LOGISTICS AND LOW CARBON SHIPPING

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ABSTRACT
This paper reports on the on-going research concerned with the logistics dimension of the Low Carbon Shipping research project (2010-2012, jointly funded by the UK Engineering and Physical Sciences Research Council (EPSRC) and industry). The carbon emissions associated with shipping activity are first described and the need to take a systems view is highlighted. The role of containerisation, and its link to globalisation, is discussed in the context of its share of shipping's emissions. Our on-going research approach is next described and which comprises three streams of activity: (i) mapping the UK's shipping activity, (ii) mapping end to end supply chains, and (iii) visioning the UK's future maritime logistics infrastructure.
Keywords: Logistics, carbon emissions, containerisation, UK shipping activity, end supply chains

1. SHIPPING AND CO_2.

UNCTAD's Multi-Year Expert Meeting on Transport and Trade Facilitation document (2009) summarised nine different studies published between 2000 and 2009 on the subject of CO2 emissions from international shipping. The findings of the various research projects showed that CO2 emissions from worldwide shipping have increased rapidly over a relatively short time period. Buhaug et al (2009) claimed that in 2007 total world shipping (including domestic and international) was responsible for emitting 1.046 billion tonnes of CO2, which is equivalent to approximately 3.3% of total global CO2 emissions (Figure 1). UNCTAD (2009) has estimated that CO2 emissions from shipping are projected to increase by a factor of between 2.2 and 3.1 between 2007 and 2050, which could result in shipping being responsible for up to 8% of total global CO2 emissions by 2050, in the absence of technological, operational or market based measures.

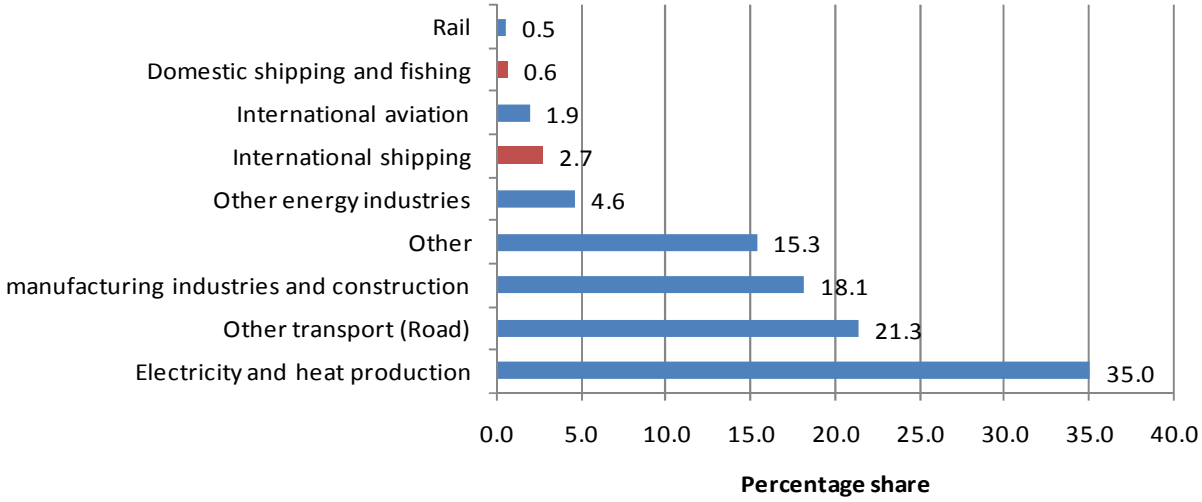

Figure 1: Emissions of CO_2 from shipping compared with global emissions from other industries (2007) (Buhuag et al 2009).

2. THE IMPORTANCE OF TAKING A SYSTEMS APPROACH

The focus of the work being conducted by the authors of this paper is on the logistics dimension of shipping and CO2; specifically how can logistics practices mitigate the (growing) CO2 footprint associated with shipping activity. Such logistics practices encompass, but are not limited to:

Vessel operations, routing and efficiency;
Landside routing of freight;
Overall supply chain structures and cost drivers;
Port strategies and activities.

It is now generally accepted that supply chains, and not individual firms or products, are the basis of competition in the global marketplace (Christopher, 1992), where the supply chain can be defined (ibid) 'as the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer'. There is a growing appreciation of the impact that best practice logistics and supply chain management (SCM) can have on firm success. In the intervening years since Christopher first put forward his proposition in 1992, many successful organisations have learned how to use their supply chains both to differentiate their offerings from those of the competition and to compete with other actors in the market. Much has been written on and learned from the experiences of these organisations, many of which are now household names [see, for example, Ferdows et al. (2004) on the Spanish clothing retailer Zara, and Lee (2004) on the computer manufacturer Dell]. Today then, many organisations are aware of the fundamental importance of using effective and efficient logistics and SCM practices in order to drive down costs and concomitantly add value to their marketplace propositions. Shipping and ports constitute important links and nodes within many supply chains, both in terms of their costs and their performance.

When seeking to mitigate the (growing) CO2 footprint associated with shipping activity, we need then to understand how this fits with the wider supply chains and logistics systems within which shipping operates. As well as this wider supply chain dimension, other work packages within the 'Low Carbon Shipping' research programme will conduct research into other pertinent dimensions: engineering aspects (vessel design and energy systems); shipping economics; human factors; regulatory aspects; etc. Accordingly, this research project adopts a whole systems approach with six individual work packages feeding into a holistic model of the shipping system (the work reported here relates to work package 3: 'Shipping, ports and logistics').
With regard to focal vessel types, the consortium is focused on three vessel types – liquid tankers, container ships and bulk carriers because, according to data from IMO MEPC 60/WP.5 (Figure 2), emissions from these three categories of vessels were estimated to be responsible for 73% of emissions from all vessels covered by the Energy Efficiency Design Index (EEDI).

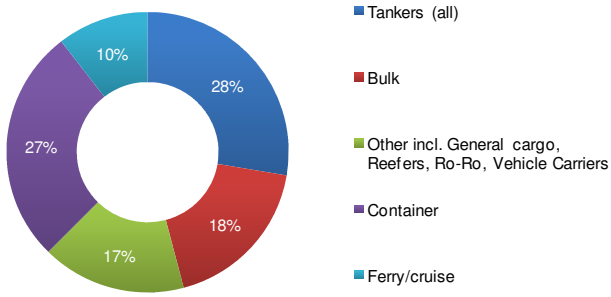

Figure 2: Ship category shares of CO_2 emissions from vessels covered by EEDI (IMO 2010)

3. THE IMPACT OF CONTAINERISATION

When considering the logistics dimension of low carbon shipping, container vessels deserve special mention. Although container ships are responsible for producing well over a quarter (27%) of global maritime CO2 emissions (from vessels covered by EEDI), the number of container ships in relation to the total global merchant fleet of ships is relatively small at approximately 10% (or 4,639 container vessels - illustrated in Figure 3). Therefore it is clear that even though container ships are few in number when compared to the total global merchant shipping fleet, their emissions represent a much higher figure, at approximately 27%.
Container ships have been associated with the rise of globalisation since their introduction - one can see a correlation between the growth of world exports and container volumes. Levinson (2010, p.1) noted that "the container didn't cause globalisation, but globalisation could hardly have occurred without the decline in transport costs that containerisation made possible". As the structure and shape of the world economy changes over the coming years, how this impacts container flows and their associated CO2 emissions is a topic of much relevance and one that we are particularly focused upon in the context of our current work.

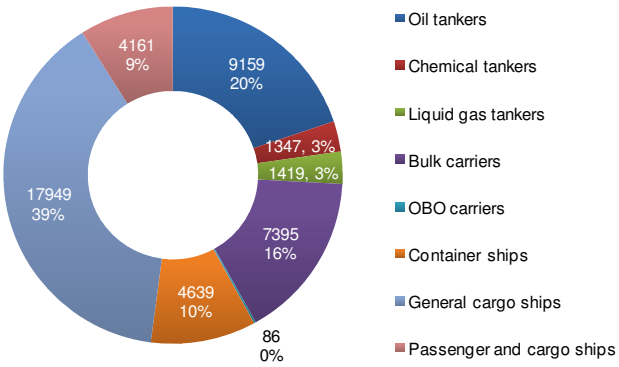

Figure 3: Number (and percentage) of ships over 300 gross tonnes as at 2009 (Shipping Statistics Yearbook 2009)

The impact of globalisation upon the United Kingdom could result in changes in the quantity of goods imported and exported to and from the UK. The Department for Transport (DfT) (2008) reiterates this by arguing that the UK is likely to see a smaller domestic manufacturing sector, which would result in fewer exports and an increasing reliance upon imported goods. Brooks (2010) also draws attention to changes in the global economy whereby developed countries are moving towards jobs based in service sectors and other industries that do not add significantly to shipping tonne miles. Brooks (2010) goes on to argue that as 'western' countries' economies have moved on from manufacturing and heavy industry, their economies are based more around providing services, such as software, pharmaceuticals, education services, bio-technology, eco-tourism, leisure and recreation and business services, which consequently means that these countries tend to import more goods by sea than they export. The DfT (2008) also agrees with Brooks' (2010) assertion by claiming that the UK is likely to focus on knowledge intensive industries and hi-tech manufacturing, which could also impact upon the volume of freight leaving the UK.

Despite the recent economic recessions of many of the world's developed countries, Heymann (2008) predicts that global maritime container volumes will grow at an average annual rate of between 7% and 8% per year until 2015. This view is also supported by evidence from Boston Consulting Group which argues that global container trade between 2008 and 2015 could increase by up to 41%, which is equal to an average annual growth rate of 5.2%. The predicted annual growth in global container volumes is also supported by Notteboom and Rodrigue (2008) who refer to research by UNESCAP (2005) to suggest that in 2015 container volumes are expected to reach 177.6 million TEU, up from 77.8 in 2002, an increase of over 128% in 13 years.

4. RESEARCH APPROACH

As noted already above, our research is focused upon the logistics dimension of low carbon shipping and thus we are interested in topics such as: vessel operations, routing and efficiency; landside routing of freight; overall supply chain structures and cost drivers; and port strategies and activities. Work is currently underway in three interrelated streams of activity and these are now detailed in turn.

4.1 MAPPING THE UK'S SHIPPING ACTIVITY

Our research is concentrating upon UK-centric freight a flow, which is freight that originates in or is destined to the UK. As a starting point then we are concerned with mapping shipping activity within and around the UK (in her ports and waters) and endeavouring to calculate the share of emissions this shipping activity represents in the context of the global total. One can easily ascertain the total volume of UK maritime freight, relate this to a global share, and thus ascertain the UK's share of global maritime traffic (and carbon emissions). This however may not be particularly accurate as it doesn't allow for the different types of vessels (size / weight / category / speed / fleet mix etc) and their associated carbon emissions. Analysis of UK shipping activity is thus on-going using various publicly available data.

One particularly informative source is AIS data which can capture ship movements and associated details. According to Eriksen et al (2006) an Automatic Identification System (AIS) is a maritime safety and vessel traffic system which broadcasts a range of basic "live" data from each vessel; these include details such as geographic position, name of ship, destination, speed, type of vessel and route travelled. Under the International Convention for the Safety of Life at Sea (SOLAS), the International Maritime Organisation (IMO) has made the carriage and use of such systems mandatory. Because of the widespread use of AIS it is now possible to track vessel movements in widely available computer programs such as Google Earth and websites like www.shipais.com and www.marinetraffic.com. Figure 4 illustrates a 'zoomed out' view of vessel movements in Google Earth around Northern Europe using AIS data. Clicking on a ship opens a separate window which provides details about the ship, and all movements within the last month.

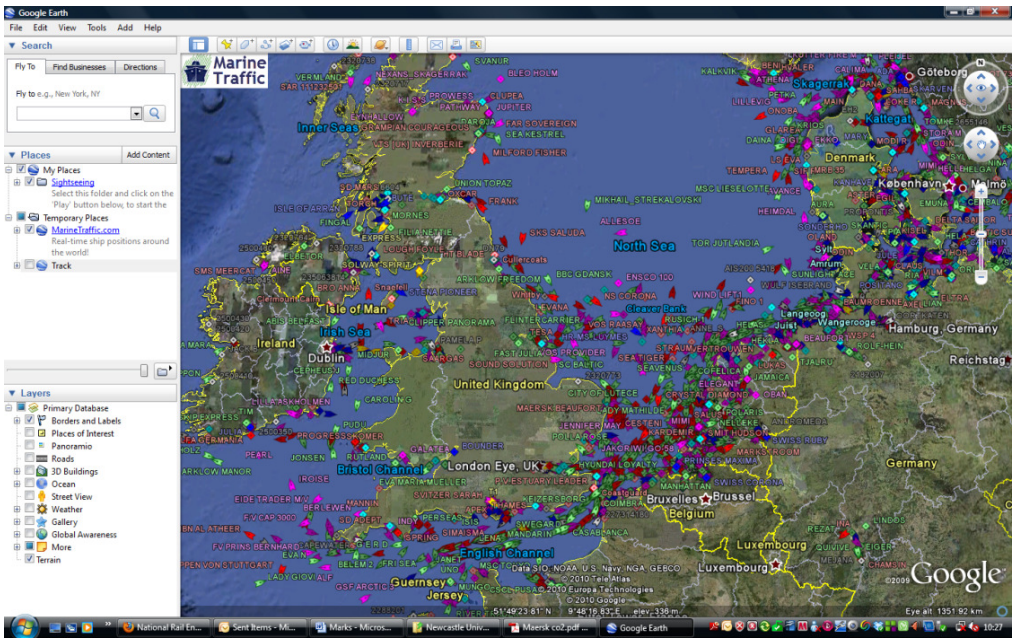

Figure 4: A “zoomed out” view of live vessel movements in Google Earth around Northern Europe

Other analysis is also on-going with regard to mapping UK shipping activity and calculating its carbon emissions. One line of enquiry for example relates to fuel sales. According for example to DECC (2011) it is possible for emissions from international shipping to be estimated from refuelling data at UK ports, whether by UK or non-UK operators. Apportioning CO2 emissions on the basis of fuel sales in the UK is however likely to be flawed, since according to DECC (2011) many shipping operators that call at UK ports purchase fuel outside the UK, where fuel prices are likely to be lower than in the UK.

4.2 MAPPING END-TO-END SUPPLY CHAINS

As has already been noted, shipping activity represents only one part of the entire end-to-end flow of freight. Central to our analysis is an on-going effort to map true origin to destination freight flows across all modes of transport, transhipment points and so forth. Only when such freight flows are understood in detail can (i) shipping’s share of total transport-related carbon emissions be accounted for and (ii) alternative routings and strategies be put forward which can mitigate the CO2 footprint associated with shipping activity. Understanding the shape and nature of freight routings is important, especially as new vessel types and operational characteristics emerge to service such freight flows.

Our on-going analysis of end-to-end supply chains comprises two complementary strands of activity:

Using secondary data: Interrogation of publicly available statistical is only of limited use as it typically doesn't allow for freight transhipment and thus gives a distorted view of freight flows (typically freight flows are reported from last port of call). Again AIS data may help in this regard (although cautioning that such data reports at the level of the vessel, not the freight consignment). Figure 5 for example illustrates the last port of call for vessels arriving at Felixstowe over a sample period. Triangulating across multiple secondary data sources may allow for a detailed picture to emerge of the end-to-end flow of freight into and out of the UK (using DfT statistics on freight flows; trade value data by country pair; AIS data; etc.).

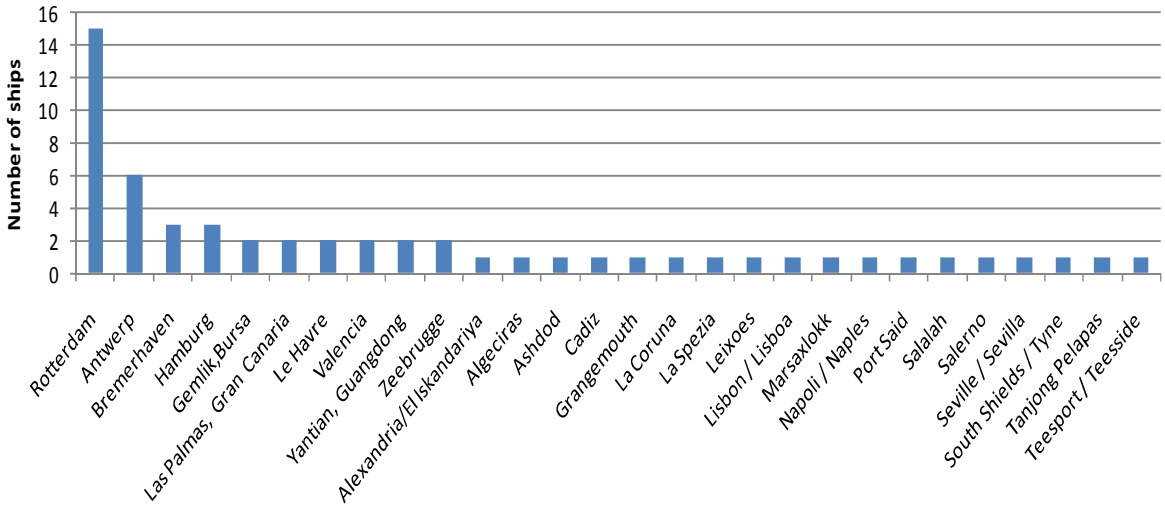

Figure 5: Last port of call for vessels arriving at Felixstowe Port between 13 and 19 May 2011. Source: www.portoffelixstowe.co.uk/shipping

Micro-level analysis of a selected supply chain with a view to analysing what freight flows, where, how, etc. and also endeavouring to understand the drivers behind routing and carrier choice decisions.

4.3 VISIONING THE UK'S FUTURE MARITIME LOGISTICS INFRASTRUCTURE

Our third stream of work concerns ports in particular (as well as other infrastructure such as port access and egress road and rail infrastructure) as we endeavour to vision what the UK's future maritime logistics infrastructure will look like in the context of new vessel designs, different operating strategies, and increased emphasis on reduction of emissions.

Consultation is on-going with the UK's ports sector and we have looked at the environmental actions taking place in 72 UK port locations and compared them with initiatives overseas. Our initial findings suggest that carbon emissions from ports and port-related activity are small compared with emissions from ships and the haulage companies that serve them (our preliminary results, for 2008, suggest that the added emissions from five major UK ports groups represent only a small fraction of those generated by the ships calling at these same ports: 174KT from ports operations compared to approximately 10MT from international shipping). Notwithstanding this small impact, ports can however take a leading role in bringing about major reductions in greenhouse gas emissions from shipping, for example improving the energy efficiency of their handling operations and developing renewable energy sources. Another possibility, already in operation in four Dutch ports, is the use of 'green passports' that offer reduced port fees for vessels meeting specified environmental requirements for emissions of carbon dioxide and other pollutants (from January 1, 2011, the Dutch ports of Amsterdam, Moerdijk, Dordrecht and Rotterdam will enjoy reduce rates for vessels that score well on their Environmental Ship Index (ESI)). Another way ports are having an impact is by providing shore-side electricity for vessels while they are in port. Called 'cold ironing', this is far more efficient than generating power on board ships for heat, lighting and other operations (it is estimated that the greater efficiency and emissions abatement technologies of generation plants compared to onboard generators can reduce CO2 emissions by more than 30%, and those of nitrogen oxides and particulates, by more than 95%, while eliminating noise pollution entirely. Furthermore, if the energy from the grid is from sustainable sources, the environmental benefit is even greater).

The final area of relevant port activity concerns the strategy of 'port-centric logistics' (Mangan et al, 2008) which can be defined as the provision of distribution and other value-adding logistics services at a port, and which in turn can reduce inefficient road transport legs and lead to optimised performance along the transport chain. We are examining the role of this strategy in the context of our micro-level analysis of a candidate supply chain.

5. CONCLUSION

As our work is ongoing (we are effectively approaching the mid-point of our three year study) it is not possible to yet make definitive conclusions from our analysis. Notwithstanding, from our research to date, it is apparent that there is much interest in and potential around how a wider logistics and supply chain approach can contribute to reducing the total shipping related envelope of CO2 emissions. We look forward to publishing our findings in the not too distant future.

ACKNOWLEDGEMENTS

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REFERENCES

Brooks, M. (2010). 'International Trade in Manufactured Goods', in Grammenos, C. (ed.), The Handbook of Maritime Economics and Business: Second Edition, London: Lloyds List.

Buhaug, Ø., et al. (2009). 'Second IMO GHG study 2009'. London: International Maritime Organization (IMO).

Christopher, M. (1992). 'Logistics and Supply Chain Management' (1st ed.), London: Financial Times/Pitman.

Department for Energy and Climate Change (2011). 'Statistical Release: UK climate change sustainable development indicator: 2009 greenhouse gas emissions final figures'. Available at: http://www.decc.gov.uk/en/content/cms/news/stat_09_ghg/stat_09_ghg.aspx (Accessed: 10 May 2011).

Department for Transport (2008). 'The container freight end-to-end journey: An analysis of the end-to-end journey of containerised freight through international gateways', London: The Stationery Office.

Department for Transport (2010). 'Transport Statistics Report: Maritime Statistics 2009', London: The Stationery Office.

Eriksen, T. HØye, G. Narheim, B. & Meland B. J. (2006). 'Maritime traffic monitoring using a space-based AIS receiver', Acta Astronautica, Vol. 58, No. 10, pp. 537-549.

Ferdows, K., Lewis, M., & Machuca, J. (2004). 'Rapid-Fire Fulfillment', Harvard Business Review, Vol. 82, No. 11, pp. 104–110.

Heymann, E. (2008). 'Prospects for the container shipping industry'. Available at: http://www.dbresearch.de/PROD/CIB_INTERNET_EN-PROD/PROD0000000000235422.pdf (Accessed: 25 April 2010).

Lee, H. (2004). 'The Triple-A Supply Chain', Harvard Business Review, Vol. 82, No. 10, pp. 102–112.

Levinson, M. (2010). ;'Why Container Ships May Downsize', Accessed 6 April 2010, Available at:http://news.bbc.co.uk/2/hi/business/7707901.stm.

Mangan, J., Lalwani, C., & Fynes, B. (2008b). 'Port-centric logistics', International Journal of Logistics Management, Vol. 19, No. 1, pp. 29-41.

Notteboom, T. & Rodrigue, J. (2008). 'Containerisation, Box Logistics and Global Supply Chains: The Integration of Ports and Liner Shipping Networks', Maritime Economics and Logistics, Vol. 10, pp. 152-174.

UNCTAD (2009). 'Multi-Year Expert Meeting on Transport and Trade Facilitation: Maritime Transport and the Climate Change Challenge' 16-18 February 2009, Geneva.