logistics: Improving the environmental sustainability of logistics*. London: Kogan Page Limited.
- McKinnon, A. and Edwards, J. (2010). Opportunities for improving vehicle utilization. In: McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (eds.) *Green Logistics: Improving the environmental sustainability of logistics*. London: Kogan Page Limited.
- Mollenkopf, D., Stolze, H., and Tate, W.L. and Ueltschy, M. (2010) "Green, lean, and global supply chains", *International Journal of Physical Distribution & Logistics Management*, Vol. 40 Iss: 1/2: 14 - 41.
- Piecyk, M., McKinnon, A. and Allen, J. (2010). Evaluating and Internationalizing the Environmental Costs of Logistics. In: McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (eds.) *Green Logistics: Improving the environmental sustainability of logistics*. London: Kogan Page Limited.
- Rubin, H. J. and Rubin, I. S. (1995). *Qualitative interviewing: The art of hearing data*, CA, Sage.
- Wu, H.-J. and Dunn, S. C. (1995). Environmentally Responsible Logistics Systems. *International Journal of Physical Distribution & Logistics Management*, 25 (2), 20-38.
- Yin, R. K. (2003). *Case Study Research, Designs and Methods*, London, Sage Publications Ltd.