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Global Sourcing and Logistics



Logistics Policy project number - LP 0507

Martin Christopher, Fu Jia, Omera Khan, Carlos Mena,
Andrew Palmer and Erik Sandberg

May 2007

This report has been produced at the Centre for Logistics and Supply Chain Management at Cranfield School of Management on behalf of the Department for Transport (DfT) under Logistics Policy project number - LP 0507

This report is accompanied by a CD containing the Comparative Product Sourcing Model. The development and operation of this model is described in the report.

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1. Executive Summary

The sourcing of products from across the global marketplace is an increasing trend associated with economic development. This trend is the result of many independent decisions taken by firms around the world looking for new sources of competitive advantage. However, these decisions can also have unintended consequences, exposing the firms to hidden costs and risks, creating congestion at different points in the global transport infrastructure and increasing emissions of pollutants and greenhouse gases.

This report presents the results of a project conducted in 2006-07, aimed at improving global sourcing practices, with a particular emphasis on the implications for the UK. The project addresses the subject of global sourcing at two different levels: at a firm level it provides organisations with a means to conduct a more comprehensive analysis of the costs and risks of global sourcing; at a government level, it provides insights for public policy in relation to the future development of the UK's transport infrastructure and the impact of global trade on the environment.

The project had three main components. Firstly, a systematic review of the literature was conducted, providing a comprehensive coverage of previous research in the subject. This was followed by fifteen case studies in seven different industries, which allowed an in-depth evaluation of the processes followed by organisations when conducting sourcing decisions, and allowing a comparison of the practices in different industries. Finally, a computer model able to analyse the costs, risks, lead-times and environmental implications of global sourcing decision was developed.

The project revealed that global sourcing trends are making supply chains longer and more fragmented and this is exposing firms to greater costs and risks. Furthermore, it was found that although some firms have systematic and comprehensive total cost approaches for analysing their sourcing decisions, many still base their decision on a minimum price approach.

It was also found that the growth in global trade and the associated increase in transportation are contributing to higher emissions of greenhouse gases, particularly CO₂. Few firms participating in the study have detailed information concerning the environmental implications of their sourcing decisions. However, it was evident that throughout the duration of the project the awareness of environmental issues increased. This could be an indication that firms are becoming more conscious of the wider implications of their sourcing decisions.

The research revealed elements of good practice in global sourcing, such as the use of total cost models, risk management techniques and environmental assessment tools. However, it also showed a high variability of practices between firms, indicating a wide gap between the top performers and the laggards. This suggests that there are still many opportunities for firms to improve their approach to making global sourcing decisions.

2. Introduction

Global trade has grown almost constantly for over 100 years, with the exception of the periods of the two World Wars. This trend is generally seen as positive for both the global economy and the individual nation states; however, it also brings with it some undesirable effects. With the growth of global trade has come an inevitable increase in the transportation of physical products. One impact of this has been a growth in CO₂ emissions arising from transportation with potential implications for global warming.

According to the World Trade Organisation (2005) the yearly real growth of world merchandise exports was 6 per cent in 2005 after outstandingly strong growth of 9.5 per cent in the preceding year. World merchandise exports rose and for the first time exceeded the US\$10 trillion mark.

At a national level, growth in international trade has implications for transport infrastructure, not only due to the increase of incoming and outgoing goods through ports, airports and the channel tunnel, but also the increase in the distances that products have to travel. Between 1980 and 2005 international freight lifted increased by 77 percent with the vast majority of it being lifted by sea (96% in volume) (DfT, 2006c). Over the same period international airfreight has increased 239 percent and, although it only represents a small proportion of total import volume, it corresponds to around 30% of the total value of imports (DfT, 2006c).

Looking to the future, there are a number of key trends that will have an undeniable impact on trade and transportation. First and foremost, Chinese foreign trade has soared, with a large segment being shipped in containers. Over the past two decades, container cargo volume, growing annually by about 8.3%, has increased three-and-a-half times as rapidly as world GDP. With ports, road transport and railways struggling to handle such meteoric growth, delays on inland transportation networks have been frequent in Europe and North America (Ryan 2006).

However, for individual organisations, sourcing offshore appears to bring benefits by allowing access to lower cost locations. Nevertheless, decisions based purely on a limited view of cost could expose the company to greater risks. From a supply chain perspective, global sourcing involves costs that might not be immediately evident to the companies involved, such as higher inventory costs, transportation costs,

obsolescence costs and in general the cost of managing business relationships abroad. Furthermore, sourcing globally can also lead to risks such as: increased response time and the associated impact on sales; loss of trust among supply chain partners; loss of intellectual property; and increased vulnerability to disruption.

The project addresses the global sourcing decision from a total cost perspective, looking at the implications for individual firms as well as for the UK as a whole. This was achieved through four main objectives:

- To gain a better understanding of why and how companies make global sourcing decisions
- To uncover the hidden costs and risks of global sourcing
- To assess the environmental and infrastructural implications of global sourcing, with particular emphasis on the UK
- To develop a model that can support global sourcing decisions, based on a holistic analysis of the implications

One of the main outcomes of the project is the Comparative Product Sourcing Model (CPSM), which allows companies to make better sourcing decisions, by providing them with a complete picture of all the costs, risk and environmental implications of their decisions. This research also provided insights for public policy in relation to the future development of the UK's transport infrastructure and the impact of global trade on the environment.

The document is structured as follows. The section following this introduction, presents a series of statistics and trends showing the development of global sourcing and its implications for the UK transport infrastructure and for the environment. The methodology section describes in detail the approaches followed to conduct the different elements of this research. This is followed by the systematic literature reviews, which uses an evidence-based approach to analysed previous research in the field of global sourcing. The case studies section presents a brief description of each of the cases followed by a cross-case analysis. The Comparative Product Sourcing Model (CPSM), is then described, including a detailed examination of the assumptions behind the model. Finally the conclusions, implications and recommendations for further research are presented.

3. Global Sourcing Trends and their Impact: A UK Perspective

In recent years there has been increasing media coverage about the volume of products coming from abroad and the distance some of these products are travelling. This has been matched by increasing concerns about the impact these imports can have on the UK economy and on the environment, due to greater greenhouse emission generated by transport. However, without understanding the nature of the problem and its root causes, it is difficult for organisations to make appropriate sourcing decisions and for the government to propose and implement appropriate policies.

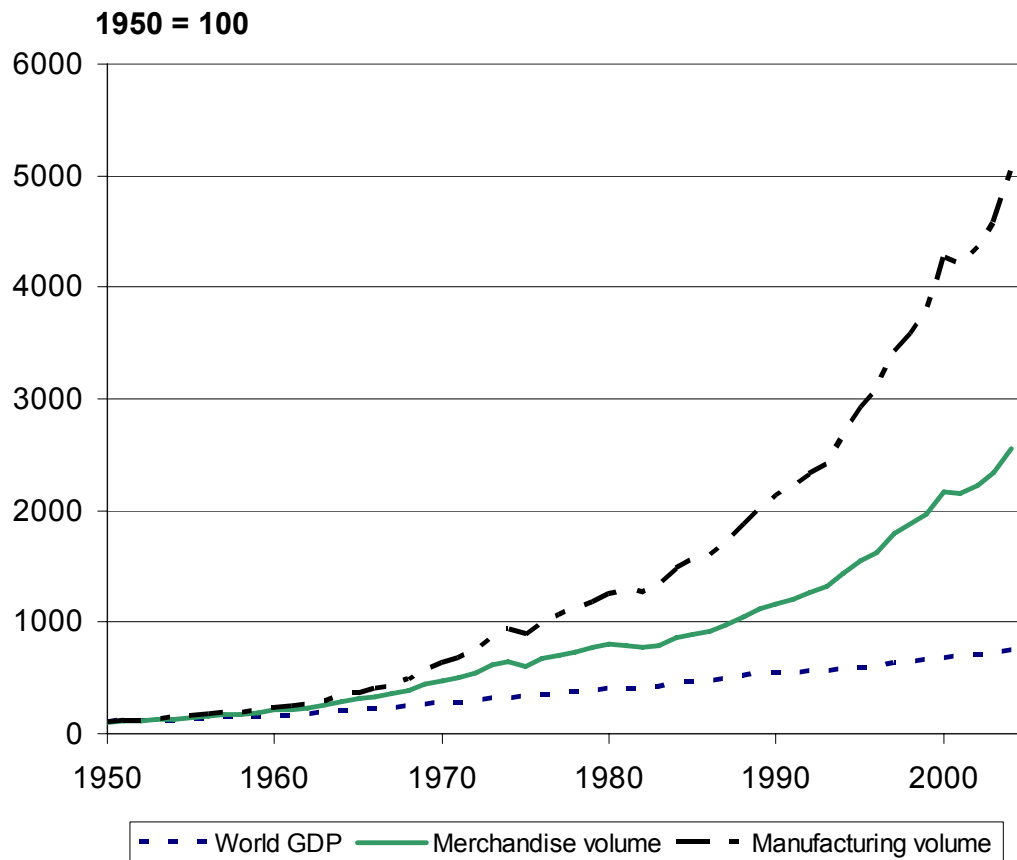
This section reviews the current trends in terms of global trade and their impact on the UK's transport infrastructure and the environment, focusing on greenhouse gas emissions. First we present some key economic indicators showing the expansion of global sourcing and explore the main factors that have contributed to this trend. Secondly, we analyse the impact that global sourcing has on the UK transport infrastructure, focusing on ports, airport and roads. Finally, we look at the impact of global trade on greenhouse gas emissions, particularly carbon dioxide (CO₂), which is considered as the most important of the manmade greenhouse gases (IPCC, 2007:2). CO₂ emissions are closely associated with the combustion of fossil fuels, which are used in most major forms of transport.

1.1. *Economic Trends*

The world's economy has been growing steadily for at least fifty years. Figures from the WTO show that since 1950, the world's GDP has increased more than sevenfold. At first sight this figure might appear substantial; however, it is modest when compared to the 25-fold increase in global exports of merchandise¹ and the 50-fold increase in global exports of manufactures during the same period (Figure 1). This is evidence of large-scale economic globalisation. Trade in merchandise and manufactures is particularly relevant for this study because it involves physical movements of products which have a direct link with transport infrastructure and transport related greenhouse gas emissions.

¹ According to the WTO, merchandise includes agricultural products, fuel and mining products and manufactures

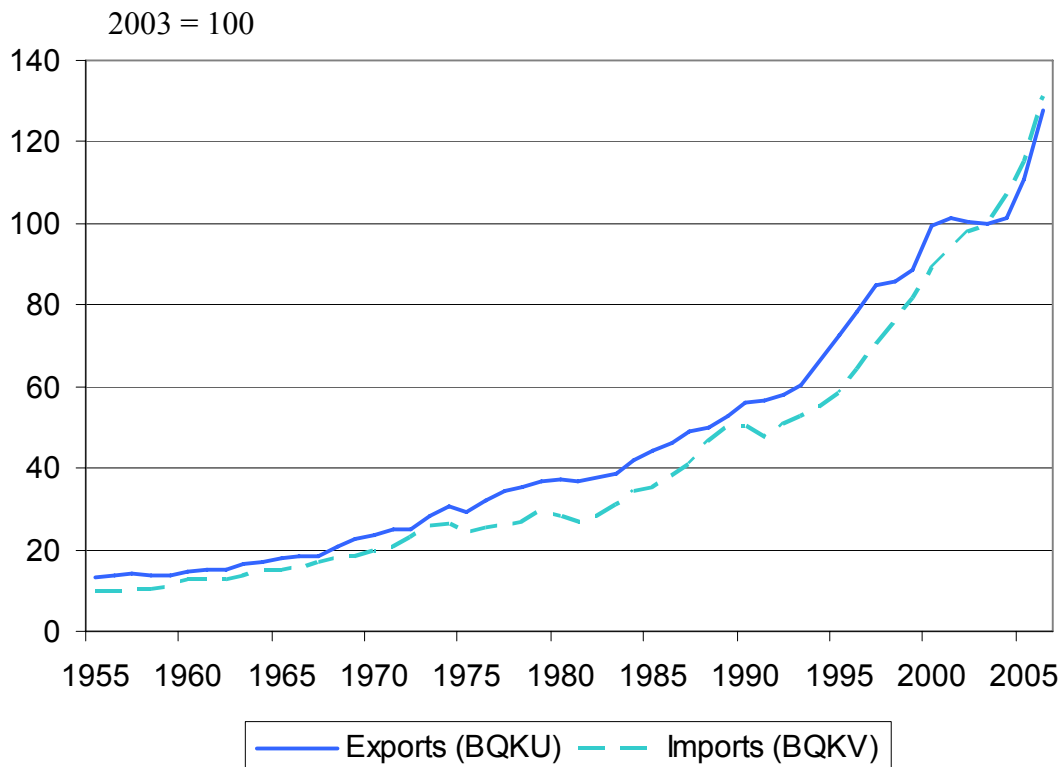
Figure 1: Indices for World GDP, Global Exports of Merchandise and Global Manufacturing Exports plotted against time



Source: Data from WTO International trade statistics 2005; analysis by the authors

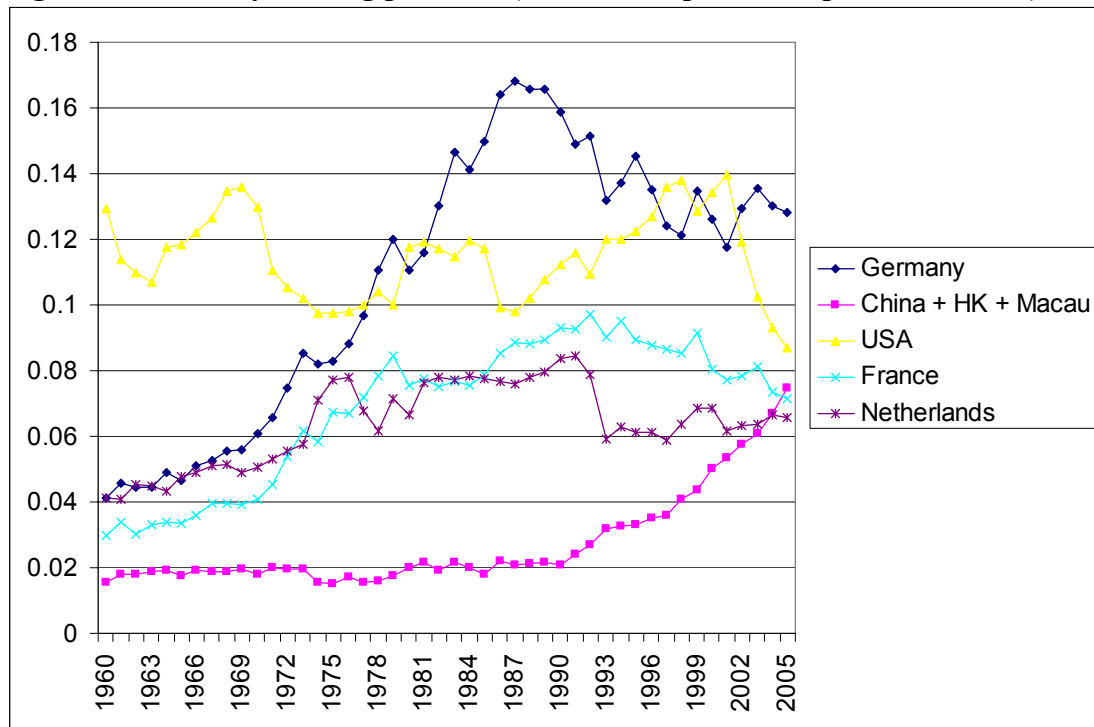
Economic globalisation has been facilitated by a range of factors and trends, which include the reduction in trade barriers, the formation of regional trading blocks such as the EU, NAFTA and ASEAN, a variation in labour and material costs between different regions, and the development of information, communication and transport technologies.

The UK has played a central role in the process of globalisation and, according to figures from the WTO, is currently ranked as the world's eight largest exporter and the fifth largest importer of merchandise (WTO, 2005). Following world trends, the UK has experienced a dramatic increase in both imports and exports over the past 50 years. Figure 2 presents the volume index for UK trade in goods, which shows that both imports and exports have increased over 10 times in the period between 1955 and 2006.

Figure 2: UK Trade in Goods (Volume Index)

Source: UK Office of National Statistics (ONS) (<http://www.statistics.gov.uk>)

Another factor emerging from global trade is the increasing distance that goods are travelling. Although there is no easily available global measure of how long goods travel, a comparison of the key trading partners provides an indication of the distances travelled. Figure 3 presents the trends in the value of imports from key trading partners as a percent of total imports into the UK. The chart shows that Germany is the UK's main trading partner when it comes to import value with around 13 percent of total in 2005. Other important European countries include France and the Netherlands with 7.1 and 6.5 percent of total value of imports to the UK in 2005. However, the total value of imports from EU countries has decreased in the last two decades from 59 percent in 1987 to just over 50 percent in 2005, according to statistics from the IMF (IMF, 2006).

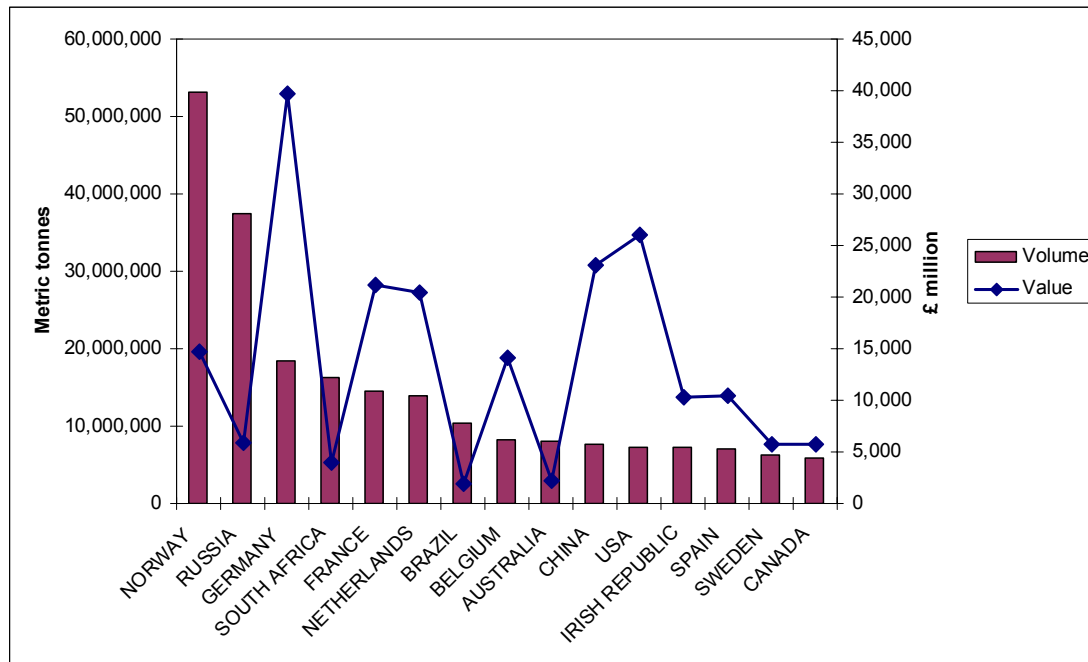
Figure 3: Some key trading partners (Value of Imports as a percent of total)

Sources: IMF (2006) Direction of Trade Statistics and UK Trade Info (2006)

Although transporting goods from Europe involves comparatively short distances, products coming from the USA and China require a substantial transportation. For instance, a product coming by sea from China travels over 17,000 km before reaching the UK coast and products coming from the United States would travel around 7,000 km from the east coast and close to 15,000 km from the west coast. It is also important to note that China has recently moved from fifth to third place overtaking both the Netherlands and France, and it shows the most pronounced increase of all countries.

Another important measure of the impact of imports on both infrastructure and emissions is the volume of imports measured in mass rather than value. Since the portfolio of products imported from each country is different, imports measured in volume and value result in substantially different figures. This is evident in Figure 4, which shows the top 15 countries of origin in terms of volume of imports into the UK and their corresponding imports in terms of value.

Figure 4: Imports into the UK measured in Volume and Value: Top 15 countries ranked by volume



Source: UK Trade Info, 2007

Norway ranks number one in terms of volume of imports into the UK, however the value of these imports is considerably lower than from other countries such as Germany, USA or China. The most likely explanation for this is that Norway exports oil, gas, and other commodities which have a relatively low value density; while Germany, USA and China export manufactured products, which have a higher value density than commodities. Other countries in similar situations to that of Norway include Russia, South Africa, Brazil and Australia. Products imported from most of these countries would require a substantial amount of transportation.

In summary, more products are being traded than ever and these products are travelling longer distances. Although these are signs of healthy economic development, they also have an impact on transport infrastructure and greenhouse gas emissions generated from transport.

1.2. *Infrastructure trends in the UK*

Increasing trade demands a transport infrastructure that is capable of handling more traffic through ports, roads and airports. Failures and delays in balancing supply with demand in of transport infrastructure can have major consequences in terms of congestion, delayed deliveries and higher inventory levels.

This sub-section presents a review of current trends in the UK transport infrastructure, with particular emphasis on ports and airports supporting these four types of international freight services. The potential impact on road and rail infrastructure is also discussed.

According to Eddington (2006), the UK's international freight is supported by four types of services: vessels carrying bulk goods, container ships, roll-on/roll-off services and air services. Table 1 compares these four types of service as well as rail, presenting values in terms of weigh, value and value density. It shows that Airfreight has by far the highest value density, meaning that high value products tend to use this form of transport, while bulk services have the lowest value density.

Table 1: UK extra EU trade: model breakdown by weight, value and value density, 2004

| | By weight (Tonnes '000s) | | By value (£m) | | Value density £/Tonne |
|-------------------------|-----------------------------|--------|------------------|--------|--------------------------|
| Bulk | 188,873 | 81.42% | 41,149 | 20.19% | £ 218 |
| Container | 33,168 | 14.30% | 58,448 | 28.68% | £ 1,762 |
| Roll On/Roll Off | 3,514 | 1.51% | 13,576 | 6.66% | £ 3,864 |
| Rail | 209 | 0.09% | 1,487 | 0.73% | £ 7,119 |
| Air | 1,659 | 0.72% | 85,280 | 41.84% | £ 51,419 |
| Other | 4,563 | 1.97% | 3,875 | 1.90% | £ 849 |

Source: Based on MDST (2006) and Eddington (2006)

1.2.1. *Ports*

Over the last 20 years, the development of international trade has resulted in a disproportionate increase in container shipping demand. For instance, between 1985 and 2004 there was a 138 per cent increase in container traffic and a 182 per cent increase in roll-on/roll-off freight movements by weight. Similarly, over the last fifteen years there has been a doubling of deep-sea container traffic compared to a 50 per cent increase in shorter distance container traffic (DfT, 2006b). As a result, port

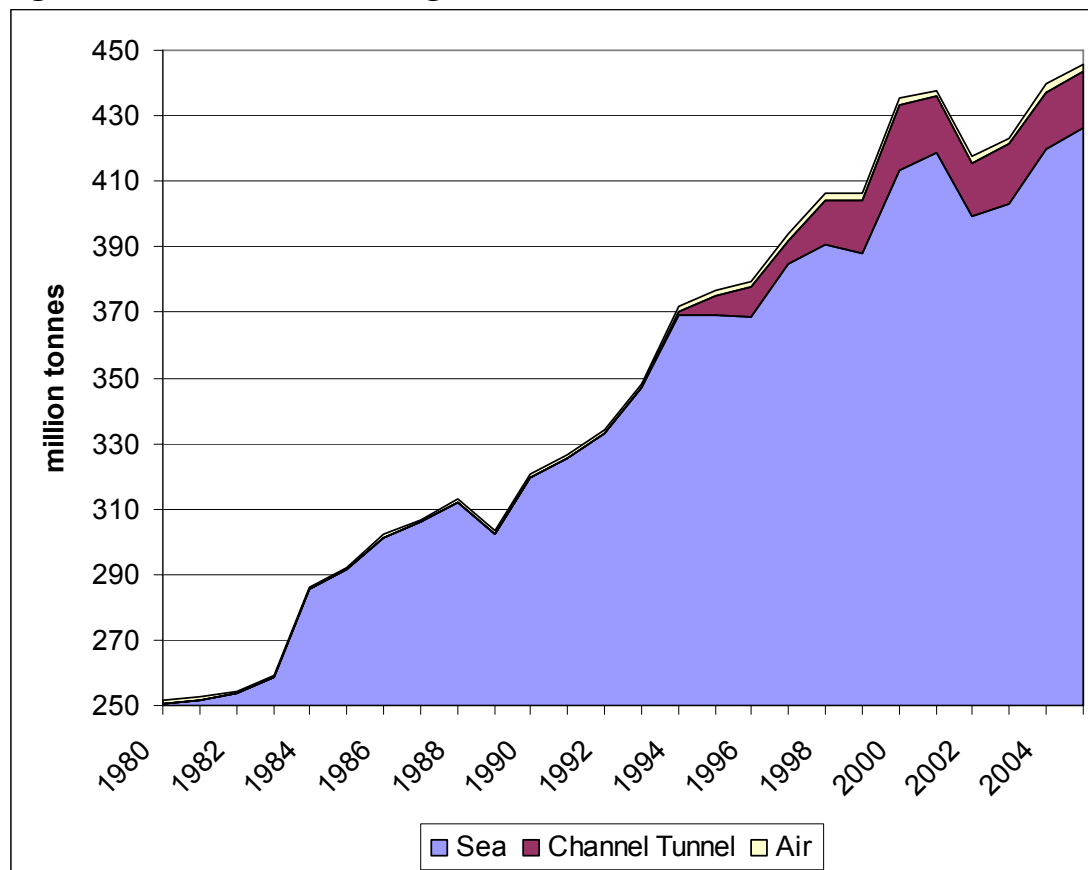
infrastructure is under increasing capacity pressures, which is already causing congestion problems involving berthing, equipment, personnel shortages and inter-modal connections, and can lead to delays in deliveries and higher inventory carrying costs for manufacturers and retailers (Quinn 2005; Logistics Today, 2005).

Alongside the growth in trade and cargo there has been a steady increase in the size of container vessels. The first container ships, introduced in the 1960s, had a capacity of around 1,100 TEU; currently the largest vessels can carry 11,000 TEU and ships with capacities of up to 13,000 TEU are on the way (Maersk, 2006). To service these ships, ports will need to increased vessel draught, and therefore a greater depth requirement for access channels and berths (DfT 2006a).

The increasing influx of cargo to European ports originates primarily from Asia (mainly China), from the new Central European members of the European Union (mainly Poland, Latvia, Lithuania, and Estonia) and to a lesser degree from the USA (Quinn 2005). In the period between 1990 and 2003, the volume of containers shipped between Northern Europe and North America increased by 85%, but the corresponding increase for Asian trade was 220% (DfT 2006a).

Ports are particularly important for the UK's transport infrastructure because around 95 percent by volume and around 70 - 75 percent by value of the UK's international trade is transported by sea (DfT, 2006b). According to the DfT, approximately £330 billion of the UK's international trade was moved through seaports and the UK ports industry is the largest in Europe in terms of freight tonnage, handling a total of 573 million tonnes of foreign and domestic cargo in 2004 (DfT, 2006b).

Figure 5 shows the UK's international freight lifted from 1980 to 2005. This chart highlights the overwhelming dominance of sea freight for international trade in terms of volume. According to DfT's maritime statistics report (DfT, 2006c), foreign imports by sea increased from 190 million tonnes in 1995 to 262 million tonnes in 2005, while all foreign exports by sea dropped from 178 million tonnes to 164 million tonnes.

Figure 5: UK international freight lifted

Source: DfT (2006c) Transport Trends 2006 Edition, Department for Transport
<http://www.dft.gov.uk/pgr/statistics/datatablespublications/trends/current/transporttrends2006>

Table 2 presents traffic trends at the top ten ports from 1995 to 2005. It shows that the vast majority of ports have experienced a substantial increase in traffic during the last ten years in line with the increases in international trade.

Table 2: UK top 10 ports 1995-2005

| Port | 2005 Thousand Tonnes | 1995 Thousand Tonnes | % Change |
|-----------------------|----------------------------|----------------------------|----------|
| Grimsby and Immingham | 60,686 | 46,790 | 30 |
| Tees and Hartlepool | 55,790 | 46,076 | 21 |
| London | 53,843 | 51,362 | 5 |
| Southampton | 39,947 | 32,383 | 23 |
| Milford Haven | 37,547 | 32,473 | 16 |
| Forth | 34,218 | 47,083 | -27 |
| Liverpool | 33,775 | 29,987 | 13 |
| Felixstowe | 23,144 | 24,082 | -4 |
| Dover | 21,145 | 12,671 | 67 |
| Sullom Voe | 20,541 | 38,335 | -46 |

Source: Adapted from table United Kingdom ports: foreign and domestic traffic by port: 1995-2005

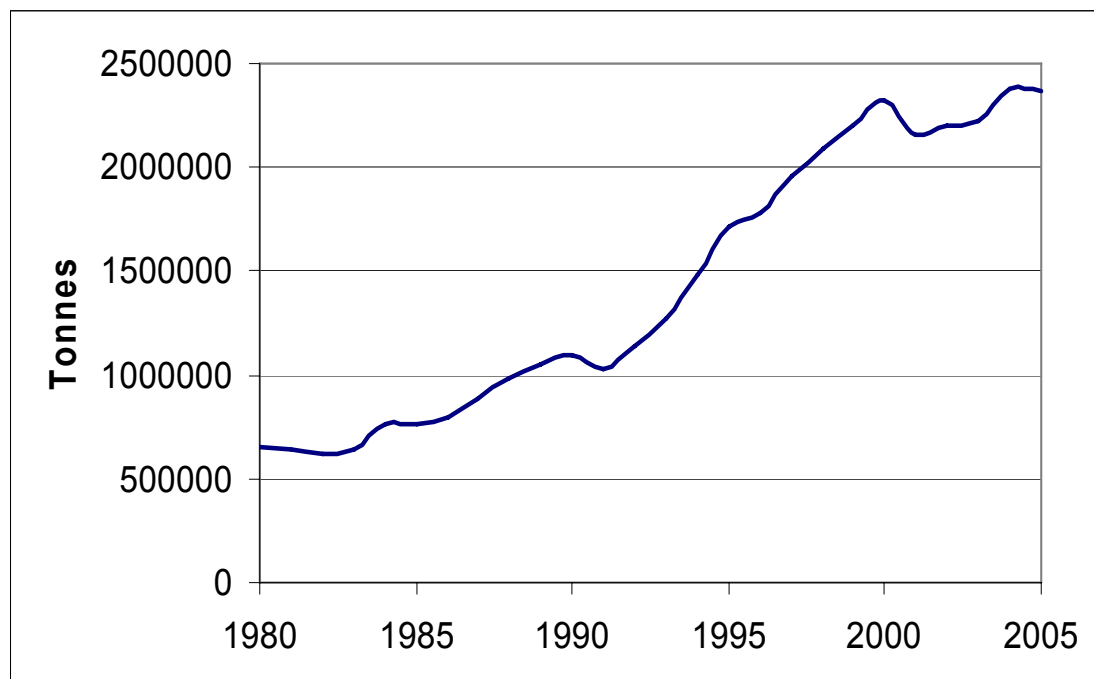
Some of the most important ports in the UK, including Felixstowe and Southampton, [which between them handle over 50 per cent of container flows (Eddington, 2006)] have started to experience congestion problems. As a result some ship operators have opted to unload cargo in Rotterdam or Antwerp, and then feed the freight back to the UK by shipping on smaller vessels through alternative ports (Quinn 2005). Felixstowe has lost over half of its transshipment work, which is reflected by the slight decrease in traffic at this port in the last ten years.

It is expected that by 2020, demand at UK ports will reach between 13.1 and 16.1m TEU (DfT, 2006a). However, considering the combined capacity of the major UK container ports was around 7.1 million TEU per year in 2003, it is clear that some major developments are required to cope with future demand (DfT 2006a).

1.2.2. Airports and Airfreight

In the period from 1980 to 2000 the total volume of airfreight in the UK almost quadrupled, however, since 2000 the trend appears to have stabilised, even experiencing some minor drops. The total volume of airfreight in 2005 was just marginally higher than in 2000, as can be observed in Figure 6.

Figure 6: UK Airfreight



Source: CAA (2006) Freight Tonnes and DfT (2006) Transport Trends 2006 Edition

One important issue to point out is the high concentration of airfreight volume moving through London airports. Around 55 percent of the 2.3 million tonnes of airfreight in 2005 was moved through Heathrow airport, with Gatwick and Stanstead accounting for around 10 percent each. These three London airports account for almost 75 percent of all airfreight volume in the UK.

In terms of volume, airfreight is small compared to sea freight; however, when it comes to value, this mode of transport is much more significant. Table 3 presents a comparison of volume and value of imports by airfreight into the UK. The table shows that while the share by volume does not exceed 0.5 percent, the share of value went as high as 31% percent in 1998. Unfortunately more up to date figures are not available.

Table 3: Air Trade's share of total trade (UK Imports)

| Year | Mode | Tonnes | Share By Volume | £'000s | Share by Value |
|--------------------------|-------------|-------------|--------------------|-------------|-------------------|
| 1992 | Total Trade | 183,862,319 | | 116,080,263 | |
| | Airtrade | 472,536 | 0.25% | 28,336,893 | 24% |
| 1994 | Total Trade | 184,562,688 | | 124,771,536 | |
| | Airtrade | 518,506 | 0.28% | 34,385,332 | 28% |
| 1996 | Total Trade | 171,062,466 | | 168,078,649 | |
| | Airtrade | 672,477 | 0.39% | 47,956,129 | 29% |
| 1998 | Total Trade | 177,195,876 | | 172,454,490 | |
| | Airtrade | 886,748 | 0.50% | 53,632,304 | 31% |
| Source: DfT, 2000 | | | | | |

Table 3 also indicates that there has been substantial growth in air trade over the period 1992-98, and according to figures from the DfT the largest sector of growth is freight coming from outside the EU, which already makes up two thirds of the market (DfT, 2000).

It is important to note that the reason airfreight accounts for a high proportion of import value lies in the fact that it generally deals with high value-added products or products with short shelf lives, such as fruits, vegetables and flowers (DfT, 2000). As indicated earlier, the volume density of products transported by airfreight tends to be much higher than for other forms of transport.

An indirect impact of global sourcing on air transport takes place through increased business travel, which is essential for establishing and maintaining sourcing relationships. According to Eddington (2006), the majority of international business travel takes place by air (78 percent) and the total number business trips by air in and

out of the UK reaches 72,000 per day (for both UK residents and foreign nationals). In this report we do not attempt to quantify the effects of global sourcing on business travel, but we consider it a factor contributing to the increasing number of air passengers, which have doubled since 1994 (DfT, 2006d) and this has taken place despite the reduction in air travel caused by the terrorist attacks of September 11 2001.

1.2.3. Rail and Road Infrastructure

Rail plays a relatively minor role in international freight, peculiarly when compared to sea freight, as is indicated in Figure 5 (see page 14). However, the freight coming through the Chanel Tunnel has shown consistent growth since its opening in 1994 and currently carries over 17 million tonnes of freight; just under 4 percent of freight volume (DfT, 2006c) and 16 percent of freight vehicles (Eddington, 2006). However, freight by train wagons is only 3 percent of the total bulk market (Eddington, 2006).

Global sourcing has indirect impacts on both roads and rail, firstly because it can generate additional traffic and congestion around ports and airports, and secondly because a relatively large proportion of inward freight is transported to London or the south of England. According to Eddington (2006) “firms located in these two regions account for 35 per cent of imports by weight, and 39 per cent of imports by value”. Hence, it is worth providing a brief background to the road and rail infrastructure.

The vast majority of freight moved by road (95%) is transported using vehicles over 3.5 tonnes. Table 4 presents some key statistics and trends for this category of vehicles for 1990 and 2004. These statistics indicate that total freight moved and distance travelled has increased over the fourteen-year period. The only two indicators that have decreased are the population of vehicles and empty running. This means that, even when volumes and distances have increased, fewer vehicles are required due to improved utilisation of the assets.

Table 4 also confirms that rail freight has increased over the same fourteen-year period, however, not at the same rate as road freight.

Table 4: Key road freight transport statistics

| All vehicles over 3.5 tonne | Year 1990 | Year 2004 | Units | % Increase |
|--|------------------|------------------|---------------|-------------------|
| Road freight moved | 131,000 | 152,000 | Mill tonne km | 16.03% |
| Road freight lifted | 1,645 | 1,744 | Million tonne | 6.02% |
| Road freight distance | 21,120 | 22,991 | Million km | 8.86% |
| Ave dist moved by 1 tonne | 79 | 87 | Km | 10.32% |
| Average vehicle load | 6.2 | 6.8 | Tonne | 9.63% |
| Population of road vehicles | 460,000 | 430,000 | | -6.52% |
| Empty running | 29.8 | 26.5 | % | -11.07% |
| By rail | 16,000 | 18,000 | mill tonne km | 12.50% |
| Source: Transport Statistics Bulletin, Transport of Goods by Road and Rail, DfT | | | | |

1.3. Environmental Trends

It is widely recognised that anthropogenic greenhouse gas emissions are a major contributor to global warming and that this can have serious global implications in social and economic terms (IPCC, 2007; Stern, 2006). According to the Stern Review on the Economics of Climate Change (Stern, 2006) the world's economy could reduce between 5 and 20% if no action is taken. Remedial action is estimated to cost around 1% of global GDP. It has also been acknowledged that the transport sector should play an important role in the effort to reduce greenhouse gas emissions (Eddington, 2006).

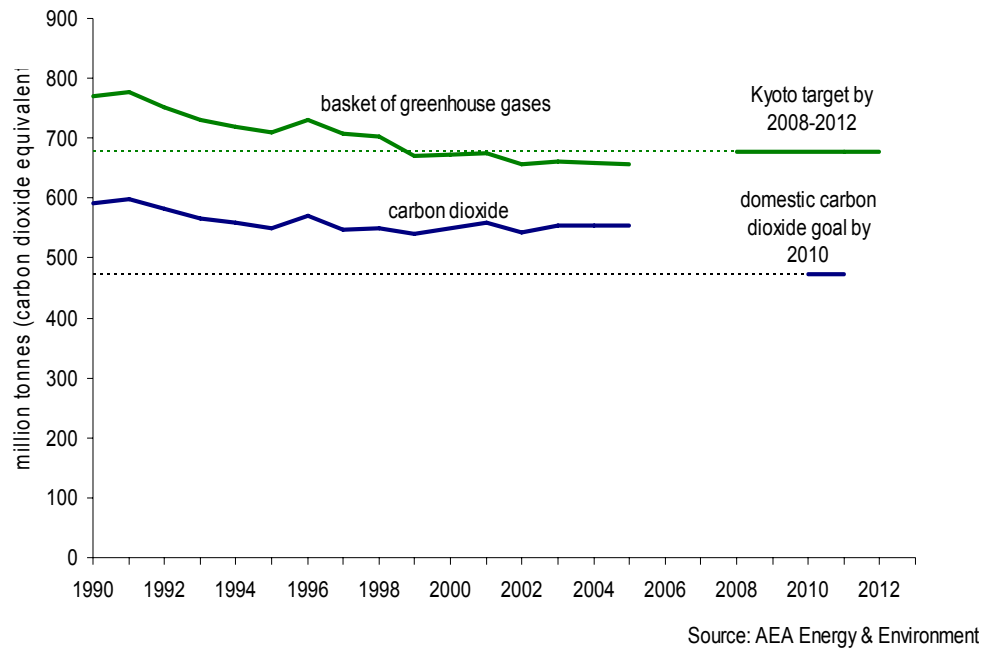
The UK is amongst the top 10 world emitters of greenhouse gases and contributes around 2 percent of world's man-made emissions (Baumert and Pershing, 2004). However, some progress has been made over recent years; since 1990, both CO₂ and the total basket of greenhouse gases² in the UK have reduced more than 10 percent, which is inline with the Kyoto target for the UK³. Nevertheless, there is still much progress to be made to achieve the UK's government target of reducing CO₂

² The basket of greenhouse gases recommended by the IPCC (1996) includes carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs) perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆). HFCs and PFCs are classes of chemicals.

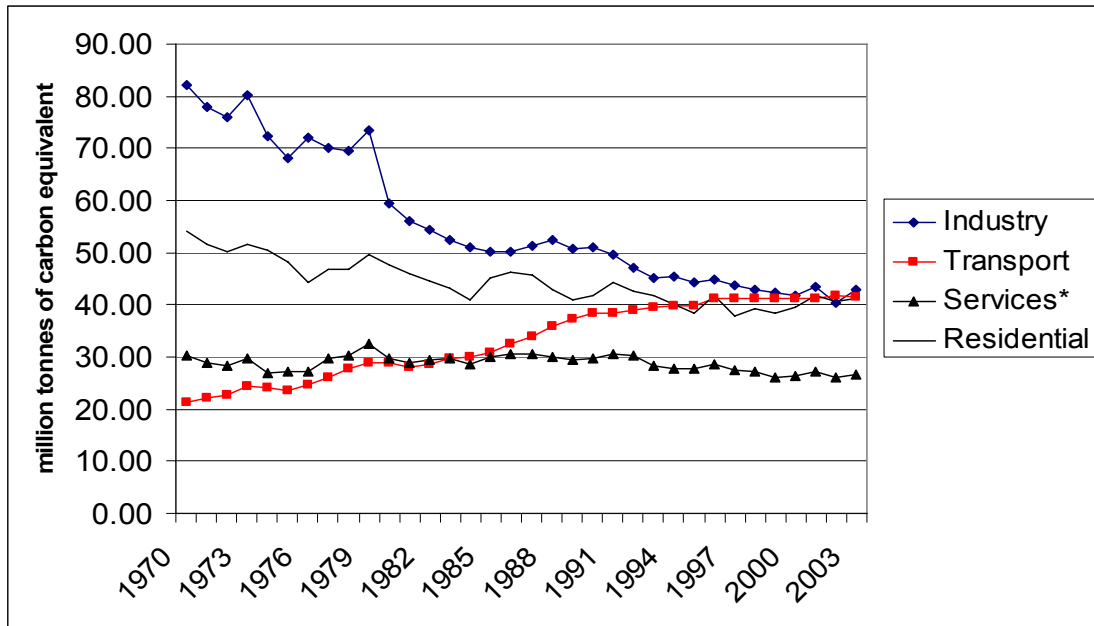
³ The Kyoto agreement signed in 1997 committed signing countries to an overall average reduction in emissions of 5.2% by 2012, compared to 1990 levels. The UK agreed to a larger reduction of 12.5% by 2012.

emissions by 20% in 2010, compared to 1990 levels (see Figure 7). Furthermore, in 2003, the UK adopted a longer-term goal of reducing CO₂ emissions by 60% by 2050.

Figure 7: Emissions of greenhouse gases: 1990-2005



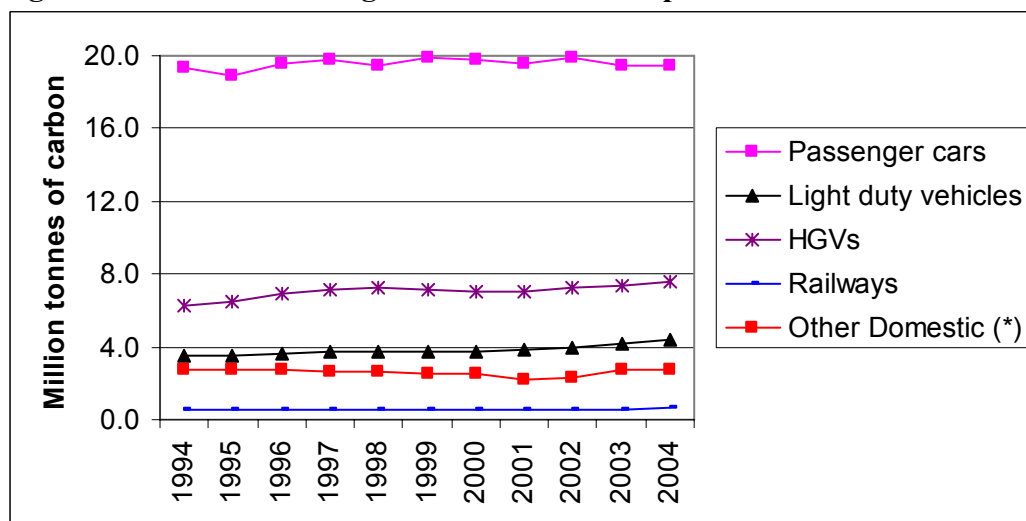
Greenhouse gases have a number of sources, some of which are natural. However, it is clear that population growth and economic development have had a substantial impact in the production of these gases, particularly CO₂ (IPCC, 2007). Anthropogenic CO₂ emissions arise mainly from burning fossil fuels which are used for heating, electricity generation and transport (IPCC, 2007). Figure 8 compares UK greenhouse gas emissions from different sources over the last 35 years. The chart shows that industry has made some progress in reducing emissions and that services and residential dwellings have also contributed to the downward trend. However, emissions from transport have continued to increase and, at this rate, will soon become the largest source of emission in the UK. This is not a UK specific problem, in fact, it is expected that global transport emissions will increase 50 percent by 2020 (Baumert, Herzog and Pershing, 2005).

Figure 8: UK Greenhouse gas emissions

* Services include emissions from commerce, agriculture, exports, land use change and other emissions.

Source: NAEI on behalf of the Department for Environment, Food and Rural Affairs

The increasing contribution of transport to greenhouse gas emissions is a significant issue, however, the largest proportion of transport related greenhouse gases are related to passenger cars, which account for over 55 percent of all domestic transport emissions (see Figure 9). It is unlikely that changes in trade have had any substantial effect on passenger cars. Nevertheless, both HGVs and Light duty vehicles, which are responsible for most freight moved, indicate growing trends and contribute 21 percent and 12 percent of total domestic emissions respectively.

Figure 9: UK Greenhouse gas for domestic transport

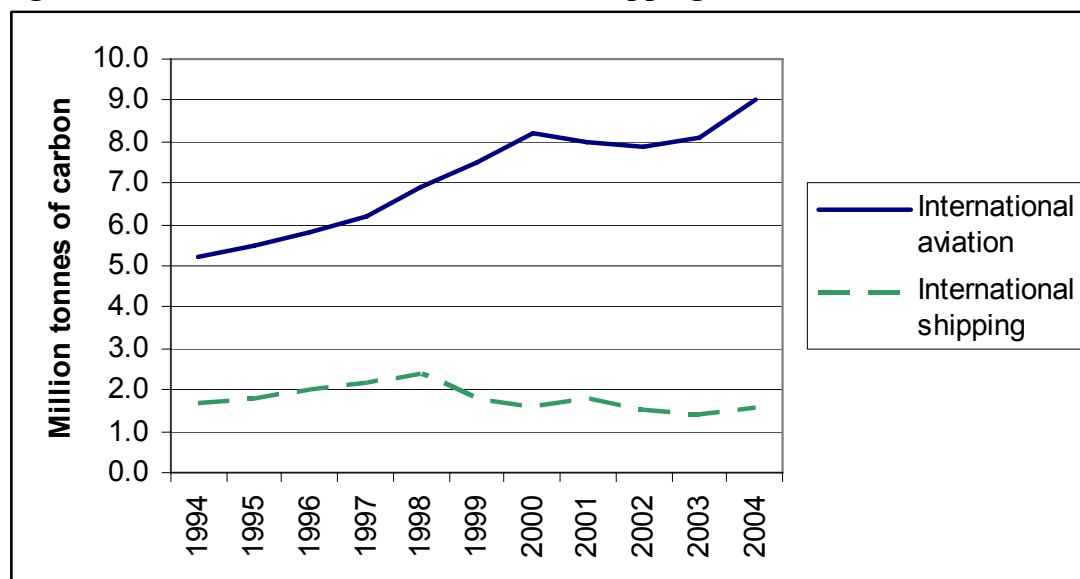
* Other domestic includes buses, mopeds, motorcycles, civil aircraft and domestic shipping

Source: DfT (2006d) Transport Statistics for Great Britain, Edition 32, DfT

Of all the transport related emissions, the ones most directly affected by changes in global trade are those related to international aviation and shipping. Greenhouse gas emissions from international aviation and shipping can be estimated from refuelling from bunkers at UK airports and ports, however the only statistics reported are those related to UK-based international aviation and shipping (Trends for these two variables are plotted in Figure 10). Although these statistics do not represent the full picture, they provide a proxy to the general trends of these two important variables.

The trend for international aviation shows a steep slope, with an increase of almost 80 percent in the period 1994-2004, and this does not consider the fact that emissions at high altitude have a stronger impact than emissions at ground level (Ellis, et al., 1999). International shipping on the other hand, shows a relatively stable trend, however, there have been recent reports that emissions related to shipping have been underestimated and could account for up to 5% of global CO₂ emissions (Vidal, 2007)

Figure 10: UK-International Aviation and Shipping emissions



Source: DfT (2006d) Transport Statistics for Great Britain, Edition 32, Department for Transport; DEFRA (2006) Sustainable Development Indicators

Global sourcing decisions have a direct impact on transport and consequently on greenhouse gas emissions. The following are some of the main factors that link global sourcing decisions to emissions:

- 1) Distance: More products are being transported over longer distances; this has a direct impact in transport related CO₂ emissions. Nevertheless, focusing on distance as a single indicator would be myopic. A recent study commissioned by DEFRA, analysed the validity of “food miles” as an indicator of sustainability and concluded that a single indicator based on total distance travelled was inadequate (Watkiss, 2005). Its limitation is that it fails to take into consideration the complexities and trade-offs between different factors, such as transport mode, transport efficiency, differences in production systems and other economic and social cost and benefits. Although this study was specific to the UK food industry, its conclusions in terms of additional complexities and trade-offs that need to be considered should be valid for other industries.
- 2) Transport mode selection: Different transport modes have substantially different CO₂ emissions and this has implications for the selection of transport mode. For instance, trucks produce considerably fewer emissions than aircraft, but substantially more than ships based on tonnage carried by each transport mode. Hence, selecting the most carbon efficient transport mode should be an important consideration during the global sourcing decision. A more detailed comparison of transport mode efficiency is provided in section 5.4.1 of this document.
- 3) Utilisation and empty running: utilisation of all transport modes is a crucial factor in reducing transport related CO₂ emissions. Statistics presented earlier showed that empty running has decreased from 29.8 percent in 1990 to 26.5 percent in 2004 (see Table 4: Key road freight transport statistics in page 18). Furthermore, it is recognised that there are factors that constrain vehicle utilization, such as vehicle size and weight restrictions, demand fluctuations and unreliable schedules. A detailed account of the causes, constraints and possible solutions to the utilisation problem can be found in McKinnon (2007).
- 4) Network Design: The increasing complexity of supply networks, with inputs for a final product being transported from a variety of sources and across several echelons makes it difficult for companies to track how much the product is being transported. For example, research looking into the manufacture and distribution of yoghurt pots in Germany estimated that if all

the movements of inputs were taken into consideration, a “theoretical” truckload would have to be moved over 1,000 km before reaching its destination at an outlet (Boge, 1995). This product made use of a very limited amount of global sourcing; however, as supply chains become longer and more fragmented, the total distance travelled to manufacture one product can only increase.

- 5) Exporting Emissions: by sourcing components or finished products from abroad rather than producing them in the UK, all of the emissions related to the manufacturing process are essentially exported to the sourcing country. Tools such as Life Cycle Analysis (LCA) are aimed at measuring the total impact of a product on the environment throughout its life, including all the embedded carbon emissions from components supplied from abroad. This type of analysis is usually used when a new product is being developed, however it is seldom used when making outsourcing or global sourcing decisions.

The problem of exporting emissions is compounded by the fact that carbon intensity⁴ varies widely across countries due to differences in economic structure, energy efficiency and fuel mix (Baumert and Pershing, 2004). The carbon intensity of the UK is 110, which is just above the EU (25) figure of 107, however some of the UK’s main trading partners have substantially different figures, for instance, Russia’s carbon intensity is as high as 427 and China’s is 201, but the figures for Brazil and France are only 73 and 72 respectively (Baumert and Pershing, 2004). Hence, product outsourced to a different country would produce different amounts of CO₂, even if exactly the same processes and equipment were used.

Recent announcements by companies like Marks & Spencer (Harvey & Rigby, 2007) and Tesco (Measure, 2007) concerning the reduction of their carbon footprint and the use of labelling to illustrate greenhouse gas emissions related to products, show a growing awareness of these issues. However, the lack of clear standards for estimating emissions is a problem, which is complicated even further by the enormous

⁴ Carbon intensity is the ratio of carbon emissions to economic activity. Figures presented in this document are in tonnes of CO₂ per million dollars of GDP/PPP.

task of analysing the supply chain for every single product and keeping data up to date as changes to product characteristics and sourcing strategies are made.

The problems of transport related greenhouse gas emissions also present opportunities for organisations. Reducing transport and improving utilisation not only reduces emissions, it also reduces costs. This alignment of objectives makes it easier to make a business case to invest in redesigning supply chains. The benefits of more sustainable supply chains can also be revenue enhancing, as customers become more conscious of the problem of global warming they will start demanding products that are delivered in a more sustainable way.

2. Methodology

The methodology used for this project has three main elements. Firstly a systematic review of the literature was conducted in order to provide the academic foundations for the research following an evidence-based approach. Secondly, a series of fifteen case studies were conducted with leading organizations in industries as diverse as oil and gas, retail and electronics. The findings from the case studies, supported with the literature review, help to expand the understanding of how companies are making global sourcing decisions and the impact these decisions are having on performance. Thirdly, a computer model has been developed to assess the impact of global sourcing decisions on four key indicators: cost, time, risk and CO₂ emissions. The model provides a strategic view of the impact of global sourcing and can be used by practitioners to support their decision making process.

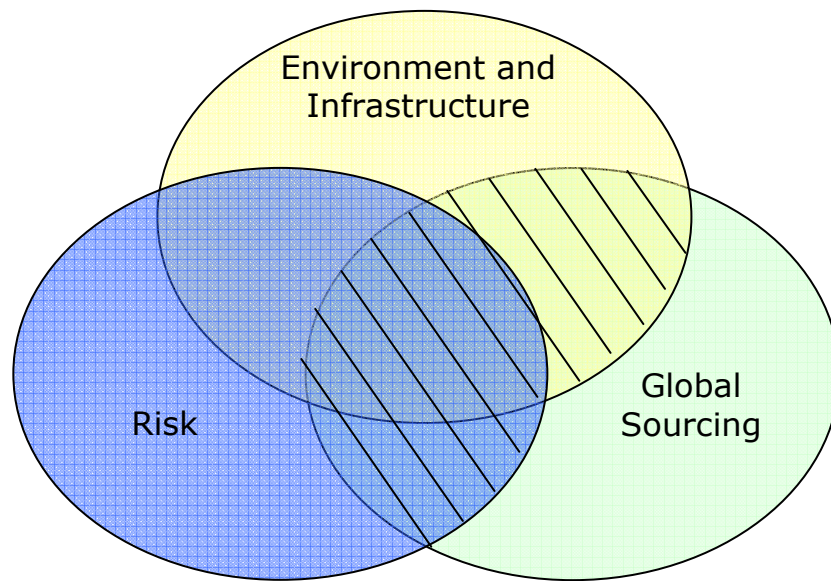
This section concentrates the methods used to conduct both the systematic review and the case studies. More details about the modelling approach and the assumptions behind the model are provided in Section 5: Comparative Product Sourcing Model.

2.1. *Systematic Literature Review*

A systematic literature review is an evidence-based approach to identifying, selecting and analyzing secondary data. The literature review performed in this study is based on the approach described by Tranfield et al. (2003). The main goals of this review were:

- To understand why and how companies make global sourcing decisions
- To uncover the hidden costs and risks of global sourcing
- To investigate the environmental and infrastructural implications of global sourcing for the UK

The Venn diagram in Figure 11 illustrates the three main subject areas for research (global sourcing, risk and environment and infrastructure) and highlights the area of focus of the research. This area covers the overlap between global sourcing and risk and global sourcing and environment.

Figure 11: Systematic Review Focus

To conduct the search a number of key words within each area of interest were brainstormed by the members of the project which included four academics and two consultants. A large number of words were initially identified, and following a discussion by the project team, the following keywords were selected:

- **Global sourcing**

Outsourcing, supplier management, global sourcing, offshoring supply chain, supply network, supply web, agility,

- **Risk Management**

Resilience, vulnerability, risk, contingency, mitigation, uncertainty

- **Environment and Infrastructure**

Transport, carbon dioxide, CO₂, air pollution, congestion, traffic, roads, ports, airports, railway

Using these keywords a series of 23 search strings, were constructed using Boolean operators (AND, OR and AND NOT) and submitted to two databases: Proquest and Science Direct (an example of one of these search string is presented in Appendix 1). These are two of the largest databases on the target subjects and were considered complementary to each other.

Around 150 different articles were identified from the searches. Following an initial evaluation, 51 articles were considered valuable for the project and were read in full-text.

A review protocol was designed to provide a structure to the review (shown in Appendix 2). Three members of the research group performed the process of reading the papers in full. In order to standardise and synchronise the process as much as possible, three papers were read as a pilot by all three members and discussed.

The results from the systematic search were supplemented using cross-references from the initial list of articles and incorporating articles that were previously known to the members of the research team. Hence, following the review of the original 51 journal articles, an additional 46 documents, papers and books were added to review, giving a total of 97 documents reviewed. The results of this review are presented in the Literature Review section of this document.

2.2. Case studies

To gain deeper insights into how companies are making global sourcing decisions, a case study approach was used. This approach was considered suitable, because it is appropriate for investigating contemporary events and because it can help answering both “*why*” questions, such as of the motives for sourcing globally, and “*how*” questions such as the models and approaches used to support the global sourcing decision (Yin, 2003).

Fifteen case studies⁵ in seven different industries were conducted. All the organisations involved are significant players in the UK and have global supply chains. The following key industry sectors were represented in the study:

- Aerospace
- Oil/Gas (MRO)
- Consumer Electronics
- Mechanical & Electrical Equipment
- Food, drink and fast moving consumer goods
- Fashion (Retail and Wholesale)
- Retail

The multiple case study approach helped to develop a more consistent and reliable account of the issues under study, providing a firm grounding for the conclusions (Eisenhardt, 1989b). The cases were selected in diverse industries; this provided views from extreme situations; from commodity products, through to highly specialised aerospace equipment. This helped to provide clarity of some of the key issues in global sourcing and to identify differences between industries.

The main data collection method was in-depth semi-structured interviews, which provided a flexible instrument to get information from the field (Yin, 2003). In total, thirty managers were interviewed across the fifteen cases. They were drawn from various areas in the supply chain but with a responsibility to manage global sourcing and/or supply chain risk.

Based on the initial literature review an interview protocol was developed and tested with a group of 28 logistics and supply chain executives at the Logistics and Supply Chain Forum 2006. Subsequently it was piloted at two companies, prompting substantial revisions to the questions based on factors such as clarity of terms and issues and time required to respond to questions, as well as suggestions by the pilot companies. This protocol provided a structure for the interviews and facilitated comparison of the cases as the analysis stage. A copy of the protocol can be found in Appendix 3.

⁵ Supply chain risk and global sourcing are commercially sensitive issues, interviews were therefore conducted on one-to-one basis with assurances made to interviewees that the anonymity of all respondents, departments and organisations would be protected. Therefore, we will refer to the participating case companies as Case A, Case B, Case C and so on to protect their identity.

The main informants were purchasing/procurement or supply chain directors, who should be the best-informed person on the subject of global sourcing. In some of the cases, one or two additional informants were selected based on accessibility, knowledge of the field and relevance of job description. Most of the interviews were conducted face to face although some had to be conducted over the telephone due to availability and location of the interviewees. Interviews were tape-recorded and transcribed for further analysis. Additionally an interview summary was prepared using a standard template which included notes and observations by the interviewer.

Documents were used as a secondary source of data. Annual reports, corporate social responsibility reports and publicly available case studies were collected for each of the case study companies. This allowed for triangulation of information gathered from interviews. A case study database was created including all the primary and secondary data from the case studies.

Initially, case studies were analysed independently, structuring all the information into a coherent case study report. Summaries of these single case reports are included in Section 4 of this report. Once this was completed a cross-case analysis was conducted to identify any trends or patterns across the complete set of cases, as recommended by Ghauri (2004). This was done by coding the data, identifying specific themes and then systematically comparing the findings from the case studies. Section 5 includes a detailed discussion on the themes that emerged from the analysis including possible explanations for the patterns identified.

2.3. *Modelling*

Modelling is a powerful aid to understanding the dynamics of a system, the issues and the choices available as well as to guide consequent decision-making. The model constructed as part of this research aimed to explore the global sourcing decision by allowing the comparison of different sourcing regions and modes of transport. The model takes into consideration four main variables that are considered central to the global sourcing decision: cost, time, risk and CO₂ emissions.

Section 5 includes a detailed description of the structure and operation of the model. This section also includes a complete account of the assumptions and methods of

calculation behind the model. Sufficient information has been provided to ensure that the results of the model can be replicated.

Testing of the model was an essential part of the development process to ensure that the software performed correctly. The model was extensively tested internally during the development process, and with the complete software to identify any inconsistencies and errors. The logic was also been discussed and validated by the team members throughout the development process. In addition, the model was issued to a number of companies for testing and the feedback incorporated into the software.

3. Literature Review

3.1. *What is Global Sourcing?*

A review of the literature indicates that there are a number of terms used to describe the purchasing process from suppliers outside the buying firm's country. For instance, foreign sourcing, international sourcing, worldwide sourcing and global sourcing have all been referred to in the literature to date. International sourcing has been defined by Johnson and Wood (1996) as buying components and inputs anywhere in the world in such a way that the manufacturer puts out a much broader net rather than relying only on local sources. Spekman (1991) cites global sourcing as the efficient use of worldwide human, material, energy, and capital resources.

Mol (2000) provides a more general definition of global sourcing as 'finding and managing sources for production of final products on a world-wide basis'. Monczka and Trent (1991) argue that international purchasing involves a commercial transaction between a buyer and a supplier located in different countries. Conversely, global sourcing differs from international buying in scope and complexity, it involves proactively integrating and coordinating common items, materials, processes, technologies, designs and suppliers across worldwide buying, design and operational locations. Furthermore, global sourcing requires horizontal integration between product design and development groups as well as between supply and demand planning activities. The definition of global sourcing given by Monczka and Trent (1991) has been adopted widely. They define global sourcing as:

"The integration and coordination of procurement requirements across worldwide business units, looking at common items, processes, technologies and suppliers" (Monczka & Trent, 1991)

In a more recent study Trent and Monczka (2005) identify five levels of offshore sourcing:

- **Level 1:** Domestic buying but often progressing toward international purchasing because of a lack of suitable domestic suppliers.
- **Level 2:** International purchasing usually limited or performed on an ad hoc or reactive basis.

- **Level 3:** Making international purchasing part of the firm's sourcing strategy but the strategies are not well coordinated across worldwide buying sites and usually focus on price improvements.
- **Level 4:** Requires worldwide information systems, personnel with advanced knowledge and skill sets, extensive coordination and communication mechanism and an organizational structure that supports global integration and an executive leadership that can clearly articulate a global vision.
- **Level 5:** This integration, which often involves the coordination of design and procurement activities, occurs during the development of new products and technology as well as during the sourcing of items or services to fulfil existing demand. This is the highest level of global sourcing.

Whilst there are different definitions of global sourcing, a common feature is that they refer to activities being sourced from or performed by an external provider and/or from a location outside the company's home country (Trent & Monczka 2005; Brown & Wilson 2005; Embleton & Wright, 1998). We take the view that the term global sourcing encompasses both offshore sourcing and manufacturing and we argue this has significant implications for supply chain risk management.

3.2. *The Trend to Global Sourcing*

A number of reasons for sourcing globally have been found in the literature. These range from firms seeking to achieve competitive advantage (Frear et al., 1992), access to new technologies and emerging markets (Ettlie and Sethuraman, 2002) and, better quality and costs compared with the same products sourced from domestic suppliers (Lowson, 2001). Much of the literature focuses on the advantages and disadvantages of global sourcing. One of the disadvantages of global sourcing, it could be argued, is the fact that many organisations have moved to global sourcing without risk management, strategic planning and often with a too limited view of the costs of relocation, the risk of establishing new suppliers, loss of flexibility, longer lead times, increased transportation costs and the impact on the environment. The positive and

negative implications for global sourcing are examined later. Here we review the literature for the key motivations underlying global sourcing.

Kotabe and Murray (1990) state that global competition has led to an increase in global sourcing of components, parts, raw materials and finished products. Fagan (1991) also cited that more and more firms are purchasing materials, supplies, parts and services from a worldwide arena to compete in global markets where price competition is fierce.

Global sourcing has gradually become a more important part of a firm's competitive strategy and is often regarded as a critical tool for firms seeking to achieve competitive advantage (Frear et al., 1992). Samli et al. (1998) state that global sourcing is a powerful factor in developing a global competitive advantage, consequently global sourcing should be planned at the highest level of the corporate organizational structure and must be used appropriately in corporate competitive efforts (Monczka and Gunipero, 1984; Monczka and Trent, 1991). Ettlie and Sethuraman (2002) suggest that global sourcing has become a critical component of corporate strategy aimed at a raising product quality, increasing manufacturing flexibility and improving product design, often through technology uniquely available to a specific region of the world market. However, Christopher and Lee (2004) pointed out that the increased globalisation of supply chains and the prevalent use of subcontract manufacturing and offshore sourcing can potentially lengthen lead times and hence lead to a loss of competitiveness. This is consistent with Trent and Monczka (2005) who highlight the risk of coping with longer distances, rules and regulations and the problems of cross-locational coordination. Das and Handfield (1997) argue that global sourcing has been catching the attention of both the academic and business levels, due to the increasing awareness of its potential strategic importance to the firm. Firms have now become conscious that globalization is a fact of life; in order to compete globally, firms must also buy globally.

However, the risk inherent in global sourcing and procurement is not always transparent. There are a number of tangible and intangible risks in the supply chain which must be managed and companies competing globally must factor risk management into their global sourcing decision making process, if they are to remain successful. The subsequent sections explore these issues and examine the costs of global sourcing.

3.3. Risk and Supply Chain Risk Management

The unpredictability of the business climate, changing consumer demands, competitive actions, fashion, quality of execution and market dynamics, have all increased the exposure to risk in the supply chain (Braithwaite and Wilding, 2005). Many companies have been aware of the need for risk management and contingency planning for some considerable time and there exists a wide body of literature from such diverse fields as economics (e.g. Kahnemann & Tversky, 1979, 1992), finance (e.g. Smith et al., 1990), strategic management (e.g. Bettis & Thomas, 1990; Simons, 1999) and international management (e.g. Miller, 1992; Ting, 1988). In the following sections we discuss the various definitions of risk and approaches to supply chain risk management.

3.3.1. Definitions of Risk

The word ‘risk’ derives from the early Italian ‘risicare’, which means ‘to dare’ (Bernstein, 1996). Hence, Bernstein (1996) suggests that risk is a choice rather than a fate; ‘the actions we dare to take, which depend on how free we are to make choices, are what the story of risk is all about’. Moore (1983) notes that the anglicized spelling of risk appeared in England around 1830 in insurance transactions and identifies the closest meaning to the word risk before it existed is ‘hazard’ as in Shakespeare’s Merchant of Venice: ‘Men that hazard all do it in hope of fair advantages’ (cited in Moore, 1983). Subsequently, Moore refers to Shakespeare’s terminology that risk is connected not only to the possibility of loss, which a common dictionary definition of risk is but also with the hope of some benefit or gain (Moore, 1983).

Moore (1983) presents two basic components of risk: first risk as a future outcome, which can take a number of forms (i.e. loss or gain) some of them unfavourable; and second, risk as a non-zero chance that the less favourable outcome(s) may occur. Therefore risk is used to cover the combination of an unfavourable result and the non-zero chance of it occurring. Moore (1983) further suggests that ‘when terms like high risk or low risk are used, the meaning commonly depends on the starting asset base and the consequences that the occurrence of the risk would have for the asset base of the individual or organisation concerned’.

According to Frosdick (1997) the twentieth century has seen the concept of risk being used only in connection with negative outcomes. Acknowledging the needs of engineers and scientists specialising in risk studies, the Royal Society Study Group (1992) defined risk as ‘a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence’.

Other negative definitions of the term are typified by Rowe (1980) who defined risk as the ‘potential for unwanted negative consequences of an event or activity’, whilst Lowrance (1980) defined risk as ‘a measure of the probability and severity of adverse effects’. Simon et al. (1997) have defined risk as an uncertain event or set of circumstances that should they occur have an effect on the achievement of the project’s objectives. Zsidisin (2004) concludes that risk exists when there is a relatively high likelihood that a detrimental event can occur and that event has a significant associated impact or cost. Similarly, Mitchell (1999) defines risk as ‘a subjectively-determined expectation of loss; the greater the probability of this loss, the greater the risk thought to exist for an individual’. However, research by March and Shapira (1987) identified that although risk is associated with negative outcomes, there are possibilities for gain; risk had a wide range of possible outcomes and not just the threat of a poor outcome.

This discussion indicates the scope of the risk construct and the divergence in expert opinion of the meaning of risk. It is useful to understand the controversy and debate on risk and acknowledge the variety of definitions proposed by experts.

A number of authors have also classified different types of risk in a supply chain context. One example is Harland et al. (2003), who lists different types of risks discussed in the literature:

- Strategic risk
- Operations risk
- Supply risk
- Customer risk
- Asset impairment risk

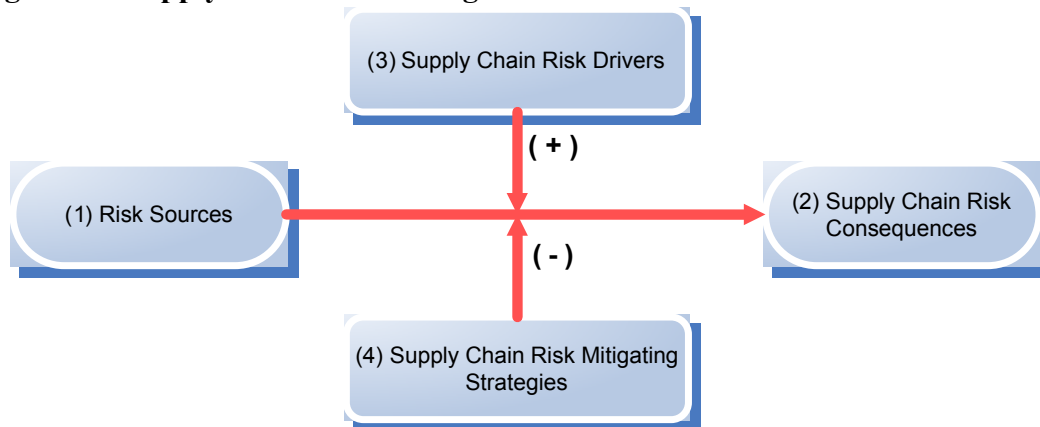
- Competitive risk
- Reputation risk
- Financial risk
- Fiscal risk
- Regulatory risk
- Legal risk

Another list covering the same areas is presented by Spekman & Davis (2004):

1. **Risk associated with the flow of goods:** i.e. the physical movement of goods as well as costs for obsolete or unwanted inventory.
2. **Risk associated with the flow of information**
3. **Risk associated with the flow of money:** For example, pricing issues, hedging, letters of credit, timely payment of bills etc.
4. **Risk associated with the internal information system:** i.e. risk stemming from e.g. persons who have access to the information system, weak firewalls, and other security-related issues.
5. **Risk associated with relations with supply chain partners:** Deals with risk of opportunistic behaviour based on transaction cost analysis.
6. **Risk associated with corporate social responsibility:** i.e. the risk of being associated with unacceptable practices e.g. child labour

3.3.2. Supply Chain Risk Management

The basic constructs of supply chain risk management have been defined by Juttner et al., (2003) as comprising four basic elements: (1) supply chain risk sources, (2) risk consequences, (3) risk drivers and (4) risk mitigating strategies

Figure 12: Supply Chain risk Management - The basic constructs

Source: Juttner, Peck & Christopher, 2003

Juttner et al., (2003) pointed out that even though risk has always been present in the process of balancing supply with demand, there are a number of factors that have emerged in the last decade or so, which might be considered to have increased the level of risk. These included:

- a focus on efficiency rather than effectiveness
- the globalization of supply chains
- focused factories and centralized distribution
- the trend to outsourcing
- reduction of the supplier base

In the literature, risk has been examined at the level of supply chains and supply networks (Harland et al., 2003). According to Turnbull et al., (1996) one of a company's resources is its network position, its relationships and the rights and obligations that go with them. Ritchie et al. (2000) developed an organisational global risk model based on relationship marketing, supply chain management and risk management. They suggest that developments in information and communication technologies and the erosion of entry and trading barriers enhance risk exposure for those managing the supply chain. They argue that risk management strategies may involve supply chain partnerships, long-term financial security and arrangements or developments in the product/market portfolio. Research has indicated that firms are more able to manage their supply networks effectively when those networks are stable

(Snow and Miles, 1992). Zheng et al. (2001), cited in Harland et al., (2003) discussed the following sources of supply network stability:

1. Designing an appropriate supply network structure
2. Choosing the appropriate type of relationship with suppliers
3. Developing and using adequate procedures for selection, evaluation and monitoring of sources
4. Designing and using a system of incentives, risk sharing practices and rewards for suppliers
5. Using tools to identify and control any possible opportunistic tendencies

3.3.3. Risk Management/Mitigation

A plethora of literature recognises the importance of risk management, (Lonsdale, 1999; Zsidisin, 2000; 2003a; 2003b; Harland et al., 2003; Karjalainen, et al., 2003; Kraljic, 1983; Yates and Stone, 1992; Eisenhardt, 1989). However, studies reveal that although risk management is becoming an increasingly common term in business life, there is little empirical evidence on how companies manage risk (Smallman, 1996; Tchankova 2002; Ruefli et al. 1999; Noy and Ellis, 2003). Research suggests that companies and managers lack an awareness of risk: ‘although managers understand that corporate risk is a built-in part of all aspects of business activity, and that any short-term or long-term decision has a risk component, their attitudes to risk are hardly considered an integral part of business strategy’. Smallman (1996) links risk management to organisational learning and highlights the importance for organisations to learn from past mistakes in order to manage risk. Therefore, risks provide an opportunity for companies to learn and manage future risks. To counteract the lack of research Ruefli et al. (1999) and Ramanujan and Varadarajan (1989; cited in Ruefli et al., 1999) call for new measures and methods to advance the understanding of the impact of risk on corporate performance and to study risk with a variety of measures in the hope that new ideas about risk and risk management will emerge.

Research by Evans (2000) claims risk management seeks to mitigate the impact of risks by reducing the likelihood of occurrence and/or the avoidance of consequences.

Cox and Townsend (1998) explain that risk management is normally measured in two dimensions: in terms of the likelihood of events or unwanted events; and in terms of the consequence or the severity of a specific outcome.

Giunipero and Eltantawy (2004) argue that conducting risk assessment when choosing suppliers has become more important in recent years because of the globalisation of supply chains. The traditional way of handling risk was to buffer against it by, for example, increased inventory levels. Modern risk management, however suggests identifying, understanding, and deciding the importance of a certain risk is a better option:

“Traditionally, companies used to adopt strategies, which buffer against risks present in their environment by using multiple sources for strategic items and holding safety stock. These buffers restrict operational performances and can negatively impact competitive advantage. New approaches involve risk management, which is a formal process that involves identifying potential losses, understanding the likelihood of potential losses, and assigning significance to these losses.” (Giunipero & Eltantawy, 2004). The authors also identify four situational factors that determine when risk assessment becomes especially important (Giunipero & Eltantawy, 2004):

- degree of product technology;
- need for security;
- importance of the supplier; and
- the purchasers’ prior experience.

3.3.4. Risk and Global Sourcing

Risk assessment should also assess the strategic importance of a global sourcing decision, where it must be carefully evaluated whether going offshore really is the best alternative. Ritter & Sternfels (2004) state that the decision for companies to go offshore should be considered from a broader manufacturing strategy perspective. To start with, they should consider what their core competences are, and consider the risk of e.g. supply interruptions, cost variations stemming from currency fluctuations, and issues related to intellectual property. A manufacturing company should also consider

opportunities to improve efficiency at home and not only consider the offshore alternative in isolation. Furthermore, products should always be designed so that production costs can be minimised.

It is also important to separate the offshore decision from the outsourcing question. As Preston (2004) argues, to go offshore does not automatically mean outsourcing. When planning for a change, managers should separate the “what” question from the “how” question. For some companies it could be better to run the factory by themselves in the foreign country. The economics of different alternatives must therefore be assessed and core activities identified (Preston, 2004).

In its essence, the above authors stress the strategic impact of a global sourcing initiative. On the same topic, Monczka & Morgan (2000) conclude that “What many [companies] fail to understand is that insourcing-outsourcing is a major companywide strategy issue, and there’s a really significant need for deep sourcing insights into its nuances” (Monczka et al., 2000).

When the decision to source globally is taken, a number of considerations have to be taken into account. For example, Vestring et al. (2005) stress that different low cost countries have a unique mix of strengths and weaknesses. It is therefore useful to consider other alternatives than China and India, which are the two most common alternatives. Based on a survey among 138 manufacturing executives, Vestring et al. (2005) conclude that among the more successful companies when it comes to assessing cost structures, more countries than only China and India are considered. To balance the risks in different countries, the authors suggest a portfolio approach where a large number of criteria are considered; maturity and stability of the nation’s infrastructure, political characteristics, size of the domestic market and local demand, currency risk, climate and weather patterns, language skills, management training, and cultural characteristics. Furthermore, long-term trends that may affect the criteria should be considered.

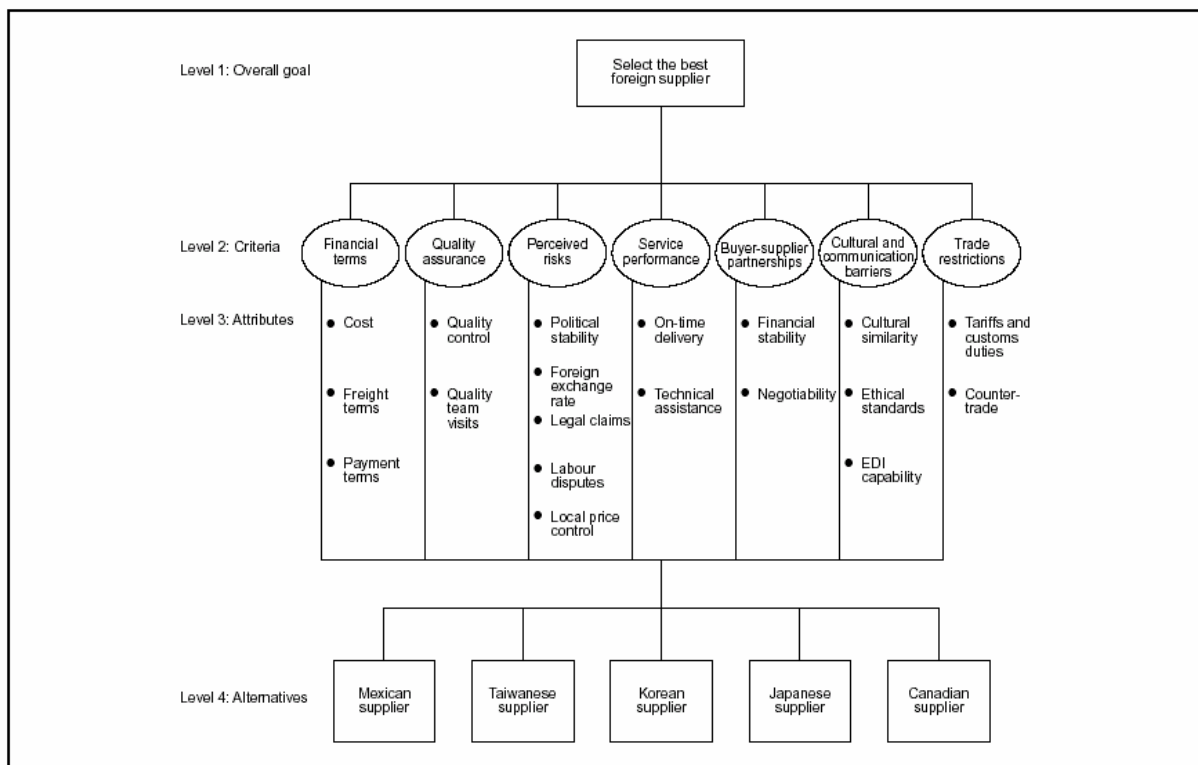
In line with Giunipero and Eltantawy’s (2004) view on risk management, many authors stress the importance of a more holistic view when assessing risk including more criteria than only costs. For example, Bhatnagar and Sohal (2005) claim that when assessing the risks for a plant location decision, you must consider “hard data” such as costs, as well as “softer” data e.g. political, labour, infrastructure, etc.

Thus, more criteria than direct cost should be taken into consideration. Even if they are not specifically related to global sourcing, Brown & Wilson (2005) suggests the following measurements to consider when considering outsourcing:

- Service levels
- Price/performance benchmarks
- Customer satisfaction surveys
- Quantify expectations
- Inventory in-house skills
- Infrastructure in-house skills
- Opportunities for improvement

Another example of suitable criteria is given by Min (1994). He argues that both qualitative and quantitative evaluation of suppliers are required and suggests the following model for supplier selection.

Figure 13: Supplier Selection Criteria



Source: Min, 1994

Whilst many authors suggest a number of additional criteria besides cost, many of them are qualitative in their characteristics. A need for more quantification is discussed by Blackhurst et al. (2005). They state that little research has been done on quantifying costs for supply chain disruptions or crises. This area will be even more important in the future due to increased global sourcing and at the same time, a movement towards responsiveness, agility and lower inventory levels. Furthermore, there is a need for further understanding of supply chain cost trade-offs between cost and flexibility; “An understanding of the relative levels of premium transportation costs required to sustain supply-chain agility and inventory levels in the face of disruptions is an important research requirement.” (Blackhurst, et al., 2005)

Building trust in relationships appears to be an important requirement for successful global sourcing. This is also discussed by Spekman & Davis (2004), who argue that the key to managing risk effectively in a supply chain is trust building between supply chain members. For example, mitigating risk through increased visibility requires that the supply chain members are willing to share information. Trust is needed for this. In order to build trust, Spekman & Davis (2004) suggest that the following actions should be undertaken:

1. Begin by defining a plan internally where objectives and goals are set. This plan can be communicated to the supply chain partners and function as a basis for the negotiation of mutual goals in the supply chain.
2. Ensure open lines of communication so that all members feel comfortable with sharing sensitive information. Level of commitment, degree of comfort and willingness to exchange the sensitive information are important parameters here.
3. Take the partner's perspective from time to time in order to better understand what drives the partner's decision process.

Christopher & Lee (2004) also discuss the importance of building trust in relationships. They present “the risk spiral”, arguing that lack of visibility leads to a lack of confidence in the supply chain. This in turn causes a build-up of buffers (e.g. inventory), which increase the lead times. As a consequence of increased lead times, visibility worsens. The authors state that to break the spiral, end-to-end visibility

must be increased. “Total end-to-end visibility will enable supply chains to be transparent, and the right information would be available to the right member of the supply chain at the right time” (Christopher and Lee, 2004).

Christopher & Lee (2004) presents three ways to break the spiral:

1. Information accuracy, visibility and accessibility
2. Alerts for out of control conditions, i.e. using supply chain intelligence
3. Responsive corrective actions, i.e. contingency plans should be available

In addition to trust building, a proactive approach to risk mitigation is discussed in the literature. For example, Giunipero & Eltantawy (2004) state that risk management should be proactive. The authors argue that in order to cope with risk, purchasers have started to work more closely with key suppliers. However, the authors state that these new “risk management practices” in fact can cause other potential risks. For example, single sourcing provides a new risk. Furthermore, Giunipero & Eltantawy (2004) state that there is a trade off between benefits gained from risk management and the costs of these activities. Money and time spent on risk management (i.e. risk mitigation strategies) should be aligned to the potential earnings.

Bovet (2005) argues that top management support as well as cross-functional collaboration are important prerequisites for risk mitigation in the supply chain. Risk mitigation through reducing lead times in the supply chain has previously been successfully adopted by many companies. However, with global sourcing this strategy becomes more and more difficult since global sourcing by definition means longer distances. Instead, Bovet (2005) suggest that companies should focus on how to optimise a portfolio of their supply chain sources and locations so that flexibility through diversification can be achieved. By thinking of the sources and locations in terms of a portfolio, similar to financial portfolio theory, a better risk and opportunity assessment can be done: “Through portfolio modelling, firms can mix and match different tactics in pursuit of the arrangement of sources, locations, and so on that maximizes the supply chain’s ability to support a specific company strategy” (Bovet,

2005). Thus, the portfolio technique is a helpful tool for balancing global risks and returns better.

Lee & Wolfe (2003) suggest six risk mitigation strategies:

1. Comprehensive tracking and monitoring,
2. Total supply chain network visibility
3. Flexible sourcing strategies (i.e. single sourcing perhaps not always good)
4. Balanced inventory management (a buffer can sometimes be good – JIT not always the solution)
5. Product and process design (e.g. postponement)
6. Demand based management (E.g. Dell sells only what is available)

Bovet (2005) also suggests a number of risk mitigation strategies on a more tactical level:

1. Improve demand management: Increase joint efforts by e.g. Vendor Managed Inventory, with distributors and customers downstream so that demand changes can be handled better.
2. Create contingency plans with suppliers: Contingency plans should be elaborated with suppliers.
3. Diversify sourcing: Avoid single sourcing or at least establish backup arrangements with other suppliers in order to reduce the dependency of a supplier.
4. Extend insurance policies: Insurance policies should include also foreign low cost countries.
5. Employ major third party logistics providers: A large third party logistics provider with broad resources can help to identify possible risks. “In essence, the logistics provider becomes a key risk-mitigation agent by continually looking over the horizon on a company’s behalf” (Bovet, 2005).
6. Model and optimise inventory: The modelling and optimisation of inventory levels across the end-to-end supply chain.

7. Increase product standardisation: Higher levels of raw materials and component standardisation can enhance flexibility.
8. Centralised product data management system: A product data management system can facilitate a change of suppliers, since new suppliers more easily can get access to necessary product information.
9. Visibility: Visibility of the goods flow can give a better overview of the situation and safety stocks can be reduced to enable track and trace. Computerised tracking systems are available.
10. Monitoring: Continuous tracking and follow up of a limited number of risk indicators, such as average lead times, weeks of orders outstanding, component delivery variability, and exchange rate movements, can function as a warning for a coming disruption in the supply chain.

Instead of increasing redundancy in the supply chain through e.g. increased inventory levels, Sheffi & Rice (2005) argue that flexibility should be built into supply chain design so that disruption can be dealt with better. They discuss these ideas in the following five areas:

- **Supply and procurement:** Having a single or a multiple sourcing strategy is not a question of right or wrong. The important task, the authors suggest, is to be aware of the pros and cons of the two different approaches. If using single sourcing, a close relationship becomes critical. This can be expensive and demanding and sometimes it is therefore better to have less close relationships with several suppliers in order to spread the risks.
- **Conversion:** In the factory, using standard processes and having several locations with built-in interoperationality can improve flexibility.
- **Distribution and customer facing activities:** Postponement strategies are suggested by the authors so that better flexibility can be achieved.
- **Control systems:** Control systems have two purposes; detect disruption quickly and enhance fast corrective actions to be taken. In order to detect disruptions, several computerised tracking and tracing systems, which increase the supply chain visibility, are available.

- **The right culture:** A culture able to sense and “hear” warning signals is important.

Sheffi (2001) argues that in order to mitigate consequences of a disruption, the best solution might be to adopt a dual sourcing strategy, i.e. source the bulk from offshore suppliers while at the same time make sure that a local supplier can provide goods if a disruption occurs. This article by Sheffi (2001) is concerned with how to tackle risks with terrorist attacks. However, he states that this new type of threat can be dealt with by refocusing on known solutions including

- Improvements of shipment visibility (by technology based tracking systems)
- Improved collaboration between trading partners and across enterprises (to better integrate the supply chain)
- Better forecasting through risk pooling methods, which e.g. includes postponement, build-to-order, product variety reduction, and centralised inventory management.

Blackhurst et al. (2005) suggests that whilst the literature on how to manage supply chain disruptions has grown due to increased global sourcing it tends to take a general, high-level view of the subject; “This perspective has led to a fairly good understanding of the ‘big picture’, but hinders the researcher from ‘drilling down’ to the key variables, the relationships among them and the methodologies or tools to manage these key issues.” (Blackhurst, et al., 2005:4069). The authors discuss a number of methods and technological means for how to discover, recover and redesign the supply chain. For example, “intelligent agents”, i.e. web-based search tools can be used to discover disruptions at an early stage. This can be used for a dynamic recognition of disruption events and redesign of the supply chain.

3.4. Risks and Benefits of Global Sourcing

The review of the literature indicated that there are two conflicting views of global sourcing. Here we examine the literature which presents both the risks and benefits of global sourcing.

3.4.1. Risks of Global Sourcing

Braithwaite (2003) presents five types of risk related to global sourcing:

- Hidden costs might erode the net earnings from global sourcing. Typically, labour cost is as little as 7-10% of the total product costs. Hence, other cost factors must be considered as well.
- Since global sourcing can mean lower responsiveness, there is a risk of lost sales.
- Quality problems might occur due to long distance relationships and the many hand-offs in the extended supply chain.
- Valuable know-how is given away
- The long-term impact on supply and demand is not clear which can distort the markets in terms of benefits gained and the risks for secure supply.

Fitzgerald (2005) has a similar list of risks related to “low-cost country sourcing”:

- Supply disruption due to poor infrastructure, communication, etc.
- Long lead times
- Poor quality
- Security issues (political instability, potential terrorist activities etc)
- Hidden costs due to changes in tariffs, duties, taxes etc

Similarly, Trent & Monczka (2005) state that when moving from domestic to global sourcing, companies have to cope with longer distances, increased rules and regulations, currency fluctuations, customs requirements, language, cultural and time

differences. They also have to manage more cross-functional and cross-locational coordination. James (1990) concludes that “Many firms have moved into globalization without a real appreciation of the environmental risks that they face with dispersed sourcing. Literally, the more links in the chain the more room for tension and the greater exposure. In many cases companies have devised global supply strategies without developing structures and systems specifically designed to reduce their vulnerability” (James, 1990). James addressed a number of factors concerned with increased risk exposure:

- **Political factors:** Companies are to a higher extent exposed to a “low cost – high quality challenge” from many developing countries. A strategic risk of transferring know-how to these countries is highlighted.
- **Economic issues:** Labour costs in the developing countries will increase in the future. In addition to this, wages are not a good indicator for low production costs, i.e. low wages do not necessarily mean low production costs. Furthermore, the costs can vary due to fluctuating exchange rates.
- **Social pressures:** An increased risk of political instability, due to increased living standards in the developing countries, is discussed. Also risk of strikes etc in the US and Europe may increase when production is moved offshore.
- **Technological imperatives:** Companies from USA and Europe with production facilities in the low cost countries find themselves forced to transfer more and more advanced technology. This increases the likelihood of “cloned” low cost competitors in the future.

Several authors argue that the globalization of supply chains and the trend towards outsourcing, have worsened the risk exposure as well as the impact of supply chain disruption (Christopher & Lee, 2004; Engardio, 2001; McGillivray, 2000). Juttner et al. (2003) also indicate that the globalization of supply chains and the trend to outsourcing are among the five key drivers of risk.

Ritter & Sternfels (2004) found in a survey that offshore manufacturing turned out to be less successful than expected due to the fact that direct labour costs as a part of the overall costs are decreasing. In addition to this, keeping production plants near end consumer (in their case in USA), increased responsiveness to changing market conditions. This can be an important competitive weapon. Furthermore, the authors

suggest that in high-tech electronics industry the long lead times as a consequence of producing overseas can result in exposure to price declines between 2-6%.

Warburton & Stratton (2002) present a case of a North American apparel manufacturer, where a dual sourcing model was adopted with 20% of the production being kept in the USA and the rest was manufactured offshore. The case company argued that even if the labour cost was dramatically less expensive offshore, a dual sourcing solution made sense. First, a number of hidden costs were associated with the offshore production, making it less attractive than it seemed at a first sight. Second, fluctuations in consumer buyer patterns made the long lead times very costly, both in terms of lost sales and redundant inventory.

Markides and Berg (1988) identified the trend to manufacturing offshore and roundly criticized it as being both unnecessary and risky. They argued that the headline benefit could be countered by risks which include the opportunity for existing manufacturing capacity to be made more competitive and the hidden costs of obsolescence, inventory holding and demand unresponsiveness.

They indicate that there are five risk factors in global sourcing:

1. There are risks that the total acquisition cost may be bigger than predicted and erode the net benefits that the initial purchase cost involves. When all factors including transportation, handling, duty, obsolescence, inventory and lost sales are factored in, the total cost may not be as attractive as the headline advantage – labour costs are typically as little as 7% to 10% of the total product costs.
2. The longer chain cannot be as responsive to variations in demand as local sourcing – for this reason there may be opportunity costs of lost sales.
3. The long distance relationship may cause risks with quality and execution and the many hand-offs in the processes to move the product to its destination may cause service failure and hence cost.
4. Product and engineering skills may be lost and valuable know-how be given away by vendors allowing others to enter markets.
5. The long-term impact on supply and demand is less obvious and may distort markets both in terms of the benefits gained and also for the risks of supply.

Similarly Fagan (1991) summarizes the downside of global sourcing as:

- High cost of overseas travel
- Brokers' and agents' fees
- Expenses for physical distribution
- Inventory buffers
- Need to rework products
- Increased paperwork
- Cash flow issues
- Business risks (lack of control)
- Exchange rate fluctuations and;
- Plans for handling political turmoil

3.4.2. The Environmental Impact of Global Sourcing

Zhu et al. (2004) claims that China is one country where the issues related to Green Supply Chain Management (GSCM) have become critical. Recent studies have shown that a majority of the world's manufacturing will be carried out in Asia in the next couple of decades. As a major manufacturing country, China has many opportunities, but they also face substantial environmental burdens with this opportunity.

Recently, Chinese enterprises have increased their environmental awareness due to regulatory, competitive and marketing pressures. Chinese enterprises often pursue such international organizational standards as ISO9000 and ISO14001 certification. However, GSCM is still in its infancy in China. Chinese enterprises have recognized its importance, but have lagged in the implementation of these principles into practice (Zhu et al., 2004).

Rondinelli and Berry (2000) argue that as transportation and logistics systems continue to integrate, their impacts on the physical environment (air, water, and land resources) will become more complex. Failure to manage the environmental impacts

of their operations raises serious potential risks for firms involved in inter-modal logistics and multimodal transportation.

They argue that increased globalisation puts new requirements on the management of a company when it comes to environmental evaluation of different transportation modes. The authors explain that proactive management of environmental issues aims to identify the following:

1. The interactions among transportation activities that have negative impact on the environment.
2. The types of environmental impact emanating from transportation operations and facilities.
3. Alternative means to control and prevent environmental pollution and natural resource degradation.

Threats of increased regulatory control by national governments and international organizations pose the most immediate risk. A second set of risks is financial. Firms that ignore negative environmental impacts not only incur opportunity costs, but also potentially higher absolute costs for pollution control technologies in the future and the loss of competitive pricing advantages. Damages to corporate image from environmental pollution or natural resource degradation can cause serious competitive problems and strong backlashes from stakeholders (Rondinelli and Berry 2000).

3.4.3. Benefits of Global Sourcing

Fagan (1991) suggested that low cost due to low labour cost, less restrictive work rules, low land and facility costs, and low taxes are not the only benefits of global sourcing. He discusses briefly a number of other positive benefits including availability (i.e. secure capacity), uniqueness, quality, technical supremacy, penetration of growth markets (i.e. get access to new markets before competitors), and high speed (i.e. flexibility).

Taken from previous research, Trent & Monczka (2003) mention price reduction, greater access to process and product technology, higher quality, and ability to introduce competition to the domestic supplier base as positive impact of global sourcing. Based on results from a survey mainly among US companies, the authors

verify these positive impacts (relative to respondents with less global sourcing). Monczka & Morgan (2000) concludes that low-cost is no longer the only reason for why companies outsource. Many companies see possibilities for development of better product features or better management of capital resources. Preston (2004) also discuss a number of other reasons including that political and regulatory environments in many countries have been improved (most notably in China). Moreover, flexibility and skill-levels of local labour markets have increased.

3.4.4. Costs of Global Sourcing

Over the last twenty years or so, steady yet significant changes have occurred in global sourcing strategy. The cost-saving justification for international procurement in the 1970s and 1980s has been increasingly supplanted by quality and reliability concerns in the 1990s (Kotabe, 1998). A review of global sourcing literature concluded that many managers view international sourcing as a quick means to achieve short-term cost advantages without regard to a sustainable competitive position (Murray, 2001). Not surprisingly, researchers have concluded that unit price reduction, although not necessarily total cost reduction, is the main outcome of international purchasing (Petersen et al., 2000).

Levy (1995) suggests that disruptions to an international supply chain can generate substantial and unexpected costs when shipping and lead times are long. The costs take the form of expedited shipping, high inventories and lower demand fulfilment. Demand-related disruptions were the most important source of instability in terms of production shortfalls and demand fulfilment. Managers will frequently underestimate the costs of international sourcing. Not only are these costs hard to quantify, but they are also difficult to anticipate.

3.4.5. Hidden Costs of Global Sourcing

Fagan (1991) distinguishes between direct and indirect (i.e. hidden) costs for global sourcing. The direct costs increase due to costs of overseas travel and communication, agents' and brokers' fees and distribution costs. The indirect includes increased inventory levels as a consequence of longer lead times, rework of products, increased

paperwork (administrative), cash flow issues and exchange rate issues (financial), strategic business risks (e.g. loss of core competence), and political turmoil.

Howell and Soucy (1991) clearly point out that there are two main problems with the cost information that companies use to make decisions. First, the existing product-cost information used to compare outsourcing and overseas production alternatives is often wrong. Second, cost analyses rarely recognize the hidden costs of international business. Shifting production overseas often drives many hidden overhead costs, such as purchasing, scheduling, communications, poor quality, higher inventory and less flexibility. The authors argue that the information about production costs for outsourcing and overseas production often is wrong, which leads to an over-costing of high-volume products. Furthermore, hidden costs increase with global sourcing. Issues like purchasing (takes longer time), scheduling, communications, poor quality, higher inventory (due to lead-time), less flexibility are all sources of hidden costs.

Lowson (2001) states that in comparison to domestic sourcing, global sourcing has inflexibility costs and hidden costs. “The operational strategy of purchasing, procurement, and sourcing has assumed a great deal of importance for many companies. But those seeking low unit cost of goods from offshore sources as their principal goal could be in for a big disappointment if they fail to consider flexibility, responsiveness, and other advantages available from local suppliers.” (Lowson, 2001:66).

3.5. *Sourcing Models and Frameworks*

Meixell and Gargeya (2005) developed a comprehensive literature review on global supply chain design models. They summarize that models developed prior to 1990 focus on global plant location problem. Models developed in the 1990-1995 period continue the emphasis on the plant location issue and pay attention to transportation issue, infrastructure, lead-time, currency fluctuation and supplier selection criteria. Models developed in the 1996-2000 period consider price as a variable and reconsider the plant location issue. Models developed since 2000 take global sourcing as a part of global supply chain strategy and that global sourcing is linked with marketing. They conclude that:

- Global supply chain models need to address the composite supply chain design problem by extending models to include both internal manufacturing and external supplier locations.
- Global supply chain models need broader emphasis on multiple production and distribution tiers in the supply chain.
- Performance measures used in global supply chain models need to be broadened in definition to address alternative objectives.
- Finally more industry settings need to be investigated in the context of global supply design.

Their main conclusion is that most models aims to solve a difficult problem related to globalisation, but few of them address the practical global supply chain design problem at a more comprehensive level.

Jin (2004) tries to find the ideal point of postponement and speculation to minimize the cost/agility trade-off meaning a mixed sourcing strategy of global and domestic global sourcing. Vestring et al. (2005) propose spreading foreign operation and outsourcing relationships over a broad, well-balanced mix of regions and countries to reduce risk and increase potential reward. For example, Hungary's labour cost is almost quadruple China's, but it can be better for Western European companies looking to offshore skilled manufacturing.

These models provide a comprehensive list of factors to consider when companies source their products or services globally and help us understand the concept of global sourcing. However, within the risk literature some more comprehensive models dealing with the sourcing process can be found.

Cousins et al. (2004) argue that the literature so far is weak when it comes to environmental supply chain initiatives in practice. Furthermore, no one has yet provided a more comprehensive approach to recognise and manage the risks involved in environment-related supplier initiatives. Therefore, the authors present a conceptual model for risk in environment-related supplier initiatives. In the model the types of exposure of environmental-related risks, how the types are perceived by the managers, and the strategic level of the purchasing function are linked to each other.

When presenting the model, it is argued that the more “advanced” and strategic the purchasing function is, the more likely it is that the company will undertake environment-related supplier initiatives.

3.6. *Requirements for Global Sourcing*

Based on a survey among companies using global sourcing, Trent & Monczka (2003) identify a number of critical success factors, which are summarised below:

- Personnel with required knowledge, skills, and abilities
- Availability of required information
- Awareness of potential global suppliers
- Time for personnel to develop global strategies
- Availability of suppliers with global capabilities/suppliers interested in global contracts
- Ability to identify common requirements across buying units
- Operations and manufacturing support/internal customer buy-in
- Direct site visits to suppliers

Based on the same survey presented in Trent & Monczka (2003), and additional case studies on 15 companies, Trent & Monczka (2005) lists the following sets of characteristics for companies with successful global sourcing:

- Commitment at an executive level to global sourcing
- Rigorous and well-defined processes
- Availability of needed resources
- Integration through information technology
- Supportive organisational design
- Structured approaches to communication

- Methodologies for measuring savings

Fagan (1991) address a number of important “global guidelines” to consider. These include the need for top management commitment, total cost – and not only direct costs – should be evaluated, relationships based on trust and respect should be developed with the foreign suppliers, the usage of technologies that enhance control should be used. Furthermore, ways to handle business risks, i.e. contingency plans, should be developed.

4. Case Studies

This section presents the results from the case studies and the discussion on the findings and their implications. We begin with summarising each case based on the primary data collected and supported by some secondary data in section 4.1. In each case we analyse the main objectives of the research and examine the companies' global sourcing strategy (GSS), supply chain risks, tools and techniques to measure the risks of its global sourcing decisions and finally we examine how and in what way the case companies consider the environmental and infrastructural implications of their GSS, an area where there was often hesitation. Managers were conscious that environment was an important (topical) issue but not one that they were explicitly expected to address. Some managers were not even sure if they had a department to address environmental issues, others suggested that this was not top priority in their GSS. In terms of transport and logistics, again there was some hesitation in answering questions on the implications of their GSS to the UK's transport infrastructure, because this was not factored in the GSS decision making, or it was not the decision of the managers we interviewed, rather the accountability of their logistics service providers.

Through a cross-case analysis we compare the main themes and patterns that have emerged as a result of the investigation. We found that the hesitation to answer questions relating to the environment and infrastructure was a common amongst managers from most of the companies interviewed. Another commonality was the lack of ownership of risk in the global sourcing decision. These issues are explored in depth in section 4.2.

4.1. Case Summaries

| Case A | Industry Sector: Retail Role of Interviewee: Global Sourcing Director |
|--|---|
| Global Sourcing Strategy (GSS) | Case A believe that they are a driver in leading change; their global sourcing strategy reflects this which is largely driven by its customers. Their sourcing portfolio is changing rapidly because the global market place has evolved so much over the last few years. However, in some product areas they are now sourcing more from Europe rather than the Far East because of emerging markets and changes in consumer behaviour. On the other hand it is exploring new sources in the Far East where capabilities are stronger. i.e. Vietnam, Madagascar, Shanghai. The sourcing strategy is determined by the product category for example quick response items are sourced primarily from Turkey, but new opportunities are arising from Bulgaria and Romania as they enter the EU. Other categories are sourced 95% China. some categories are planned to be sourced more from Britain to promote the local businesses. |
| 'Positives' of GSS | Spreading risks – range of factories that can produce the same products at varying lead times and costs. Increased number of options to source from. Direct sourcing |
| 'Negatives' of GSS | Do not have a panoramic view of the supply base, and have not always found the right supplier. Large number of suppliers, hence, supply base is being consolidated. Maintaining control of factories. Communication with suppliers, lack of visibility. 'If you get it wrong direct sourcing could go very wrong'. |
| Main Mode of Transport | Mainly sea freight, depending where products are procured from. Quick turnaround products are moved by road. Airfreight is used for strategic products only and this 0.1% of everything moved. |
| Key Priorities of Global Sourcing Strategy | <ul style="list-style-type: none"> • Reliability of product • Shipment on time • Right product • Delivered on time |
| Supply Chain Risk Management Tools & Techniques | <p>Risk management is an integral part of the global sourcing decision-making.</p> <p>Supply management programme is a standard tool kit and enables decision-makers to identify how to best deal with the capabilities from the supply base and how to document performance.</p> <p>Key performance indicators enable Case A to analyse key suppliers performance. The risk review is completed every 3-6 months and supplier scorecards are developed to assess the performance.</p> |
| Major Risks Identified in Global Sourcing Decisions | <ul style="list-style-type: none"> • Factories are ethical and not breaking civil law. • Communication with global supply base – do they truly understand company philosophy and product requirements • Miss opportunities which competitors can exploit • Lack of visibility |
| Environment & Infrastructure Considerations | <p>Aim to reduce CO₂ emissions by 60% by 2010</p> <p>Sponsoring sourcing locally and closer i.e. Europe</p> <p>Initiatives such as reducing the price of energy bulbs</p> <p>Not enough choice for transportation, UK rail network is poor and unreliable.</p> |

Case B**Industry Sector: Fashion Wholesale
Role of Interviewee: Supply Chain Director****Global Sourcing Strategy (GSS)**

The global sourcing strategy is a decision based on a combination of sourcing from the right place, for the right quality, for the right price. Global sourcing is driven by the need to continuously innovate and develop products in strategic locations. Case B are not vertically integrated and do not own manufacturing, but have established key supplier relationships to manufacture their portfolio of brands.

Although the majority of sourcing is from the Far East, high end, aspirational products will be sourced more from suppliers in Europe, which have exclusive, distinctive handwriting because individuality and high quality is difficult to source from the Far East.

Case B's long-term initiatives include sourcing closer to home for their products. However, this is a strategic decision which means sourcing the right product from the right place, because this will ultimately involve more cost, which means that this will be for a different sort of product, which you can't source from the current suppliers or it is too risky too source or the lead times are too long. These issues are all key to driving the long-term sourcing strategy.

'Positives' of GSS**Positives**

- More control of supply base by focusing on the Far East and consolidating the supply base.

Negatives

- Time issues because of the geographical location of suppliers
- Shipping time
- Distortion in information/requirements to Far Eastern suppliers, not understanding/driving the brand strategy

'Negatives' of GSS**Main Mode of Transport
Key Priorities of Global Sourcing Strategy**

The mode of transport used is primarily ship and truck. However the current transportation of goods often bypasses the final destination and lengthens the lead-time and increases environment and financial costs. Often goods are flown to partners in America because they required JIT delivery.

- Quality
- Lead time and Cost
- Flexibility

Supply Chain Risk Management Tools & Techniques

There is no formal risk management process or a risk management team. However, the company uses critical paths and process mapping to identify and manage risks. Critical paths enable key decision makers to map out the entire critical path for a product and then identify where the risks could be and manage those risks. The way that that the process works is that 99% of the products are sourced globally, the particular management teams for that brand or product will develop a critical path from end-to-end in the supply chain, this enables them to view product risks, transport risks etc, which they can mitigate. The critical path process is amended around those risks to lessen the impact and likelihood of risks.

Major Risks Identified in Global Sourcing Decisions

A major risk to the business is that Case B have no formal risk management structure or contingency plan. Hence, in case of a supply chain disruption, the company is not prepared for unexpected risks and have no formal strategy or process of managing such risks.

In addition, Case B is dependent on a number of key suppliers to develop their products; this puts the company at great risk, because there is no back up supplier if something was to go wrong.

Environment & Infrastructure Considerations

Case B sources 99% of their products globally, which are shipped worldwide with significant implications transport, which the company recognises. Working together with their shipping managers, Case B is in the process of making their logistics more efficient and less costly to the environment by shipping goods directly and not bypassing the destination. The policy that the company is working to achieve is to ship their products as opposed to flying them around the world.

The use of chemicals such as fabric dyes in the factories is also of concern to the company.

Risks associated with Transport infrastructure will come up on the critical path analysis that is done for each product. These are then communicated to the shipping managers that manage the risks. The shipping managers then have good transparency of where the product is.

| Case C | Industry Sector: Consumer Electronics Role of Interviewee: Supply Chain Strategy Manager |
|--|--|
| Global Sourcing Strategy (GSS) | <p>Case C sources products globally from: USA, Asia, Europe and Latin America. Manufacturing is fully outsourced to contract manufacturing in Asia, Latin America and Europe and Brazil but only for postponement activities. The main components of their global sourcing strategy are:</p> <ul style="list-style-type: none"> • Continuous Innovation • Provide technology at affordable prices • Provide a full portfolio of products for Imaging and Printing. <p>The strategic decision making process for sourcing is:</p> <ul style="list-style-type: none"> • Supply Chain Group analyzes potential cost reduction opportunities for a given Service Level • Supply Chain and Manufacturing Organization establish a pilot for sourcing • Operations run the pilot • After evaluating results against assumptions the location is chosen |
| ‘Positives’ of GSS | <p>Positives</p> <ul style="list-style-type: none"> • Low Costs • Possibility to establish local agreements under a bigger umbrella for a global service suppliers (like 3PLs) |
| ‘Negatives’ of GSS | <p>Negatives</p> <ul style="list-style-type: none"> • Lost of flexibility, longer response time • Operational Risks (Inventory, Lost of Sales, Damages) • Strategic Risks (dependence on other countries’ economy) |
| Main Mode of Transport | <p>The mode of transport used is primarily ship and the factors taken into account when choosing this mode of transport are the cost per unit and the lead-time. However the company envisages that transportation via air is likely to increase for some products if rates continue to decrease, but shipping goods will remain the primary mode of transport</p> |
| Key Priorities of Global Sourcing Strategy | <ul style="list-style-type: none"> • Quality • Cost • Flexibility |
| Supply Chain Risk Management Tools & Techniques | <p>The <i>Procurement Risk Management</i> (PRM) organization is responsible to set guidelines and to provide consulting and training for Manufacturing and Logistics Organization when dealing with suppliers.</p> |
| Major Risks Identified in Global Sourcing Decisions | <p>Major risks are classified as the following:</p> <ul style="list-style-type: none"> • Geographical Concentration Risk • Transport Risks (oil prices, accidents) • Economic risks (on those countries hosting the suppliers and factories) • Availability Risk (supplier business continuity) • Price Risks (negotiation power) • Demand Risk (impact of demand falls on longer pipelines) |
| | <ul style="list-style-type: none"> • Corporate policies: CMs are managed globally so the agreements are established on a worldwide level, in this case the policies must be respected no matters the location the CM is operating • Reverse Logistics - Local suppliers for reverse logistics are being developed. |
| Environment & Infrastructure Considerations | <p>As a consequence of their global sourcing decision, risks of environmental damage are identified based on the guidelines for environmental responsibility</p> <p>For Latin America there is a bottleneck currently due to a lack of investments on infrastructure, so global sourcing has a limit to growth unless there is a change in current investment levels. To assess the risks of the transport infrastructure, in terms of the Global sourcing decision for America, Latin America, the company considers the expected volume of inbound products and the capacity available in ports, roads and airports, The expected investment and economic impact on such level of investment are also considered.</p> <p>The risks of failure in their transport network are managed by identifying and maintaining other potential locations and routes as alternatives. The suppliers are engaged in the risk management plan related to transport network</p> |

Case D**Industry Sector: Consumer Electronics
Role of Interviewee: Supply Chain Manager****Global Sourcing Strategy (GSS)**

The GSS is driven by cost, however currently 95% of products are manufactured in Europe and only 5% in North America and Asia. The company is planning to increase its sourcing more from LCM such as Far East and Eastern Europe.

Sourcing decisions are made by product line to decide which factories will manufacture which products based on cost.

The company mainly distributes to key accounts directly, from factory to end customer warehouses, this significantly reduces the risk of any disruption in the logistics pipeline.

‘Positives’ of GSS

- Direct distribution to customers
- Low costs

‘Negatives’ of GSS

- Lead time
- Silo mentality – departments working in isolation, no transparency in the supply chain

Main Mode of Transport

By sea for globally sourced products and by lorry throughout Europe

Key Priorities of Global Sourcing Strategy

- Delivery on time
- Low costs
- Quality

Supply Chain Risk Management Tools and Techniques

As the company works in a silo mentality the supply chain manager was not able to tell us if any supply chain risk tools existed in the company, however a more subjective approach to risk assessment was conducted for managing the supply chain by looking at the possible impact or likelihood scenarios of decisions made by the supply chain manager.

Major Risks Identified in Global Sourcing Decisions

The company’s main concern is the transportation of products because, it is not able to utilise fully the different means of transport that are available due to lead time pressures. It would like to use rail more but finds it too unreliable.

Environment & Infrastructure Considerations

Maximising the most efficient route to transport products to customers using the most efficient mode of transport is currently a challenge. Because the company is working to tight lead times, the company is not able to utilise other forms of transport.

Because of lack of transparency in their supply chain they do not have visibility of information costs, distribution costs, economic costs etc so are not able to conduct a total cost assessment of their sourcing decisions.

Despite having an environmental department, to date there has not been much focus on carbon footprint of their supply chain and the environmental impact has not been factored into the sourcing decisions.

| Case E | Industry Sector: Mechanical & Electrical Equipment Role of Interviewee: Logistics and Supply Chain/ Low Cost Manufacturing Project Team |
|--|---|
| Global Sourcing Strategy (GSS) | <p>GSS has been mainly driven by low cost sourcing, and this has taken place in the last 12 months. So low cost sourcing is a new strategy for the business and is a response to marketplace requirements. The company terms their offshoring strategy as ‘product transfer’ to LCM and have created a low cost manufacturing project team to develop this strategy and manage the benefits and risks. This team is responsible for the transfer programme and they take a holistic approach by mapping out a critical path of activities which includes manufacturing, supply chain and logistics. In addition a logistics council has been established to co-ordinate logistics activities. Currently 40% of products are manufactured and finished globally, this will grow to 70% by the end of 2008.</p> |
| ‘Positives’ of GSS | <ul style="list-style-type: none"> • Cost • Quality • Capacity • Good transport infrastructure in China |
| ‘Negatives’ of GSS | <ul style="list-style-type: none"> • CSR • Reliable supply chains in China • Product transfer is still a new strategy for the company , so changing company culture can be a risk to the strategy and understanding the true benefits vs Total costs is important |
| Main Mode of Transport | <p>By road within China, shipped from China, and currently some products are transported by air from UK to China, because of some wrong decisions of what the company was going to manufacture and what they were going to buy from China.</p> |
| Key Priorities of Global Sourcing Strategy | <ul style="list-style-type: none"> • Low cost manufacturing (LCM) • Responsive supply chain- to product variants • Vendor reliability • Quality |
| Supply Chain Risk Management Tools & Techniques | <p>The company is increasingly aware of managing supply chain risks, particularly now with their shift to product transfer to LCM, and has set up a LCM project team to manage the risks associated with low cost sourcing decisions.</p> <p>There are no specific tools to manage risks however the general approach to brainstorming the critical risks that could impact their business and process mapping are used widely.</p> |
| Major Risks Identified in Global Sourcing Decisions | <p>A major risk to the company is their customer not understanding what LCM means and the increased lead times for products. Product variants also pose a risk with LCM. In addition, product management decisions are critical and must be planned upfront. Understanding what product to transfer is a risk, because if the total costs/risks are high is it beneficial to source from LCM? Other risks identified are:</p> <ul style="list-style-type: none"> • IPR • End-to-End costs • What products to transfer |
| Environment & Infrastructure Considerations | <p>The company is looking at ways to improve their communication with their 3PL to mitigate logistics risks. They are also aiming to consolidate loads in 2007 when their product transfer is higher so that transport can be streamlined. Currently the company has various routes for transporting goods to their locations; this is costly, lead-time and probability of risks increase.</p> <p>The company aims to reduce the carbon footprinting of their products as they collaborate with their 3PL to consolidate their logistics so that there are less containers being shipped across the continents.</p> <p>Their long-term aim is to simplify the number of suppliers they have providing international logistics</p> |

| Case F | Industry Sector: Mechanical & Electrical Equipment Role of Interviewee: Materials & Inventory Manager/Project Manager |
|--|---|
| Global Sourcing Strategy (GSS) | <p>The company's GSS is driven by two key factors:</p> <ol style="list-style-type: none"> 1. to source from low-cost regions (LCS) 2. to source from areas where the company manufacturers and has a market presence i.e. China – for supply chain optimisation/efficiencies |
| 'Positives' of GSS | <p>This is underpinned simply by the philosophy of sourcing the right quality at the right price. The majority of products are manufactured in the UK, with around 30% final assembled and tested in China for the China and Eastern markets. Some niche products are manufactured globally and sourced locally to where they are manufactured. The company envisages that globally sourcing will increase in the next five years to satisfy their product portfolio, and develop their supply chain to source where it is appropriate for the product in terms of low cost, quality and closer to market.</p> <ul style="list-style-type: none"> • Higher quality sources in China • Availability of specialist technology • Manufacturing in markets local to source |
| 'Negatives' of GSS | <p>A major disadvantage recognised by the company is that at the early stage of the product lifecycle long lead times caused by GSS can be a problem if a design or quality issue becomes apparent midway, they have committed to stock which could be flawed in its design or quality. Others are:</p> <ul style="list-style-type: none"> • Liabilities within the supply chain • Lack of visibility |
| Main Mode of Transport | <p>Mainly by ship, but often air freighted if required for shorter lead time on some products</p> |
| Key Priorities of Global Sourcing Strategy | <ul style="list-style-type: none"> • Cost • Efficiencies – shorter lead times - more responsive supply chain |
| Supply Chain Risk Management Tools and Techniques | <p>Supply chain risks are managed collectively by the operations, purchasing/sourcing and materials department. There is no risk department. Members from each department will assess the various risks of their sourcing decisions within the context of the project specific risks. For example the risk assessment of existing suppliers and the risks that may occur from a change in a source or manufacturing in a different way.</p> <p>A risk matrix which acts as an aide memoire is used to identify project specific risks collectively and therefore what actions need to be planned and taken to mitigate and manage the risks.</p> <p>The company is looking to develop additional tools to help manage certain risk areas as a consequence of their GSS.</p> |
| Major Risks Identified in Global Sourcing Decisions | <ul style="list-style-type: none"> • Reduced flexibility • Increased inventory • Continuity of supply • IPR • Maintaining quality |
| Environment & Infrastructure Considerations | <p>Risks have increased for variant items which are just used on certain machines or certain spares, these are more difficult to forecast in terms of how much stock the company needs to hold to support unforecastable customer demand</p> <p>Transportation issues and risks are currently managed by the company's logistics providers. However the company aims to work closer with their logistics providers to share information on where risks are and how the logistics providers intend to manage them so that the company is more aware of the things that could go wrong.</p> <p>The company has increased its awareness of environmental and ethical issues, and the aim is to look at these in more depth</p> |

Case G**Industry Sector: Fashion Retail****Role of Interviewee: Design Director & Design Team, Supply chain Manager****Global Sourcing Strategy (GSS)**

A truly global company with a global supply base. The GSS to the Far East is purely driven by cost and to benefit from economies of scale, and to Turkey for lead-time. There are the two main supply bases which are close partners and joint ventures. However, other sources, such as India, Portugal, Romania act as contingency of suppliers for certain products which cannot be sourced from the two main sources because of a particular capability.

A global supply base geographically dispersed in this manner gives the company flexibility to take advantage of both lean and agile supply chain. This also gives the company power of sampling products in two or three sources before committing to an order which can provide best cost or lead-time.

'Positives' of GSS

- Flexibility in Supply Chain
- Cost
- Capabilities and skills not available in local or other sources

'Negatives' of GSS

A key negative implication of the GSS would be suppliers not understanding project briefs, and not delivering on time. However, the company has built strategic supplier relationships to mitigate such risks. Other downsides would be the lead times for products from China as the company is forced to respond to short product lifecycles and to design as close to customer requirements as possible.

Mainly sea and by road in Europe and UK.

Main Mode of Transport**Key Priorities of Global Sourcing Strategy**

- Delivery on time
- Understand product requirements
- Cost
- Flexibility

Supply Chain Risk Management Tools and Techniques

At present there are no specific tools to manage supply chain risks, project specific risks are assessed by different departments which work through a critical path approach, for example design will assess features that could cause problems in manufacturing, whether the design can be manufactured by a particular supplier, or if it is not a current design etc. Purchasing will also work with design to assess appropriate sourcing options, as well as assessing the risks of supply base capabilities etc. however other departments are not so well integrated.

Major Risks Identified in Global Sourcing Decisions

Two major risks identified by the company are:

- Lead time
- Copyright of designs

These risks have increased because of their GSS, and are critical to the business because their competitive advantage lies in bringing fast fashion to the market – the right design at the right time. If competitors copy design ideas, the risk is that they can launch their version in stores before the company even has a chance to manufacture it and thus risk holding obsolete stock

Environment & Infrastructure Considerations

The company does consider the impact that manufacturing of their clothing has on the environment in those countries such as the dyeing and printing of their products and has a ethical trading policy which it regards with importance, however it is more a priority to be a fast fashion and low cost company rather than one which is environmentally friendly

Case H

Industry Sector: Mechanical & Electrical Equipment
Role of Interviewee: Global Sourcing Director
Global Sourcing Strategy (GSS)

Global sourcing strategy is driven by innovation. Case H are market leaders and innovation gives them competitive advantage. Because of their GSS, the company aims to use their supply base more as a source of this innovation. This is achieved through:

- Negotiation
- Supply change
- Specification change
- Low cost country sourcing
- Volume pooling

The company is presenting many of different market segments from high value adding innovation to low cost, it has designed in flexibility in its supply chain to respond to their market segments, so that they can be present in different markets.

Products currently mainly sourced from Europe with around two thirds of the procurement spend and some from US and a little from China. The GSS is set to change in the next five years: more sourcing from China and move from Western Europe to Eastern Europe

'Positives' of GSS

- Flexible sourcing
- Low cost
- Innovation

'Negatives' of GSS

Currently, the supply chain is too dispersed. Suppliers are not close to the market and this increases their carbon footprint. The size and weight of the products that are being transported are so big which limits them to mode of transport, which can be costly.

Main Mode of Transport

Mainly use trucks in Europe, ships from the Far East, but also use a lot of airfreight for some very big machinery which is required from very long distances in a short time.

Key Priorities of Global Sourcing Strategy

- Innovation
- Quality
- Delivery
- Price/Cost

Supply Chain Risk Management Tools and Techniques

The company has a risk department and a risk manager for the company as a whole but this has not been extended throughout the organisation to manage project specific risks, it was more general overview of what could impact the business as a whole. In the last 12 months, this has changed sourcing and purchasing departments now developing project risk assessments.

The risk process for project specific risk assessment is a matrix which measures the size of spend against the complexity or the risk of spend. This also enables teams to decide between make or buy decisions based on the level of risk to the company.

Major Risks Identified in Global Sourcing Decisions

- Single sourced- dependent on suppliers who are unique in their area
- Suppliers are dispersed too far from market place, so increases carbon foot printing
- IPR- this is a major risk, the suppliers own the IPR and because they are single sourced they cannot switch suppliers easily. Where the company owns IPR there is a risk of other companies/suppliers copying ideas, this is a huge risk as the company invests heavily in innovation and R&D

Environment & Infrastructure Considerations

The challenge for the organisation is to meet the global needs of their market places, and this is achieved in the supply chain by minimising costs and/or lead-time. Environment although recognised as important is not a priority, because ultimately the company is focused on efficiencies demanded by their customers which are not concerned about the impact this has on the environment.

In terms of risk management, the company is more concerned about dealing with risks to supply as opposed to risk to the environment.

The company aims to address their logistics problems of shipping and flying their products globally and they have a company policy which says where possible and appropriate minimise the effect on the environment.

| Case I | Industry Sector: Oil/Gas Role of Interviewee: Global Distinguished Advisor |
|--|--|
| Global Sourcing Strategy (GSS) | <p>An approach defined as procurement supply chain management which means that the company fulfils demand for goods and services to the local market place to obtain maximum impact in terms of performance value, cost and safety. It is service and technology driven</p> <p>Many decisions are governed by JVs, regulations and host governments.</p> <p>Some global deals with global suppliers</p> <p>Standard global model contracts and global measures of performance.</p> <p>No major changes in strategy (past + future)</p> |
| ‘Positives’ of GSS | <p>Positive: potential for new suppliers, secure supply; not driven by price (too much risk)</p> |
| ‘Negatives’ of GSS | <p>Negative: lack of quality; lack of integrity; some countries demand local content</p> |
| Main Mode of Transport | <p>Transport mode: depending on nature of material/component; sea for raw materials like chemicals and cement; road from own supply point; air for urgent components. Milkrun for platforms</p> |
| Key Priorities of Global Sourcing Strategy | <ul style="list-style-type: none"> • Performance value • Cost • Safety |
| Supply Chain Risk Management Tools and Techniques | <p>Risk management lies in balancing demand and supply; based on capabilities of the supply market</p> <p>Level of risk is continuously assessed based on quality, safety and technology</p> <p>Use of standard methodology, ‘what if’ scenario planning.</p> <p>Have a cross functional team to evaluate risks</p> |
| Major Risks Identified in Global Sourcing Decisions | <ul style="list-style-type: none"> • Poor supplier reliability • Quality • Supply integrity • Governed by local regulations so restricted to use local sources |
| Environment & Infrastructure Considerations | <p>Have considered environmental implications but it is not considered a huge issue (not so much transportation)</p> <p>Have a code of conduct detailing how to deal with stakeholders</p> |

| Case J | Industry Sector: FMCG Food & Drink Role of Interviewee: Global Sourcing Director |
|--|---|
| Global Sourcing Strategy (GSS) | <p>The sourcing strategy is based on balancing cost and customer service. The sourcing strategy is determined by type of products: bulky products (e.g. detergents, paper, etc) are sourced locally to reduce logistics costs; small high value products are produced in a few factories and then distributed around the world.</p> |
| 'Positives' of GSS | <p>To make the sourcing decisions the company looks at sales projections and service level requirements from different regions, then they look at local supply availability and import tariffs and duties, and finally at the capital costs involved. Find a balance between cost and service levels. 90% of product comes from within the EU. In the future, Easter Europe is more likely to develop.</p> <p>Contracts and supplier relationships vary in length. Tend to use short-term contracts (and relationships) for commodities and long-term for strategic supplies.</p> |
| 'Negatives' of GSS | <p>To optimize total delivered cost (logistics and manufacturing)</p> <p>Difficult trade-off between cost and service</p> |
| Main Mode of Transport | <p>Road is the dominant source of transport (95%). Rail takes the rest Rail is not used for deliver to customer because of long lead-times and poor reliability</p> |
| Key Priorities of Global Sourcing Strategy | <ul style="list-style-type: none"> • Customer service • Cost • Quality |
| Supply Chain Risk Management Tools and Techniques | <p>There is a health and safety organization focused on looking at risks at the plants.</p> <p>There is a business continuity plan for every plant, which the plant engineer is responsible for. This includes risks at suppliers.</p> <p>Business continuity planning and health and safety analysis are used to assess risks</p> <p>Generally use dual sourcing or multiple sourcing to mitigate supply risks. For most products they have several plants so can source form another one in case of a disruption</p> |
| Major Risks Identified in Global Sourcing Decisions | <p>Since most of the product comes from EU. The company finds that there is not much risk of global sourcing</p> |
| Environment & Infrastructure Considerations | <p>Environmental issues are in line with the company's economic necessities, and the company aims to minimize transport as much as possible. The company looks for a high vehicle utilization (90% +). The network is designed to minimize transport and achieve high utilization.</p> <p>Life cycle analysis is conducted when designing new products. They try to design new products to have the minimum environmental impact.</p> <p>The company primarily use road and road congestion is a big issue. Rail is not always appropriate, firstly because rail is not as flexible as road, but also because it is not as reliable and not always more cost effective. All of our plants have rail connections, but they are not fully utilised.</p> |

| Case K | Industry Sector: FMCG Food & Drink Role of Interviewee: Distribution Manager |
|--|---|
| Global Sourcing Strategy (GSS) | Global sourcing decisions are made by the supply chain team which involves commercial, procurement, technical and supply chain functions. The strategy is climate driven; in the summer 95% percent of the product is sourced from the UK, in winter 100% comes from abroad. Current average spend 60% sourcing locally; 40% from abroad. This is not likely to change in the future. The company own farms in UK, Portugal, Spain and Kenya. In the USA they have developed close relationships with partners (Florida, Arizona and California). Also buy in the spot market in Italy and France. Product has a shelf life of 8 days and retailers require a minimum of 5 so they operate stockless supply chain. Total lead-times are between 24-36 hours from all sources. |
| 'Positives' of GSS | Positive: Guaranteed supply base year round; Mirror image crops (UK & abroad); quick lead-times, stockless supply chain |
| 'Negatives' of GSS | Negative: Food miles (flying product from Kenya and USA); differences in technical standards (USA suppliers have lower standards) |
| Main Mode of Transport | Mode of transport: Road (Europe – Mainly Portugal and Spain); Air (Kenya and USA – occasionally from Europe in case of emergencies) In making global sourcing decisions they look at product characteristics, production standards (pesticides, etc.), lead-times and price Criteria for choosing suppliers include: reliability, capability (Farming & Technical), good communication, financially stability, trust (open and honest suppliers and good understanding of our demands) |
| Key Priorities of Global Sourcing Strategy | <ul style="list-style-type: none"> • Reliability • product integrity (i.e. quality) are key. • Cost, • flexibility and lead-times are also important. |
| Supply Chain Risk Management Tools and Techniques | No formalized processes or tools for managing risk. It is all based on experience. Supply chain design contributes to reducing risk: long standing relationships; stockless approach reduces some risks, high levels of control of the supply chain. Distribution manager responsible for supply chain risk The main strategy for managing transport risk is direct control of all the transport and customs. Two audits per year are conducted at suppliers to ensure that standards are being met. This helps to ensure product integrity. |
| Major Risks Identified in Global Sourcing Decisions | Main risks of global sourcing are reliability of airfreight and road congestion. Product integrity as quality problems can be very serious. For this reason steps are taken to ensure that standards are met, primarily through supplier selection and auditing. |
| Environment & Infrastructure Considerations | Have an environmental team (working for 18 months) which started from a project with M&S. Main environmental risks are related to CO ₂ emissions: Air miles, vehicle utilization and fuel efficiency They have performed lifecycle analysis for all products, from farm to delivery to retailer. No major transport infrastructure issues in the UK |

Case L**Industry Sector: Aerospace
Role of Interviewee: Commodity Director****Global Sourcing Strategy (GSS)**

Global sourcing strategy is to source high volatility parts close to home and low volatility / high volume in low cost countries. Main reasons to go abroad are to satisfy powerful customers. Also need to establish a market in China (growth) In the future, the company expects the GSS will change because of cost pressure; they will increase international sourcing based on capabilities; better corporate coordination; implementation of low cost sourcing strategy.

'Positives' of GSS

- Capability
- Counter trade
- Cost

'Negatives' of GSS

- Lead times
- Cost of transition
- Maintenance of relationship
- Only suitable for some segments

Main Mode of Transport

Various modes of transport: Air for high value components (e.g. . avionics) , mainly sea for low value / high volume, road in certain cases

Key Priorities of Global Sourcing Strategy

- Quality
- Delivery Responsiveness
- Cost

Supply Chain Risk Management Tools & Techniques

No formalised process for global sourcing related risks (maturity of organisation). Recognise this increases risk

Process for managing risks depend on the type of risk (e.g. Quality through SPC; Obsolescence through engineering solutions)

Commodity managers are responsible for managing risks related to their own commodity.

Major Risks Identified in Global Sourcing Decisions

- IPR
- Quality
- Damage to products to obsolescence
- Reliability and flexibility of vendors

Environment & Infrastructure Considerations

No specific environmental and ethical trading policy, however the company encourages ISO14000

| Case M | Industry Sector: Aerospace Role of Interviewee: Global Sourcing Manager |
|--|---|
| Global Sourcing Strategy (GSS) | <p>Global Sourcing strategy: to explore advantages of global sources and use it as a lever with current local suppliers. Strategy influenced by politics and offset. Functions involved in global sourcing decision: purchasing, logistics, customer facing, engineering, manufacturing & quality. Case M expect that in the future: emerging markets will develop and UK sourcing will decline</p> |
| | <p>Sourcing Spend: 60% UK; 40% abroad (US, Europe, Japan); 1 % from emerging markets</p> <p>A structured process for making global decisions is as follows:</p> |
| | <ol style="list-style-type: none"> 1. Look at customer requirements 2. Look at marketplace (availability) 3. Create vision around a commodity 4. Select suppliers 5. Implement |
| ‘Positives’ of GSS | <ul style="list-style-type: none"> • Capability • Total Cost |
| ‘Negatives’ of GSS | <ul style="list-style-type: none"> • Distance • Capacity • Quality issues • Difficult to set up suppliers • Cultural differences • Implementation Costs |
| Main Mode of Transport | <p>Road for local supplies; sea and air for overseas</p> |
| Key Priorities of Global Sourcing Strategy | <ul style="list-style-type: none"> • Delivery • Quality • Cost (all important) – used to select suppliers |
| Supply Chain Risk Management Tools & Techniques | <p>Clearly established risk management process. It is embedded into the purchasing process and is used in a variety of situations</p> <p>People: They have risk management process owners, although accountability remains with the buyers</p> <p>Tools: use risk profiles to map risks according to likelihood and implications</p> |
| Major Risks Identified in Global Sourcing Decisions | <p>Major risks: distance (more stretched chain), ensuring capacity and capability of suppliers, IPR, Cultural differences, difficulties in setting up new suppliers and their support network.</p> |
| Environment & Infrastructure Considerations | <p>Take CSR very seriously</p> <p>Some implementation of ISO 14000</p> <p>Looking at recycling issues</p> <p>Looking at using less airfreight</p> <p>Development of indigenous supply chains to avoid excessive movements</p> |

| Case N | Industry Sector: Consumer Electronics Role of Interviewee: Supply Chain Director |
|--|---|
| Global Sourcing Strategy (GSS) | The global sourcing strategy for hardware is to manufacture in the lowest cost region (lowest cost end-to-end) and customize in region; for software to make it available digitally. Main sources: China, Malaysia, Thailand. The global sourcing process focuses on looking at end-to-end cost (including tax, etc) use simulation to estimate; look at risks. |
| ‘Positives’ of GSS | <ul style="list-style-type: none"> • Leverage global demand with 1 or 2 vendors in low cost countries (i.e. economies of scale) |
| ‘Negatives’ of GSS | <ul style="list-style-type: none"> • lack of knowledge • lack of agility (loss of sales) • poor visibility |
| Main Mode of Transport | Sea |
| Key Priorities of Global Sourcing Strategy | Time to market |
| Supply Chain Risk Management Tools & Techniques | <p>The risk process centres on an analysis of complete supply chains which is evaluated against security and intellectual property which are both very critical to the business.</p> <p>Responsibility is on risk manager (team focused on assessing risk)</p> |
| Major Risks Identified in Global Sourcing Decisions | <p>Long replenishment times (agility in responding to demand); piracy, product hijacked, delays in transport (e.g. Customs); geopolitical risks; changes in tax regimes, changes in environmental requirements (ROHS, WEE), Piracy</p> <p>Look at security issues (e.g. loss of IP) stability of supply and geopolitical risks</p> |
| Environment & Infrastructure Considerations | Environmental issues are taken into consideration at the design phase of each product. An environmental team is 100% dedicated to monitoring global environmental requirements into the design phase and when selecting suppliers who are may be involved in manufacture or distribution of the product. |

Case O

Industry Sector: FMCG Food & Drink
Role of Interviewee: Global Sourcing Director
Global Sourcing Strategy (GSS)

Global sourcing is used as a strategy to reduce cost and deliver better product to the customer. Main sourcing countries include primarily from Western, Central and Eastern Europe (e.g. Poland and Czech Republic) and increasingly Asia (e.g. Thailand, China, Philippines) Global sourcing decisions are consultative. There is a Global sourcing team dedicated to making “global sourcing studies” and they have a structured methodology for doing so. This is a cross-functional team including logistics, manufacturing, finance people. 50% of spend is within UK 50% from abroad. It is expected that global sourcing will continue in the next five years to reach around 70% of spend.

‘Positives’ of GSS

Benefits: Reducing cost and gaining access to capabilities not found in the local country

‘Negatives’ of GSS

Negative: Long lead-times and higher inventory levels

Main Mode of Transport

Transport mode: road from Europe, from Asia by sea, no airfreight at all

Key Priorities of Global Sourcing Strategy

- lead-time
- flexibility
- cost

Supply Chain Risk Management Tools & Techniques

The global sourcing team is responsible for assessing risks as part of the global sourcing decision. These teams produce regular audits to determine the global sourcing capability of different suppliers. They can request support from other teams such as health and safety or customs experts to assess specific risks

Risks are managed through early expert assessments (avoidance) and inventory (mitigation)
Use of global suppliers with long standing relationships also helps to mitigate risk
All new processes are thoroughly tested before starting operations

Major Risks Identified in Global Sourcing Decisions

Two types of risk:

- Real: lead-times; transport risk (mitigated with inventory but cannot mitigate with airfreight)
- Perceived: loss of control (traditionally the company operated with regional supply chains)

Environment & Infrastructure Considerations

A variety of environmental issues are involved in the sourcing decision such as, packaging, use of plastics, lifecycle analysis & CO₂.

Risk to the environment is looked at from an innovation and new product point of view. The company wants the new product to be more efficient than the previous generation in terms of their carbon footprint and to be able to generate less waste throughout its life (e.g. intermediate packaging, product packaging, and disposal)

No formal assessment of CO₂ emissions at suppliers

4.2. Cross-Case Analysis

Each case study has been analysed using the techniques proposed by Ghauri (2004), what follows is a cross-case analysis – searching and comparing the cases for emergent themes, patterns of commonality and key differences. These are validated by triangulating our analysis with the focus group findings and with the expert opinion we sought.

4.2.1. Global Sourcing Strategy and Key Priorities From The Supply Network

For this part of the cross-case analysis, we asked the managers interviewed to discuss their global sourcing strategy (GSS) and assess the positives and negatives of their GSS decision making and the impact on their current supply base. We also asked them to discuss their key priorities from the supply base and how these were managed.

- **Globalisation of Supply Chains**

All the organisations we interviewed have global supply chains in terms of either outsourcing part of their business to overseas suppliers or wholly relying on offshore suppliers for their business. The fashion wholesaler (Case B) manufacturers 99% of their products offshore, which was surprising considering the volatility of fashion markets which require quick response. However, the company was conscious of the risks they faced with an extended supply chain and are currently reviewing their global supply chain strategy to mitigate and manage the risks.

“We don’t own any manufacturing, so we don’t have any choice but to outsource it...but then this does increase risk, because of the geographical location of our suppliers, we have got time issues, it is quite difficult to put across exactly what you want or what is wrong with some sort of product”

However, in line with Case B’s expansion plans, in the next five years the sourcing strategy is expected to change. North America is an important market and the Far East is a growing market, hence there are plans to expand sourcing in both these regions. Although the majority of sourcing will be from the Far East, high end,

aspirational products will be sourced more from suppliers in Europe, which have exclusive, distinctive handwriting because Case B believes it is still difficult to source these products from the Far East.

“Going forward we will be looking for sources closer to home for the right sorts of products. There is no point doing it for the sake of it, it's got to be for the right sort of product, because it's going to involve more cost”

Case B's long-term initiatives include sourcing closer to home for their products. However, this is a strategic decision driven by the following drivers:

- sourcing the right product
- from the right source,
- at the right cost

Surprisingly cost has least priority in their sourcing decision, because the company recognises that changing the strategy to source closer to home will ultimately be costly in the short term, but the fact that they are able to reduce risk in their supply chain by sourcing the right product for their markets from the best sources, means that in the long-term this is a more cost-effective sourcing strategy.

In contrast case E from the mechanical and electrical equipment sector has recently globalised their supply chain and the key driver behind their strategy is cost. Over the last 12 months case E has developed a low cost manufacturing project team to identify low cost sources suitable to transfer the manufacture of their products and benefit from low costs. This team is responsible for the transfer programme and they take a holistic approach to managing their low cost product transfer programme by mapping out a critical path of activities which includes manufacturing, supply chain and logistics. In addition a logistics council has been established to co-ordinate the logistics activities. Currently 40% of products are manufactured and finished globally. However, this will grow to 70% by the end of 2008.

“In our global sourcing strategy, a lot of management time is spent on trying to understand what the market place needs and how we can provide that through low cost manufacturing... but the key issue for us is can we get the supply chains in China set up to be reliable?”

Case E is going through period of significant change, by transferring the manufacture to low cost sources and developing new relationships, the company is conscious of exposing themselves to ‘new’ risks. However, products are being transferred periodically, which enables them to assess the performance and reliability of new suppliers.

In addition to cost, Case E discussed capacity and supplier skills as key factors which had a significant impact on their global sourcing strategy. However the quote below suggests that although the managers interviewed were happy to transfer commodity products they were cynical of introducing product variations to their new supply sources and as a result these are currently manufactured in their factories in the UK, closer to the design source.

“The more we put out there the cheaper the logistics come going back because we are able to take advantage of full container loads...we have a good chance of getting the Chinese supply chain to make sure the total cost is right. Whatever you do, don’t try and confuse them and don’t try and put in three or four variants...once you have got the procedure set, stick to it and you will get skill, you will get really good quality and you will get quite a quick turn around on fairly reasonable volumes.”

However, in Case H, also from the mechanical and electrical equipment sector, innovation is the key driver of their global sourcing strategy. As market leaders, innovation provides them with a competitive advantage and the company’s aim is to drive innovation from their global supply base which they are currently in the process of expanding to the Far East and Eastern Europe.

“We are number one in our small market. The only way that we are going to stay that way is through innovation and that’s what I’m driving, so that’s our strategy.”

Interestingly, a key reason for sourcing more globally is to reduce their carbon footprint by setting up manufacturing of their products closer to their markets. This decision has been taken by the global sourcing manager to control their supply network which is geographically far too dispersed and results in long lead times.

“By definition we are a long way from some of our markets so our carbon footprint has always been poor, and I am doing more and more sourcing in China and doubling the amount of business I do in China every year. I am increasing the supply chain...China for us is a great market so it makes sense to move much more towards there...We will also move from Western Europe to Eastern Europe much more.”

The fashion retailer Case G, on the other hand, has a well-established global supply chain. The GSS to China is purely driven by cost and economies of scale, to India for specific products and skills not available in other sources and to Turkey for lead-time. Therefore the company takes full advantages of combining both lean and agile approaches in supply chain management. There are two main supply sources which act more as close partners rather than suppliers. Their relationships with suppliers are built on trust and commitment. As the company operates in a volatile market, they require quick response, delivery on time and flexibility from their supply chain. For instance often a product designed by their Turkish suppliers could be produced in China to benefit from lower manufacturing costs; equally a design from the China suppliers could be made by their Turkish suppliers because a shorter lead-time is required for that particular garment/design. This type of understanding with their global supply base is of paramount importance to achieving a competitive advantage in the business and enables the company to manage their supply chain risks.

“We know the strength of the Chinese office versus the Indian office and the Turkey office, so what the designers do is often they start doing a sample and send it out to Turkey, India and China just to have it set up in all the places but then to just see...it depends on production times and what volume of production each country has going through each time, so they flux the orders, they might sample the same style in two different countries...ideally its all supposed to go out of China or India just because of price but quite often it needs to be really quick so it goes from Turkey.”

Other sources, such as India, Portugal, Romania act as contingency suppliers for certain products which cannot be sourced from the two main sources because of a particular capability. A global supply base geographically dispersed in this manner gives the company flexibility to take advantages of cost, particular skills in emerging markets and gives the company power of sampling products in two or three sources before committing to an order which can provide them with the best ‘deal’ in terms of lead time and cost.

In comparison one of the companies we interviewed from the retail sector Case A believe that they are a driver in leading change, their global sourcing strategy reflects this which is largely driven by its customers and spread globally to utilise various hubs such as Turkey for fast fashion, Portugal for Ceramics and India for steel to satisfy their product categories. Their current sourcing portfolio is changing rapidly because the global market place has evolved so much over the last few years. Interestingly, in some product areas the company is now sourcing more from Europe rather than the Far East because of emerging markets and changes in consumer behaviour. On the other hand it is also exploring new sources in the Far East where capabilities are stronger, i.e. Vietnam, Madagascar, Shanghai. The sourcing strategy is determined by the product category for example quick response items are sourced primarily from Turkey, but new opportunities are arising from Bulgaria and Romania as they enter the EU. Other categories are sourced 95% China. Some categories are planned to be sourced more from Britain to promote the local businesses.

“The benefits of our global sourcing strategy is that in some of our product categories for example in clothing, we are spreading risk, we have a range of factories that can produce the same products at varying lead times and costs. We have more options; we want to develop more partnerships, key relationships with suppliers.”

- **Global Sourcing in Pursuit Of Low Cost Manufacturing (LCM)**

It is no surprise that most of the managers we interviewed identified LCM as one of the most important factor for their global sourcing strategy. In some companies it was the single most important factor for offshoring their businesses, whilst in others it was

an additional advantage because they were seeking new skills and capabilities. However, an analysis of the case studies reveals that LCM alone is not sufficient to ensure the cost advantages of global sourcing decisions, other issues such as logistics planning, transportation, reliability and understanding product requirements must be factored into LCM strategy to take advantage of globally sourcing.

Two of the companies that we interviewed from the Mechanical and Electrical equipment sector Case E and Case F were driven to global sourcing for low cost manufacturing reasons. Case E has been driven to low cost manufacturing because an increasing number of their products are becoming commoditised:

“Unfortunately our products are being commoditised so we need to use low cost sources and of course that takes away an advantage we used to have. These are tough challenges, but the right challenges. Where we need to be responsive is making decisions around what does the market place truly value.”

Although globalisation of their supply chain is intended to reduce costs for Case E, because it is a change of strategy, there are a number of barriers to overcome to fully take potential of the benefits of low cost manufacturing such as:

1. Supply chain reliability
2. Transportation

One of the main challenges for Case E is to identify which products to transfer to their ‘new’ low cost supply base. Despite the low cost advantages of manufacturing the company recognise that product specific risks have increased considerably in the supply chain such as: getting the suppliers to understand the product requirements, company philosophy, health and safety issues and to shorten the product lead-time. Although supply chain risks have increased because of their decision to source globally, the company plans to double its offshore manufacturing to its global supply base by the end of 2008.

“Trying to make sure you select the right products to put out into those supply chains is pretty critical. If you get that wrong and the market moves then you have almost

got to make sure that if customers want to enjoy the pricing of a low cost manufactured product that they understand all the other risks, and they need to be organised and they need to have good planning systems in their businesses to be able to decide what they can flex and what they can't flex."

Transportation is an area of heightened risk for the company because they are trying to come to terms with their extended supply chain, the disruptions that may occur and the reliability of various modes of transport. As a result of bad decisions, the company has had to air freight products to its customers so that they were delivered on time, because the company did not factor in product delays from their new suppliers who did not fully understand the product requirements. In this case, the company did not benefit from LCM, because they were forced to use an expensive mode of transport to deliver their products. This is a good example of companies not fully understanding the total costs of global sourcing, where there is more complexity and uncertainties in the supply chain compared to local sourcing.

"We are still flying some components from here (UK) to China. That is born out of the fact that we have probably made some wrong calls. We are probably still saving some money, but it is still our air freight costs and our total costs that are probably not as ideal as we would like...trying to agree what you are not going to manufacture and what you are actually going to buy from China is critical!"

Similarly Case F's global sourcing strategy is also driven by cost, however the majority of their products are still manufactured in the UK, but in the next five years this is set to change to utilise low cost regions (LCR).

"Because we have got people out there (China) and because it's a large part of our market it has become part of our global source. We didn't have a global approach to our outsourcing five years ago. But again market trends and availability of sources throughout the world has changed all that."

But the managers stressed that the decision was not a purely cost driven decision, it is about cost and efficiencies, so that final assembly and configurations can be made closer to the market and China in some instances is closer to their markets.

“We will take advantage of where it is cost effective, and whether the risks are deemed acceptable we will source from wherever and whether that is to the Far East or whether it is increased in Europe of locally here (UK) or America for example. We will continue to look at developing the supply chain and source where we think appropriate for the product or for our whole business basically.”

Case F illustrates the point made earlier of managers recognising the full benefits of their global sourcing strategy cannot be achieved on low cost alone, but rather it is a decision that is taken to either satisfy their product portfolio by taking advantages of highly skilled and technical labour in emerging markets at a lower cost or benefiting from good quality at a lower cost. The important issue is that these decisions are in line with the wider business strategy.

“...And also the quality in China, you know in some cases it would be a better quality than we get elsewhere so it is not just purely cost driven”

The manager in Case H also from the mechanical and electrical equipment sector illustrates this point clearly. He expressed that:

“The key benefits of the global sourcing strategy ...how does the purchasing strategy align with the overall company strategy and that is probably a good way to answer the question of what are the key benefits...purchasing is not just about shaving corners off the cost, it is actually about being able to be present in the market to grow your sales.”

In Case H, cost is not a priority as we have discussed earlier in the report, but because some of their market segments require low cost, then the company have designed a low cost supply chain to meet those requirements and these are aligned with their purchasing to procure from low cost sources rather than from high value adding innovation suppliers. The manager we interviewed believes that this is the key advantage of global sourcing: the alignment of the supply network and deciding what you should make offshore and what you should buy from offshore sources.

“These guys are only interested in cost, you can have the best R&D department in the world, you can have the best logistics in the world, you can be the number one in your market, but if the cost is not low enough, then it is not going to fly.”

A comparison of the cases within this sector indicates that the global sourcing challenge for them is to design appropriate supply chain strategies to meet the demands of their (niche) market places and to align their supply chain processes to benefit from LCM without increasing their lead times or compromising on quality and innovation.

- **Delivery on Time and Absolute Product Quality Requirement**

The demand for products to be delivered on time and for absolute product quality as a key priority from their supply networks was a prevalent theme in the case studies. However, both priorities were often difficult to achieve simultaneously. For example, not all companies we interviewed were prepared to wait and risk late deliveries to customers, whilst some companies would rather wait than risk the greater consequences of compromising on quality. However, what we found was that some companies found it very difficult to achieve both quality and delivery on time from their global supply network. For example the fashion retailer and the fashion wholesaler demand both, but often struggled on certain product lines which either meant product delays or a compromise on product quality.

When asked about key performance indicators for assessing their suppliers, the manager from Case B (fashion wholesaler) replied:

“On time, in full, it’s mostly about delivery. Delivery and quality standards...because of the geographical location of the suppliers, we have got a time issue, it is quite difficult to put across exactly what you want or what is wrong with some sort of products, but we have developed quite a few initiatives to help with that: video conferencing, so we can see and talk at the same time without having to fly out there.”

In terms of delivery the same manager responded to this as a downside of their global sourcing strategy:

“The downside of our current global sourcing strategy is the amount of shipping time that it can take, no matter how good your representatives are, sometimes they are not actually driving the brand strategy and the right message can be difficult to get across.”

In contrast, the manager from case F expressed Far Eastern sources in a positive light:

“...Also the availability of higher quality sources in China because China has moved on from being cheap and cheerful to being higher quality and the infrastructure is there as well.”

Compromising on quality could be the result of companies increasingly demanding faster supplier responses and often this is at the detriment of quality and a risk to delivery schedules because it reduces the supplier's capacity to deal efficiently or effectively with supply chain disruptions.

For Case E, one of the companies that we interviewed from the consumer electronics sector, achieving quality was a key priority, however the company struggled with its logistics and ensuring product deliveries on time.

“For sure a key priority is the quality of the product because once again that is the instant image that we have, so the quality of the logo is very important, then to arrive on time is the second thing and then the cost...we mainly distribute to our key accounts direct so from the factory to end customer warehouse, so a big part of the distribution flow is by road...Now one of the big challenges in this distribution set up is of course with having different routes...there are for instance different means of transport that we are not really able to utilise fully, due to the fact that the lead time is not sufficient or reliable from a time perspective and therefore for instance we're not really able to use rail as we would like to.”

In comparison, the manager we interviewed from Case F, (mechanical and electrical equipment sector) identified quality as a key priority for their global network so much so that cost would be a trade-off:

“Quality is the priority. If we can’t get the quality then we are not even going to entertain it. If we can get the quality then subsequently couldn’t get the cost we again, wouldn’t entertain it if the risk was so. Quality is number one and cost has to be able to carry the lack of flexibility and increased lead times and the things that are associated with those costs.”

Delivery on time was a key priority for the aerospace sector (Cases L and M), but it was also identified as one of the disadvantages of global sourcing. Typically these companies were forced to go global for lower costs, pressure from their powerful customers and in one of the cases because of political reasons. However, in a sector characterised by innovation, considerable investment in product development and R&D, which are lengthy processes in the supply chain, sourcing globally has added to the lead times and exposed the products to increased risk of design piracy, hence IPR of their products has become more critical as a consequence of their global sourcing decisions. Describing the cost of transition as a negative implication of their global sourcing decision, the manager from Case L described:

“The negative aspects are the costs of transition, and typically within aerospace we are talking about something like an 18 month lead time from kicking off a project to actually receiving a good product through the door which is not particularly unusual and not particularly spectacular but that’s where it is typically. It’s a transition cost, its maintenance of the relationship. So whereas a particular local site in the UK may have a local supply base that they know well, they start to realise that it’s much more difficult to look after a supplier on the other side of the world. Their documentation, procedures and processes, their ways of working need to be systemised and much clearer than when they are working with a local supply chain”.

- **Pressure to Maintain (Technological) Competitive Advantage**

The companies that we interviewed from the mechanical and electrical equipment and the consumer electronics sectors were most pressured to ensure they maintained a technological competitive advantage in their global supply network. The very nature of their products requires them to provide innovation and often leading edge designs. Most of the companies we interviewed from these sectors indicated that sourcing

globally for technology and innovation was more advantageous, because of the vast choice, higher level of skilled technology and highly creative people around the world. However, for others, the loss of IPR, copyright and piracy meant that some companies were more insecure to share and/or transfer product knowledge. For example IPR was a sensitive issue for Case H, because of experiences that they have had in the past with Chinese suppliers. The manager we interviewed commented on the issue of IPR and China:

“...Do we have patents aboard or propriety designs upon our products? Particularly in China they do have a well-earned reputation for piracy and stealing ideas. We have had some experience of that already, because we have a lot of innovative designs and are number one and we have our own R&D and we spend more on R&D than any other company in our industry, we are very paranoid about that problem.”

In the consumer electronics sector, Case C, the manager we interviewed suggested one of the benefits of their global sourcing strategy was accessing new markets with high technical skills at lower costs.

“By establishing product development centres located all around the world we can leverage the knowledge from different regions and increase the speed of the technology dissemination. By moving factories to low cost locations we are able to provide best in class technology at affordable prices for all customers around the globe.”

In comparison the manager we interviewed in Case H (mechanical and electrical equipment sector) described the disadvantages of sourcing suppliers for innovation could cause a locked-in effect if you are single sourced:

“Where we have not been very clever is on intellectual property they (suppliers) actually own the patents as well as the design. So to move away from them would actually be very difficult and there we have no leverage.”

The above quote indicates a major risk in global sourcing, which must be identified before an offshore decision is made particularly if sourcing from a supplier for the

first time. In this case, the company was committed to the source for the lifecycle of the product which can be as long as 40 years! The fact that the suppliers owned the IPR meant that the suppliers could not seek alternative supply sources, so for them maintaining a competitive advantage is increasingly difficult. As the company moves more towards global sourcing it plans to leverage its supply chain in two ways:

1. Sourcing innovative supply bases
2. Patenting and owning copyrights on designs

“Ultimately where the championship is won or lost is on innovation, those suppliers who are prepared to share their ideas with us and if they’ve got an idea they will come to us rather than our competition, then these are truly partners in the making and anyone who is giving us innovation as well as price, quality and delivery, then they’re simultaneously driving growth and cutting costs.”

Both of the companies we interviewed from the fashion sector have developed sourcing strategies to seek competitive advantage through a combination of seeking suppliers with particular skills/technical capability that can manufacture the right product and at the right cost. The companies achieved this advantage by sourcing from a mixture of suppliers with various skills and close proximity to market for quick response and to enable late configuration of products.

However, a cross case analysis of the two companies indicate that the fashion retailer was better equipped to maintain a competitive advantage than the fashion wholesaler. The key differences between the two are illustrated in the table below.

Table 5: Strategies for Achieving Competitive Advantage

| | Strategies for Achieving Competitive Advantage | |
|----------------------------------|--|--|
| | Case G Fashion Retailer | Case B Fashion Wholesaler |
| Current Strategy | Globally dispersed supply chain – A mix of Far Eastern and ‘close to home- Turkey’ suppliers hence take advantage of low cost without risking delivery schedules. Take advantage of closer sources for quick turnaround products and control different product lead times Very close strategic relationships with two main suppliers/partners | Global supply chain – majority sourced from Far East and too far from market places. Results in long lead times and product delays. Late customisation not always possible because of this, biggest risk of this is product becoming obsolete by the time it reaches the market. Have a large number of suppliers |
| Changes to GSS in Future | To continue to identify potential sources in emerging markets that can provide competitive advantage in terms of cost and delivery on time | Long-term initiatives include sourcing closer to home for their products. Consolidate their suppliers and develop key partners Source closer to market to improve their lead times |
| Risks & opportunities | Strong relationships developed over time enables the company to demand flexibility, drive innovation, and reduce disruptions in SC because of good visibility of the end-to-end chain all at a low cost. Could risk complacency in their SC, with long-term suppliers too comfortable and not driving the brand strategy | Major risk to the company is time, suppliers are geographically located too far from market place and shipping times are too long. Increases carbon footprint. Information is distorted in lengthy and complex supply chains, suppliers not understanding product requirements and company’s brand strategy. |

Companies from the fashion sector also indicate the pressure of seeking competitive advantage from their suppliers though product differentiation. They were seeking advanced technical improvements in their raw material sources as well as their garment manufacturers at a lower cost and in quick response to meet the demands of their market places. For the fashion wholesaler, Case B, piracy and managing copyright was a huge problem for their high fashion brands which were easily copied and sold before the company even managed to launch them.

However, it was a different approach in the aerospace sector, where one of the managers we interviewed from Case L, described their hybrid supply chain strategy as sourcing globally for high volume/commodity items but using local sources, when requiring quicker response to set of problems or when dealing with exclusive items which require highly technical skills.

“Global sourcing is great when you’ve got the right mix of certain products, if you are looking for an agile supply chain which can respond in a certain way to a certain set of problems, it may not be that a global source is right, so there are constraints around that. For example if you are dealing with one-offs, which are highly technical and require hands-on work with engineers you are not going to go to China. But at the same time if you are dealing with parts where you are making several hundreds or thousands per year, with a high labour content with a high degree of repeatability it makes sense to source globally.”

- **Poor Synchronisation of the Supply Chain**

Poor synchronisation in the supply chain because of outsourcing and/or offshoring decisions was a common problem felt by most of the managers we interviewed. Product complexity exacerbated this risk. Having a number of component manufacturers and various routes to transport the final product also heightened risk in global supply chains. A lack of communication with the global supply base which may not understand the product requirements, and the brand strategy was seen as a key risk. Some managers discussed the difficulty of viewing their supply chain end-to-end, which impaired their sourcing decisions by not identifying the risks and costs of what to make and/or what to buy from their global supply chain.

The mechanical and electrical equipment sector clearly identify with poor synchronisation of their global supply chains. One of the managers from Case F described the complexity of having different tiers to manage, the challenge being to make sure that collectively they all worked to the same brief/plan:

“...We have a tiered management sort of structure, there is a first tier, second tier and third tier who are doing assembly work effectively for us. So one of the challenges there is to try and manage the suppliers in a way where they work collectively to the same plan, which can be a difficult sort of challenge...we are looking at trying to manage messages and alerts between the various places in the chain, so you can have visibility of what is going on out there.”

The manager from Case E also described a lack of visibility of their end-to-end costs and the difficulty they had in identifying which product to transfer or not:

“I think the decisions around which products to transfer took ages to actually decide, but what we did do is recognise the differences between transfer and Chinese culture and what was important in a manufacturing sense out there. Then the problem is to identify which products are going into what source, and in what sequence they are coming in, we are trying to increase our visibility end-to-end ...so trying to agree what you are going to manufacture and what you are actually going to buy from China.”

The companies from the fashion sector complained that suppliers not understanding clearly what the product requirements are, was a major issue in their global supply chain. The fashion wholesaler felt that language barriers, time differences and cultural differences were all factors that contributed to the lack of synchronisation in the supply chain. The manager from Case B described:

“Because of the geographical location of our current suppliers, we have got time issues, it is quite difficult to put across exactly what you want or what is wrong with some sort of product, but we have developed some initiatives to help with these issues, such as video conferencing, because the right message can be difficult to get across.”

Similarly, in Case G, the manager expressed the importance of communicating their product design to their suppliers and the sharing of information on timely basis:

“After this we won't really get anymore information now for spring/summer season other than what maybe our competitors might be doing different to us and we might react quicker to those things but otherwise this is all we have, (Range information) its like a bible for us.”

One of the managers from the Consumer Electronics sector (Case C) was an exception. This company has managed to synchronise and co-ordinate activities in its global supply network through close supply chain relationships which makes end-to-end costs more visible by sharing product knowledge and risks:

“Having global suppliers with presence in all locations we operate in, we can easily adapt the portfolio to a specific location with full support and leverage from its suppliers, sharing risks many times”

- **Consolidation and a Globally Dispersed Supply Network**

Consolidation of the supply network which is spread out more globally was another key issue. By this we mean that companies were seeking to consolidate their supply network at the same time as having them located in various strategic locations around the globe – either where they had a global presence so that they can better control their logistics and consolidate their transportation routes to reduce costs and carbon foot printing or to seek competitive advantage from sources with a unique skill/product or to shorten lead times for products that required more flexibility which their current lean supply chain did not offer. Some companies had consolidated their supply chains and were now seeking new suppliers to satisfy their growing product portfolio. Some of the companies, which were single-sourced, were seeking new suppliers in key locations around the globe.

These companies had recognised that single sourcing increased their vulnerability and dependency on suppliers, although they had achieved good quality, reliability and delivery performance. Now these companies were identifying a different approach to their global sourcing decisions, which they termed ‘strategic sourcing’ – buying the right product from the right place at the right price. This now meant seeking ‘new’ sources/suppliers from emerging markets such as Eastern Europe, Madagascar, South Africa or North China for specific products, hence companies which were single sourced planned to disperse their sourcing portfolio to benefit from the advantages of multiple sourcing, such as increasing competition between suppliers to pitch the ‘best’ product. For example some large retailers force their suppliers to bid online to gain the best (cheapest) prices for their requirements. All companies remain anonymous, but they can see online when the bids change and are forced to compete with one another for the best price in order to win the contract.

The retailer (Case A) we interviewed is a very good example of a globally dispersed supply network. This company is in the process of consolidating its global supply

chain but it also has a sourcing department which constantly searches for new suppliers/sources around the globe that can best match their product requirements. Because the company is directly sourcing some of its products from 1st tier suppliers, understanding supplier capabilities and their capacity is even more critical. Therefore, it is developing close partnerships and asking its suppliers to invest in them to mitigate risks. As a leading global player, Case A could be making its suppliers dependent on them and increasing risks, but Case A argue that joint investment and closer supplier relationships will be mutually beneficial particularly as they are procuring more directly from source.

“We are sourcing locally in UK and Europe as well as globally, before we mainly sourced from Far East, but now we are sourcing more from Europe, because of our product portfolio requirements, more penetration of certain products so it makes sense to source from there, it depends on the product category you’re looking at which determines your sourcing strategy ...

Table 6: Product Category Management

| PRODUCT CATEGORY MAPPING AT CASE A | | |
|---|----------------------|---|
| PRODUCT CATEGORY | COUNTRY | TRANSPORTATION |
| Toys | China | Shipped & exploring Trans Siberian Train Link |
| Glassware/Ceramics | Portugal | Shipped/road |
| Plastics | Italy | Shipped/road |
| Steel | India | Shipped |
| Cookware/garden furniture | China | Shipped & exploring Trans Siberian Train Link |
| Fast fashion | Turkey | Shipped, road, air |
| Fresh Vegetables/Fruit | UK and Europe | Air |
| Value Add Embellishment | India and Bangladesh | Shipped/road |

Sourcing strategy including transportation mode is determined by product category

It is clear from the above table that Case A have a global supply base to satisfy their product portfolio, the above table only lists some of their product categories! The manager we interviewed said that a major factor contributing to their sourcing

decisions was a lack of transportation options. For example, they felt that they were very limited to the transportation modes in the UK because they found the UK rail network very unreliable and they also faced a number of problems with the size of their containers. However, as the company is increasingly moving sourcing from the Far East to Eastern Europe, it is exploring ways of consolidating loads and managing its transportation routes more efficiently.

The fashion wholesaler which is single sourced for certain product lines is also finding that this has increased their dependency on their supplier and is looking to change its sourcing options from mainly sourcing in the Far East to exploring new options in Eastern Europe or India for particular fabrics or embellishments. The company believe that a more flexible approach to sourcing will give them a competitive advantage for their premium brands and make them less vulnerable to supply chain risks.

“The global sourcing strategy is a combination of the right place, for right quality and for the right price. For one of our brands, getting everything made in the Far East probably does not fit the more premium nature of the brand that we want to express, so the short term strategy is focused on the quality of the product and long term strategy will be to move the sourcing as appropriate per product.”

The cases we explored in the mechanical and electrical equipment sector (Cases E, F and H) showed some similarities in how they expected their global sourcing strategies to evolve in the next five years. All three cases were driven by cost and quality as key priorities from their global supply network and all had a global market presence, so for them it made sense to manufacture in locations closer to their market. The companies were consolidating their buying or sourcing but at the same time were investing in a core number of suppliers scattered across strategic locations around the globe. For example the manager at Case F described:

“One of the changes that we look to global sourcing for is to procure more of the products from within a smaller supplier portfolio. We will look to consolidate our procurement across the group and where we can we need to utilise low cost regions.”

For all cases spreading their supply network globally was driven by a number of other key factors, besides cost:

1. Consolidate transportation routes
2. Take advantage of capabilities
3. Manufacturing closer to markets

In Case E, global sourcing is still relatively new for the company and a major issue for them is managing their much longer supply chains and working together with DHL Exel, the company plans to consolidate its logistics and use more cost effective modes of transport:

“The dynamics that are changing across the business and getting a mind set and an organisation that is capable of delivering long distance supply chains is quite interesting, we are working with DHL Exel to consolidate loads, so we can bring order quantities down and we can simplify the amount of suppliers we have providing international logistics.”

For Case H, their biggest issue has been that they have been heavily single sourced and a very long way from their markets, so their carbon footprint has always been poor and as a consequence they are forced to transport a huge amount of their freight by air, but part of these problems stem out of a lack of organisation internally in the company which worked in silo functions. Therefore, departments did not analyse the risks of their decisions collectively.

“We actually do a scary amount of freight by air because we are not very well organised. The biggest logistic challenge we have got at the moment is a rotary platform which is about 50 meters in diameter, it’s very big, very heavy, lots of metal and lots of electronics and for some reason the centre of excellence of manufacturing for this is in New Zealand, which has a huge industry but sits on the edge of the planet. We are doing a test of this rotary in a farm in the UK and in order to get into the test farm in time we had to fly the whole thing. That is something we would really quite like to avoid.”

The manager described that by globally dispersing its supply network, the company will be able to better organise logistics of its heavy machinery because suppliers which are close to the customers can directly transport the products to the customer to reduce the lead-time and carbon footprint.

In summary, information from the cases indicate that supply chain design is an important consideration for managers when planning their global sourcing strategies, particularly in terms of managing risks of their global sourcing decisions. For most companies we interviewed a combination of lean and agile approaches in their supply chain was critical to benefit from low cost advantages at the same time as benefiting from a flexible and responsive supply base. For other companies, having a globally dispersed network meant that they were able to manage their transportation routes more efficiently and consolidate logistics to avoid bypassing the final location for delivery. Supply chain design, considers risk management. In the next section we describe this issue in detail.

4.2.2. Supply Chain Risk Management Tools and Techniques

For this part of the cross-case analysis we asked the managers interviewed to describe what their current tools and techniques (if any) are to identify and manage risks in their supply chains. They were also asked to assess what they believed to be the major risks of their global sourcing decisions. Details of the tools and techniques used to manage risks are outlined below with supporting quotes from the managers concerned.

- **Supply Chain Risk Management Tools and Techniques**

The research revealed that nearly half of the companies we interviewed had no specific risk management process, although some companies were in the process of developing the risk management process within supply chain management/or as part of their business continuity planning, whilst in others there were no formal risk tools or techniques, it was rather more a sporadic decision or based on subjective judgement by the sourcing or procurement manager. We found that in the other half of the companies there was a mixture of formalised risk management processes

embedded in strategic decision making or procurement with risk managers and/or risk teams and others who were engaging in project specific risk management using simplistic methodologies to assess the risk impact of their global sourcing decisions. Summaries of the responses relating to each sector are presented in the following pages.

Retailer

The retailer we interviewed had a comprehensive and well-developed risk management process to assess the capabilities and the vulnerabilities of their supply base on continuous basis. Risk management is an integral part of the global sourcing decision-making. The process is called the supply management programme which is a standard tool kit and enables decision-makers to identify how to best deal with the capabilities and vulnerabilities in the supply base. Key performance indicators enable Case A to analyse key suppliers' performance. The risk review is completed every 3-6 months and supplier scorecards are developed to assess their performance especially for suppliers in the food area.

"We never take more than x% of a supplier's business – so it doesn't crash!"

The supply management programme is an improvement of their business continuity planning procedures that were originally developed. The current approach enables the company to assess risks internally and in the wider network so that they can better identify end-to-end costs in their supply chain. The risk assessment process looks at a wide variety of risks such as supplier's capability especially in terms of delivering on time, and has also built contingency plans to respond to risks particular risks of floods, hurricanes or terrorist threats which have increased in the last five years.

Food & Drink (FMCG)

The Food and Drink (FMCG) sector case companies had developed a range of tools and techniques for supply chain risk management. The health and safety teams were primary responsible for co-ordinating risk management activities for their organisations. In one of the companies the techniques consisted of a business continuity plan for every plant, which the plant engineer is responsible and accountable for as well as assessing risks in the supply base. Currently the risk

process for making a global sourcing decision is decentralised and managed by various teams such as health and safety, R&D or plant engineering which all assess and manage risks associated with their function. There is lack of joined up thinking between the various teams and this could result in risks occurring at any point in the supply chain because there is no co-ordination between the functions to conduct a holistic risk assessment of a global sourcing decision.

Similarly, in the second company we interviewed from this sector, business continuity planning was part of their risk management process and as in the first case, also supported by the health and safety team. However, the key difference from the other company which operated risk management in a silo structure is that the global sourcing department is responsible for the risk management process and supported if necessary by the health and safety team. The sourcing teams jointly conduct a risk assessment of their sourcing decisions by using a qualitative tool to assess the impact of their decision and determine the course of action to mitigate the risks. Supplier evaluations on a continuous basis also facilitate their risk management process.

Oil/Gas

In the oil company risk management lies in balancing demand and supply; based on capabilities of the supply market, and analysing the risks associated with matching demand. The company uses a standard methodology to assess the risks of demand and supply and have a cross functional team to evaluate the risks. The level of risk is continuously assessed on quality, safety and technology to work out the optimum strategic sourcing option.

“We are looking at all the different components of supply and demand and we try to assess what level of risk would be associated with each and we match it together to come up with the options and we hopefully select the most appropriate best value, least risk option.”

One of the techniques that the oil company uses in its risk management process is scenario planning which is a checklist of ‘what if’ type questions to assess the suitability of certain suppliers. This consists of a cross functional team – an expert

from safety, an expert from supply chain and a technical expert who work together to articulate risks from those different perspectives and develop the risk strategy.

“We play lots of ‘what if’ scenarios and sensitivities in trying to work out what is the appropriate way forward. We look at technology and who has the best technology, some have got an advantage- what do we need to reduce the risk and create credible competition so for all elements of supply and demand, we ask three questions and we have a methodology that we use to do that analysis.”

Aerospace

The difference between the aerospace companies we contacted was that one of them had no formalised risk management approach whilst the other had a clear and well-established risk management process. The main reason for this significant difference however, could be that one of the companies we interviewed was only established 2-3 years ago, whilst the other has been established for years and is a well respected and recognisable name in the industry.

The manager we interviewed from the company with no formal risk management process recognised that this increased their risks because there were no systemised procedures to manage their sourcing decision. However the company currently use a range of tools to respond to their critical risks such as IPR, obsolescence and quality and various personnel are assigned responsibility for managing these risks, such as the commodity manager in the UK and the country-sourcing manager in China. The manager stressed that their current strategy does not enable them to have an end-to-end view of their supply chain and also suggested that one of the major implications of global sourcing is the lack of knowledge that companies have on managing risks associated with those decisions and the level of investment companies need to make to respond to and manage those risks.

“One of the negatives is the miscomprehension of companies not actually understanding the amount of investment required within their company and within the country as well, to actually manage and mitigate those risks.”

However, the second company we interviewed has a clearly established risk management process which is supported by a group of experts in risk management. The risk management process is used in a variety of situations including changes of suppliers or sourcing new components. Risk management is embedded into the purchasing process and accountability of risk remains with the buyers. The current technique which the group use to assess risks is Risk/Impact Diagrams. This technique enables the group to develop risk profiles of their sourcing decisions and involves identifying potential risks and assessing their implications by measuring the likelihood of an event against the impact of the risk on the company.

Consumer Electronics

There were big differences between the two companies we interviewed in the consumer electronics sector in terms of risk management tools and techniques. In the first company we interviewed, the problem was the lack of co-ordination between departments. As the company works in a silo mentality the supply chain manager was not able to tell us if any supply chain risk tools existed in the company because he was not responsible for them. However, he suggested in other departments there could well be a more formalised approach to risk management. The manager we interviewed conducted a more subjective and qualitative approach to risk assessment of the supply chain by looking at the possible impact and likelihood scenarios of global sourcing decisions.

The second company we interviewed had a more formalised and robust risk management process. Risks were identified and managed by specific groups assigned for such purpose, general risks like criminal (theft, unethical behaviour); damaging (fire, earthquake, etc) and business continuity were managed by groups related to infrastructure and real estate. On the supply chain management side, and more specifically to procurement, the *Procurement Risk Management* (PRM) organization was responsible for setting guidelines and for providing consultancy and training for Manufacturing and Logistics Organization when dealing with suppliers.

Before a global sourcing decision was taken, risks were identified according to PRM guidelines, e.g. past experience, kind of relationship and the overall company

guidelines regarding risks. This was supplemented by knowledge about the potential suppliers, the country and the region of sourcing and also about past experience of such supplies. The identified risks were then included in the agreements and contracts to ensure risk sharing between the parties. Risks were also managed by identifying contingency suppliers or working with several suppliers to mitigate the risks of continuity, geography and price (negotiation power).

After a global sourcing decision, risks were identified by monitoring the identified risks factors and identifying new risks not initially identified. These were managed by taking corrective actions according to the monitoring process and reviewing agreements and by changing the concentration of suppliers according to the results of monitoring. There were several departments responsible for managing the risk process when making global sourcing decisions:

- The Manufacturing function was responsible for managing contract manufacturers
- The Logistics function was responsible for managing 3PLs
- The Procurement function was responsible for the managing other Suppliers
- All functions are supported by the PRM (Procurement Risk Management) function.

To manage the risks of global sourcing, the company had contingency suppliers located in other regions. In case of unexpected supply chain risks, the company had a set of alternative suppliers and could transfer inventory from other locations. Their risk mitigation strategy relied on having a dual sourcing strategy- managing at least two suppliers for the same product, sometimes in the same geographical region.

The company's risk profile has been impacted by global sourcing in the following ways:

- Because of a longer pipeline (ASIA-Americas, ASIA-Europe) their logistics costs are more dependant on oil prices.
- Overall costs were affected by variables such as exchange and interest rates.

Mechanical & Electrical Equipment

The techniques used by the mechanical and electrical equipment sector differed in all three companies interviewed, but the similarities were that all the techniques were based on qualitative statistical tools which enabled them to assess the risks in their supply chains. Also all the companies conducted project specific risk assessment as well as managing risks in their wider supply network. All the managers we interviewed recognised the importance of risk management and were either in the process of investing more time and resources into risk management or were planning to establish a more robust approach to risk assessment and creating a more risk aware culture in their organisations.

In one of the companies we contacted from this sector, the managers mentioned that the significant changes they have made in the last 18 months had made them more aware of managing the risks of their new sourcing strategy. As a result of their decision to transfer products offshore, the company has identified that they are more exposed to risks in their extended supply chain. Therefore they have developed a low cost manufacturing (LCM) project team to manage the risks of their low cost sourcing decisions. One of the managers we spoke to said:

“The decisions around which products to transfer took us ages to decide...so we put the resources behind setting up a project team to manage those decisions. We are now able to determine what the purchasing savings are going to be and we are able to estimate what we could offer to the market place...If you haven’t done your homework in relation to what the end-to-end costs are then you could be losing money!”

The company have no specific tools to manage risks however the project team manager will brainstorm the critical risks that could impact their business and use process mapping to aid their decision making process.

In the second company we interviewed supply chain risks are managed collectively by the operations, purchasing/sourcing and materials department. There is no risk department, but the risk management process consists of members from each

department who assess the various risks of their sourcing decisions and manage these within the context of the project specific risks. For example the risk assessment of existing suppliers, sourcing from new suppliers or product modifications etc. A risk matrix which acts as an aide memoir is used to identify project specific risks collectively and therefore what actions need to be planned and taken to mitigate and manage the risks. The company is looking to develop additional tools to help manage certain risk areas as a consequence of their GSS. The manager we interviewed stressed the importance of risk management:

“What we have to do is far better understand what the risks are and where necessary manage those because there are different risks and different implications to the business. Whether that’s reduced flexibility in the supply chain, increased inventory or whether it’s less tangible risks like IPR which we really need to consider. We have had to look to significantly develop our risk management and be able to demonstrate to the business what the risks are, how we are mitigating those, how we are eliminating or how we manage them.”

The final company we interviewed from the mechanical and electrical sector in comparison to the first two cases we have described above had a risk department and a risk manager for the business as a whole. This was more of a strategic approach to risk management which assessed risk such as financial stability of the business or what could impact the business critically. However, this process did not extend within the company in individual departments to assess project specific risks. However, in the last 12 months, this has changed and now sourcing and purchasing departments have developed an approach to conduct project risk assessments. The risk process for project specific risk assessment is a matrix which measures the size of spend against the complexity or the risk of the spend. This also enables the departments to decide between make or buy decisions based on the level of risk to the company.

Fashion (Retail and Wholesale)

The fashion sector appeared to be less developed in supply chain risk tools and techniques than the other sectors we contacted. Although both the companies we

interviewed recognised the importance of risk management they had less sophisticated techniques to assess them. The similarities between both the companies we interviewed were the process they went through to enable them to view the supply chain end-to-end. However, as with several other organisations we consulted, the fashion companies were working towards developing a more robust supply chain risk process.

The fashion wholesaler had no formal risk management process or a risk management team. However, the company used critical paths and process mapping to identify and manage risks. Critical paths enabled key decision makers to map out the entire critical path for a product and then identify where the risks could be, what their implications are and what actions should be taken. This enables them to view product risks, transport risks etc, which they can mitigate. The critical path process is amended around those risks to lessen the impact and likelihood of risks. The company has no contingency plans and presently feels vulnerable to unexpected risks, because they have no exit strategy.

“Once we have mapped it on the critical path its quite easy to see where the risks are, either time risk, transport risk, environment risk or whatever, so you plan your process around reducing those risks...it is not formalised as a risk management process...you make your decision and then you manage your decision around it. I think people probably use a lot of management tools, but don’t necessarily recognise them as such.”

Similarly, the fashion retailer had no specific tools to manage supply chain risks. Project specific risks are assessed by different departments which work through a critical path approach, for example design will assess features that could go wrong in a product design or whether the design can be manufactured by the supplier or if it is not a current design etc. Purchasing will also work with design to assess appropriate sourcing options, as well as assessing the risks of supply base capabilities etc. however other departments were not so well integrated.

4.2.3. *Major Risks Identified in Global Sourcing Decisions*

As a result of global sourcing decisions, managers described a number of risks that had major implications for their businesses. Details of some of the major risks are outlined below with supporting quotes from the managers concerned.

- ***Pressure for Supplier Lead-time Reduction***

The increasing demand for suppliers to reduce their lead-times was considered a major risk by several companies. However, the pressure to reduce lead times increased other risks in the supply chain. For example, companies from the fashion, consumer electronics and mechanical electrical sectors demanded quick response but the pressure to shorten their lead-times reduced the supplier's capacity to deal efficiently with supply chain disruptions. Therefore this had a knock-on effect on quality.

“Lead time is the biggest area of risk that we struggle to mitigate, its not just a single tier supply chain, we have a multi-tier supply chain going out to China and various other people involved. It is managing that lead-time across a number of suppliers and trying to manage the relationships between the other players. In a chain it is difficult and in some areas our lead-time from end to end is 26 weeks. Our lead-time to our customers is 10 days. We don't forecast. That is the area where we don't have the detection system in place that knows that there is a problem on the third tier, for us to take action. Long lead times are always going to be a struggle for us.”

In another company lead-time was considered a major risk because of the transportation routes or lack of choice of mode of transport was available at the various supply base locations. Some companies had poor integration with their logistics departments, which did not plan the transport routes efficiently and often did not deliver direct to the final location which often caused delays and also increased the carbon footprint of the supply chain. Some logistics providers were consolidating loads to increase their efficiency from the Far East, but found once they were in the UK, the poor reliability of rail limited their options on the mode of transport available.

“There are different means of transport that we currently are not able to utilise fully, due to the fact that the lead time is not sufficient or reliable from a time perspective and therefore for instance we’re not really able to use rail as we would like to.”

- **High Switching Costs**

For some of the companies we interviewed high switching costs were a major issue. These companies often single sourced, and were highly dependent on their suppliers’ technology or capability. The risk of single sourcing was acknowledged but was also unavoidable particularly for one of the companies we spoke to from the mechanical and electrical equipment sector which was locked in to their suppliers’ capability as well as their IPR, which was owned by the supplier for a product which had a long product life cycle.

“We are highly single sourced because we have such a relatively low spend covering such a huge range of components and products across the entire globe. Our spend is spread very thinly and the way that we maximise that spend is by single sourcing. That obviously has huge risks and very big knock on effects to the supply chain because the way that you counteract being single sourced is that you hold more stock or you make sure that you are not very far from your customer in case it all goes wrong, there are logistics and supply knock-ons from that.”

For the fashion wholesaler, there was no choice but to source products from a particular supplier or region that was unique with a particular skill set or competence. The wholesaler identified that over-dependence on a supplier which could only apply the finish they required increased their risks, because in the case of something happening to the supplier the company had no contingency plan.

“We do not have a formal contingency plan to manage risks...if a factory burnt down I think we would be quite stuck really.”

- ***Communication with Suppliers/Understanding Product Requirements***

For the retailer, communication with suppliers who understood their product requirements was vital and it was considered a major risk to the business. Because the company has a huge supply base, effective communication is a pre-requisite of good sourcing decisions. The company directly sources for some its products, so it is even more crucial that suppliers understand product requirements. The retailer identified that it was difficult when communicating with new suppliers to get them to understand your expectations.

Vice-versa if the retailer did not fully understand the supplier's capabilities, there could be missed opportunities that competitors can jump on. Driving performance of suppliers and managing product requirements were achieved through good communication with the supply base, but information was often distorted in the supply chain because of lack of communication. This increased costs in the supply chain because some products had quality issues so had to be sent back and others were not manufactured to the required specification or there were faults in packaging etc.

“Communication with suppliers is a key, the challenge is for them to understand what is expected by us. We have too many suppliers and a lack of visibility, you can't manage expectations, when moving to somewhere new, about roles and responsibilities...if you get it wrong it could go very wrong.”

- ***Loss of Intellectual Property Rights (IPR)***

For many of the companies we interviewed loss of intellectual property rights was considered a major risk of sourcing from China. Some locations were identified as hotspots for copyright and piracy, and this caused problems for innovative products with design patents. For some companies protecting their IPR was a major risk but it was also a key priority from their suppliers, so in some cases the suppliers were accountable for this risk. One of the managers from the mechanical and electrical

equipment sector described that they lost their IPR to their supplier, which has meant that they are now locked into them for the duration of the product cycle which in this case was over 40 years. In this case the company has exposed themselves to asset-specific risk.

“We have not been clever on intellectual property they actually own the patents as well as the design. So to move away from them would actually be very difficult.”

Currently the company is developing risk management in their global sourcing decisions and has begun to assess the risks of sourcing from certain suppliers, using a risk matrix which enables them to identify the risks of IPR, distance of the supplier, if they are single sourced and how complex the product is. This has enabled them to reduce their dependency on the suppliers and mitigate the risks of losing their IPR.

“China has a well earned reputation for piracy and stealing ideas, we have had some experience of that because we have a lot of innovative designs and we are number one, we are the biggest in the industry and about twice the size of our nearest competitor. These guys operate on a local basis and account for more than half of the global market, these are the guys that would steal our ideas with no problems, so these are the risks that we need to consider: single source, intellectual property- if the factory was burnt down, how complex is the product to make somewhere else?”

In another company the risk of theft was considered high, so they shipped some products they shipped by different routes, where the risk of theft and loss was low.

“If you’ve got long supply chains to your operations which are open to normal transport mechanisms the risks would increase, but if you take the North Sea as an example when we order stuff it comes on the suppliers lorries to our supply base, which we control, packed into containers and it gets transported on an exclusive company supply vessel to the installation so the risk of loss and theft via supply chains in the North Sea is lower.”

- ***Product Variations***

Companies from the mechanical and electrical equipment sector stated that sourcing globally for stable and commodity items was easy and cost effective but as soon as they announced a design modification or product variations, then the risks increased. The companies believed that the Chinese are good at producing standard items but as soon as you deviate from that and ask them to do something different, they were not as capable to adapt to changes in the production capacity.

“I think where the risks start to increase is when we pick variant items which are just used on certain machines or any certain spares. That is where it becomes more of a judgement of how much stock you need to hold on to support unforecastable customer demand...We have obviously costed into our project if we needed to air freight product in rather than by sea, if we needed to significantly shorten the lead time.”

Another manager we interviewed agreed:

“Whatever you do don’t confuse them, don’t try and put in three or four variants. Once you have got that procedure set, then stick to it and you will get skill...they are excellent at copying, it goes wrong when you start to introduce things like product variation.”

- ***Geographical location of suppliers***

The geographical location of suppliers was considered a major risk for some companies particularly those in the consumer electronics, retail, mechanical and electrical and fashion sectors. All these companies experienced supply chain problems such as long lead times because the source of manufacture was often too far from the end market. Companies complained about the lack of transparency in their supply chain because their supply base was dispersed in various locations. The risks were higher for complex products which were sourced from different locations and finally assembled and configured at a different location. Synchronisation of suppliers that were so spread out to work together was identified as a major risk of global sourcing.

“I suppose our biggest supply chain risk is that my suppliers are not near the point of use. I cannot have suppliers half way up a mountain in Pakistan and in the middle of America serving a 500-acre farm. By necessity we are a long way from some of our markets, so our carbon footprint has always been poor...I’m buying stuff from China and bringing it back to Europe.”

Another manager representing a company from the same sector agreed:

“The challenge for me is to try and manage a supply chain that is extended to low cost regions and has a tiered management structure. Getting them to work together collectively to the same plan can be a difficult sort of challenge. Ours is an arrangement of low cost regions or suppliers of specialist technology, so when you try to combine them in a supply chain sometimes you are probably asking them to do work that is slightly less comfortable or less familiar to them. So it is a challenge!”

4.2.4. The Environmental and Infrastructural Implications of Global Sourcing for the UK

In this section of the interviews we raised the issue of the impact of global sourcing decisions on the environment and infrastructure. We were particularly interested in identifying how managers dealt with the issue of making their supply chains more carbon neutral, by reducing carbon footprints with their suppliers. We aimed to capture an insight into the initiatives global companies are using to reduce carbon emissions in their extended supply chains and understand the impact this has had in the company’s global sourcing strategy. Below we summarise the key issues that we analysed from the cross-case analysis, which is supported by relevant quotes from the managers we interviewed.

- ***Challenges to Reduce Carbon Footprint in the Supply Chain***

The manager we interviewed from one of the companies from the mechanical and electrical sector was the only manager we interviewed from this sector who

recognised the growing significance of reducing CO₂ and discussed the key challenges of reducing carbon footprint in their supply chain. The company has always manufactured too far from their markets, which means that their carbon footprint has always been poor. In addition, in the last year they have increased sourcing from China and bringing products back to Europe for testing and final assembly so it has doubled the carbon footprint in the supply chain:

“Our carbon footprint has always been poor. Our company policy says that we will where possible and appropriate minimise our effect on the environment...but this is why I’m interested to participate in this project because in all our decision making about going to China, we have talked about the risk of supply but not talked about the risk to the environment. We are getting the basics sorted out, which is assurance of supply, getting the quality right and getting the costs down. Environment comes us a fourth priority behind all of those. Keeping the shareholders and customers happy is priority one and neither of them give a damn about the environment!”

The above quote resonates what most of the managers we interviewed felt about carbon neutrality and the impact of their global sourcing decisions on the environment. When asked specifically about this issue, we found that some managers hesitated to discuss this issue and some of the managers were confused with our questions and responded by discussing their ethical trading policies of offshore sourcing and/or their policy for corporate social responsibility. However, about a third of the managers stated that they either have environmental teams to assess health and safety issues at supply bases, another third responded that CO₂ was not regarded as a central issue or the manager didn’t think it was a top priority issue and the final third were taking a proactive approach to reducing CO₂ in their supply chains through lifecycle analysis or were taking these issues more seriously.

We also found that companies we interviewed later in the project were much more aware of the ‘carbon’ issue and this reflected in their discussions about the environment. This could be due to the fact that this issue has been widely publicised in the media and press reports recently and perhaps companies felt obliged to make themselves sound environmentally friendly! We found that the managers we interviewed towards the end of the project were certainly more open to discuss the impact of their global sourcing decisions to the environment. However, even in these

latter companies we found little evidence of actions being taken to manage their carbon footprint, and only three of the companies we interviewed were proactively taking a wider view of their supply chains end-to-end and factoring in the costs to the environment in their total costs of global sourcing.

- ***Environmentally Efficient Supply Base***

About a third of the companies we interviewed stated that environmental considerations were taken in to account when selecting suppliers, or when monitoring the manufacturing plants in terms of hazards, health and safety issues of chemical usages, or when monitoring pollution from textile dyestuffs to the local environment. Therefore, these concerns were limited to the impact on the local environment where the products were manufactured but were not taking into account the total supply chain and how they considered the impact on the environment when transporting goods from end-to-end in their supply chain. There appeared to be confusion in discussing this issue and these companies talked about how ethical their suppliers were and how socially responsible the companies were rather than understanding the carbon footprint of their supply chain. For example, when asked to discuss the risk of environmental damage because of sourcing decision, one of the managers we interviewed from the aerospace sector responded:

“We don’t really take it into consideration although we are becoming more aware of the situation and we take CSR very seriously.”

When asked if the company looks at the environmental footprint of their supplier, another manager from the oil and gas sector replied:

“Yes we did and in the machines they produce because we are very aware of the sorts of emissions that we have from our offshore installations so we look to get the most efficient environment performance as well, we look at the reliability so that we don’t have to flare gas offshore, we look at their operational efficiencies so that they are lower in terms of CO₂ emissions...we have taken a stand in terms of having to design our facilities for minimum environmental discharge.”

However, this manager only discussed reducing CO₂ at their manufacturing plants, and making sure that the plants were more environmentally friendly. However in terms of transportation it was a different story:

“We don’t look at lowering CO₂ in our transportation to get it to us because its not like we are buying compressors every week...depending on the project we may buy 3-4 compressors a year.”

- ***Designing Products To Be More Carbon Efficient***

Just under a third of the companies we contacted were taking environmental considerations seriously. They developed environment teams (a dedicated team to look at CO₂, air miles and fuel efficiency) to review and manage the impact of their sourcing decisions to the environment. One of the ways in which they monitored this was through life cycle analysis. For example one manager from the food and drinks sector stated that they conduct a life cycle analysis for all products from farm-to-delivery-to-retailer. This enables the company to track its carbon footprint and plan an efficient and carbon friendly supply chain.

Similarly another food and drink manufacturer described how they consider environmental implications and CO₂ in their sourcing decisions, it is a fundamental part of the process which designs new products to be more efficient than the previous generation in terms of their carbon footprint and to be able to generate less waste throughout its life (e.g. intermediate packaging, product packaging, and disposal). Therefore a variety of environmental issues are involved in the sourcing decision such as, packaging, use of plastics, lifecycle analysis and CO₂.

- ***Closer Integration with Logistics***

We identified that half of the companies we interviewed were making proactive decisions to integrate more with their logistics providers to increase transparency in their supply chains and to plan their transportation to gain more leverage. Therefore companies were engaging in closer relationships with their logistics providers to either consolidate their loads, or plan their transportation routes better or in some

cases direct shipment to customers to avoid bypassing final markets. These factors were considered purely to reduce cost and to reduce lead times which were two of the top priorities companies required from their supply network as discussed in section 7.3, however, the wider implications of this is that it could reduce the carbon footprint in their supply chains, but there is no evidence in the cases to suggest that such moves were planned to reduce CO₂, the priority understandably was to reduce cost and lead times.

One of the managers we interviewed from the mechanical and electrical sector mentioned for example:

“We are still flying in some products from China, that is born out of the fact that we have made some wrong decisions. But our air freight costs and our total costs are probably not as ideal as we would like...we are co-ordinating our logistics strategy and working closer with DHL Exel to consolidate loads to get more leverage.”

The manager we spoke to in the fashion wholesaler business described:

“What we are looking to do is to make things far more efficient and less costly on the environment by moving more things by direct shipment because I think we all have got a history about bringing it in and then ship it back again, so it kind of bypasses the place it is going to...so we are looking at how we can consolidate and manage that for smaller distribution partners in the Far East nearer to the destination before bringing it here and then sending it back again, that’s heartbreaking, absolutely heartbreaking!”

- **Limited Mode of Transport and Reliability**

Two of the major concerns expressed by the companies we interviewed were the limitations of the mode of transport that was available and the poor reliability of the UK’s transport infrastructure – mainly rail. The managers believed that this often inhibits them from designing ‘green supply chains’ and organising their logistics in a more efficient manner in terms of reducing carbon footprints in the supply chain.

A few of the managers described the poor reliability of the UK rail network and increases in taxes and tolls on motorways as creating more problems such as increases

in product costs, which does not deter companies from offshore sourcing but rather forces them to search further for other even lower cost alternatives to counteract these additional costs. One of the managers from the food and drinks sector clearly stated:

“Taxing road is not the right solution it will only make the products more expensive!”

5. Comparative Product Sourcing Model

5.1. *Introduction*

The global sourcing model developed as part of this research has been designed to help practitioners make better sourcing decisions by allowing them to estimate the impact of different sourcing decisions and compare the differences between local and global sourcing. The model looks at four main elements of the sourcing decision:

- **Costs:** The model helps the user to capture the key costs driving sourcing decisions. It includes both costs that are clearly visible, such as the cost of manufacturing and international shipping, and the hidden costs such as interstate and cross border taxes, quota and anti-dumping costs and inventory holding (including financing and opportunity costs).
- **Time:** the model estimates the total time for both local and global sourcing. This provides a measure of agility to respond to sudden changes in the market.
- **Risks:** The model enables the capturing of the different types of risks that affect the sourcing decision and assessing their impact and probability of occurrence. This provides the user with a profile of the risks involved and their priorities.
- **Environment:** Global sourcing can have substantial environmental implications. The model focuses on the impact on one key environmental indicator which is the emission of carbon dioxide into the environment. The model assists the user by estimating the impact of sourcing decisions on CO₂ emissions.

The model has been developed based on research in different industries and it can be adapted to different circumstances and industrial contexts. It is not meant to replicate all of the complexities of a specific situation but to compare and contrast the most important variables of the sourcing decision, providing a strategic perspective.

5.2. Model Description

The model has been designed with three essential characteristics in mind: ease of use, quick set up and operation, and aesthetic appeal. To allow ease of data input, the model has been developed using Microsoft Excel. The following pages describe the operation of the model.

5.2.1. Data Entry: Front Page

When the model is first started, the user is presented with a front page consisting of a brief model description, copyright and disclaimer information. The main operational part of this worksheet, shown in Figure 14, allows the user to input two sourcing locations for comparison, with a selection of data set up and calculation buttons. The first and second source locations are drop down menus with a selection of offshore locations to choose from. The second sourcing menu, as well as the same offshore locations, also includes a local sourcing option for the UK.

Figure 14: Main input form

The figure shows a screenshot of the 'Comparative Product Sourcing Model' front page. The interface is organized into three main horizontal sections within a yellow background. The top section, 'First Sourcing Data Entry', features a dropdown menu for 'First Source Location' with 'China' selected, and three buttons: 'Costs', 'Activity & Risks', and 'Flows'. The middle section, 'Second Sourcing Data Entry', features a dropdown menu for 'Second Source Location' with 'North America' selected, and the same three buttons. The bottom section contains a large 'Calculate' button, and below it, three buttons: 'Results Table', 'Graph', and 'Risk Graph'. A 'Close' button is located to the right of the 'Calculate' section.

For each of the two sourcing locations, three worksheets are available to enter data. A “Close” button on this front page leaves the spreadsheet in place but displays all the

Excel drop down menu options and icons that were hidden when the spreadsheet was loaded.

Through the various worksheets in the software, buttons can be selected which move the user around the input and results screens. On each worksheet, the user can navigate to the next worksheet using the “Next” button; return to the previous worksheet with the “Back” button, or press the “Close” button to return to the main input form.

5.2.2. Data Entry: Costs


The button labelled “Costs” on the main input form displays a worksheet containing a pictorial representation of the facilities and transportation legs of a global supply chain (see Figure 15). Below each facility or leg a tab can be selected to display a table of cost information for specific elements in the chain. The information required under each of these tabs is described below.

Figure 15: Costs input screen

Globally Sourced Goods - Costs

?


 Manufacturer



 Inland Carrier


 Port terminal


 Customs


 International Shipping


 Port terminal


 Customs


 Inland Carrier


 Ship to DC


 Buyer

Select =>

General Costs

Manufacturing

Ship to Port

Port of Despatch

International Shipping

Port of Receipt

Ship to DC

Distribution Centre

| | |
|----------|--|
| £100,000 | Initial cost of setting up offshore sourcing |
| £10,000 | Annual cost of supporting offshore sourcing |
| £20,000 | Annual cost of setting up the terms of payment |
| £250,000 | Annual cost of compliance |
| £250,000 | Quota and anti dumping costs |
| £0 | Other annual general costs |

Back

Next

Close

- **General Costs:** This tab refers to annual costs which will be incurred, but do not fall under a specific supply chain heading. There are five specific general cost elements and a sixth classified as other.
- **Manufacturing:** requires the entry of an annual cost of manufacturing a product or group of products.
- **Ship to Port:** covers the cost of moving goods from the manufacturing location to a port of despatch, and includes not only freight costs, but also any cross border or interstate taxes that may be incurred.
- **Port of Despatch:** this refers to a shipping port or airport, but could also be a rail terminal. For sourcing locations in mainland Europe, the port of despatch could also be the manufacturing location itself, if the movement is by road. In this case, any “Ship to Port” costs may be minimal. The “Port of Despatch” costs cover the cost of handling the goods as well as the costs of export duties and documentation.
- **International Shipping:** represents the cost of moving the goods from the offshore country to the arrival location in the UK, by a specific mode of transport.
- **Port of Receipt:** in the UK could be a shipping port or airport, but could also be a rail terminal. If the international shipping movement is by road, the “Port of Receipt” could also be the receiving Distribution Centre.
- **Ship to DC:** this tab displays a table which allows the user to enter the cost of moving the goods from the arrival location in the UK to a final receiving point or Distribution Centre.
- **Distribution Centre:** this tab displays a table requesting information on the selling price per unit so that the model can produce the manufactured and delivered cost as a percentage of the selling price. If applicable, an annual cost can be entered to cover any modifications that need to be made to the received goods such as repacking, labelling and assembly. The final piece of cost information is the cost per tonne of carbon dioxide. A default value of £24 per tonne, derived from Department for Transport literature, will be applied unless this value is changed by the user.

In addition to the costs specified, each tab contains an entry entitled “Other”, which can be used to allow users to include any additional costs which may be specific to their company.

5.2.3. Data Entry: Risks

The button on the Main Input Form labelled “Activity & Risks” produces a similar worksheet to the “Costs”, with the same pictorial representation and tab options, as shown in Figure 16. As well as general information about the product and activity a list of potential risk factors are included. For each risk the user is asked to state the likelihood of the risk occurring, and, if it does occur, the impact it will have on the business. A scale of 1 to 5 is used, plus a N/A option if the risk poses no problem to the company.

Figure 16: Activity and risks input screen

Globally Sourced Goods - Activity and Risks

Manufacturer Inland Carrier Port terminal Customs International Shipping Customs Port terminal Inland Carrier Buyer

Select => Product Characteristics **Manufacturing** Ship to Port Port of Despatch International Shipping Port of Receipt Ship to DC Distribution Centre

| Risks | Likelihood | Impact |
|---------------------------|------------|------------------------|
| Vendor Reliability | 3 average | 1 insignificant |
| Currency Fluctuation | 3 average | 3 average |
| Quality of Production | 4 good | 4 fairly significant |
| Vendor Flexibility | 3 average | 5 very significant |
| Infrastructure | 4 poor | 2 fairly insignificant |
| Raw Material Availability | 4 poor | 1 insignificant |
| Labour Availability | 3 average | 3 average |
| Other Manufacturing Risk | N/A | N/A |

Back Next Close

As well as a defined list of risks, a further option of other risk is included under each tab option to allow for specific company risks not specified in the model. The “Product Characteristics” tab displays a table that requests the input of information about the product or group of products being manufactured. As well as the main characteristics of the manufactured items, there is a drop down list of Incoterms which is used to assess the position in the supply chain at which goods are transferred from the seller/manufacturer to the buyer/customer. At this point stockholding costs are incurred and these are included in the final calculations.

The “Manufacturing” tab contains a list of seven potential risks plus one manufacturing risk classified as ‘other’. The tables displayed under all the other tabs include a range of risk options. In addition the typical clearance time for a container is requested under the “Port of Despatch” and “Port of Receipt” tabs. Under the “Distribution Centre” tab, as well as the risk of obsolescence, the user is requested to input the typical weeks of stock held at the distribution centre and a percentage of cost price to cover the stockholding charge. This latter value should cover the cost of financing the stock, obsolescence, space in the distribution centre, shrinkage, insurance and labour associated with counting the stock, etc. A typical default value of 25% is suggested.

5.2.4. Data Entry: Flows

The “Flows” worksheet is the final data entry form, shown in Figure 17. Each of the data shown on this worksheet is provided from a drop down list. By default, the Factory Location field is the same as the sourcing location shown on the main front sheet, as is the Port Location field. Depending on this offshore location, the “Ship to Port” Transport Mode will provide a list of Air, Sea, Rail or Road. This same list will appear for the “International Shipping” and “Shipment to Distribution Centre” Transport Modes. Certain Eastern European manufacturing locations will not have a transport mode option of ‘Sea’.

Figure 17: Supply chain flows input screen

| Globally Sourced Goods - Movement | |
|--|----------------|
| Product Industry | Automotive |
| Manufacturing | |
| Factory Location | China |
| Ship To Port | |
| Transport Mode | Rail |
| International Port and Customs | |
| Port Location | China |
| International Shipping | |
| Transport Mode | Sea |
| Domestic Port and Customs | |
| Port Location | Dover sea port |
| Shipment To Distribution Centre | |
| Transport Mode | Road |
| Distribution Centre | |
| Location | Milton Keynes |

The domestic port locations consist of four airports and eight seaports. The “Distribution Centre” location can be selected from a drop down list of over 100 major towns in the UK as well as the all the counties which can be used if a distribution centre is nowhere near a major town. The facilities and transport links between them are displayed on a map adjacent to the data fields. If a factory location is changed to another part of the world, the map automatically changes to display the correct world region.










The same data is requested for the second comparative sourcing location. If the UK is chosen, then the supply chain covers the same fields of information but limited to manufacturing data, data covering transport from the manufacturing centre direct to the distribution centre, and data for the distribution centre itself.

5.3. Results

There are three outputs from the model: a results table, a graphical representation of the results and a graphical assessment of risk.

Selecting either the “Calculate” or the “Results Table” button on the main input form, causes the model to perform analyses of the input data to produce a table of results for each of the two sourcing locations, as shown in Figure 18.

Figure 18: Results screen

| Tabular Comparison of Results | | | | | | | | | |
|-------------------------------|---|---|---|---|---|---|---|---|--|
| |  |  |  |  |  |  |  |  |  |
| Function | Manufacturer | Inland carrier | Port of despatch | International shipping | Port of receipt | Inland carrier | Distribution centre | Other | Total |
| <u>Globally Sourced</u> | China | Sea | China | Air | London sea port | Road | Milton Keynes | | |
| Cost per unit | £6.67 | £0.43 | £0.53 | £9.50 | £1.87 | £0.05 | £4.00 | £3.76 | £26.81 |
| Cost as a % of sales | 13.9% | 0.9% | 1.1% | 19.8% | 3.9% | 0.1% | 8.3% | 7.8% | 35.5% |
| Kms travelled | 0 | 2623 | 0 | 14290 | 0 | 83 | 0 | 0 | 16996 |
| Kgs CO ₂ per unit | 0.00 | 33.76 | 0.00 | 8063.85 | 0.00 | 2.41 | 0.00 | 0.00 | 8100.02 |
| Days | 0 | 8 | 2 | 1 | 2 | 1 | 0 | 0 | 14 |
| <u>Globally Sourced</u> | North America | Rail | North America | Sea | Dover sea port | Road | Milton Keynes | | |
| Cost per unit | £13.33 | £0.81 | £1.07 | £2.11 | £3.73 | £0.06 | £4.03 | £7.11 | £32.25 |
| Cost as a % of sales | 27.8% | 1.7% | 2.2% | 4.4% | 7.8% | 0.1% | 8.4% | 14.8% | 69.3% |
| Kms travelled | 0 | 2207 | 0 | 9239 | 0 | 206 | 0 | 0 | 11529 |
| Kgs CO ₂ per unit | 0.00 | 43.70 | 0.00 | 118.91 | 0.00 | 2.41 | 0.00 | 0.00 | 165.02 |
| Days | 0 | 7 | 1 | 17 | 1 | 1 | 0 | 0 | 27 |

Back

Next

Close

Open Options Window

Update Table

The results show values of cost per unit, kilometres travelled, kilograms of carbon dioxide per unit and days travelled for each of the facility locations and transport modes in the supply chain. There is an additional heading of “Other” which represents the cost per unit for those costs that come under the heading of “General Costs” in the “Costs” data entry. At the present time, the carbon dioxide emissions are only calculated for the transport modes, but not for manufacturing.

Various ‘what if’ analyses can be performed by modifying any of the values shown in white on the Results table or alternatively pressing the Open Options Window button. This displays a screen as shown in Figure 19.

Figure 19: Scenario modelling options window

| | China | North America |
|-------------------------------------|------------------------|------------------------|
| Transport Cost Basis | Synthesised | Synthesised |
| Selling Price per Unit (£) | 48.00 | 48.00 |
| Annual Production (Units) | 150000 | 150000 |
| Annual Container Equivalents | 300 | 300 |
| Incoterms 2000 | CFR - Cost and Freight | CPT - Carriage Paid To |
| Weeks Of Stock | 10 | 6 |
| Stockholding (%) | 25 | 20 |

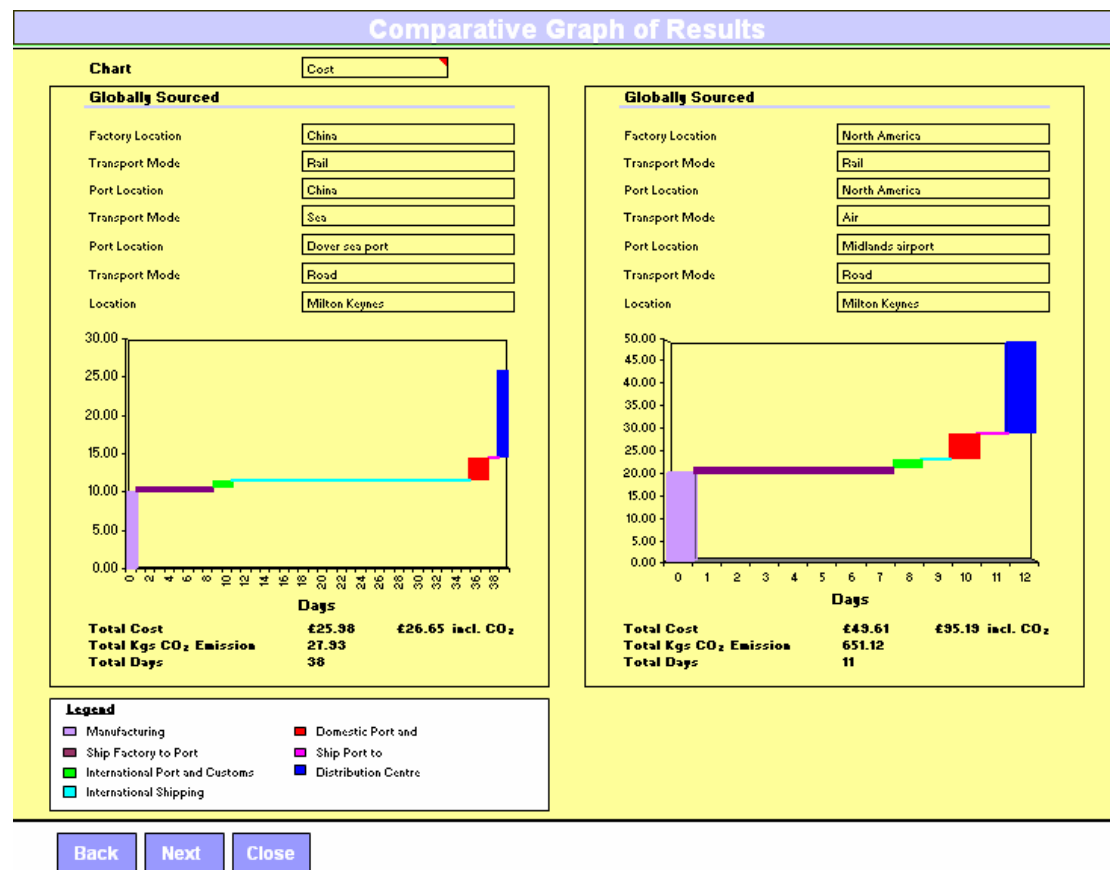
Close Window

The current values for the two sourcing locations are displayed. Again, the values displayed in the white boxes may be changed. If required, the user can select the synthesised cost option which uses default cost values for different transport modes. In the case of offshore manufacturing this is for moving goods between manufacturer and port of despatch, the international shipping movement and the moving of goods between port of arrival and the distribution centre. For local UK based manufacturing the only movement is between manufacturing location and the distribution centre. When complete, select the “Close Window” button and the main results table is displayed. Pressing the ‘Update Table’ button recalculates the data based on the new values.

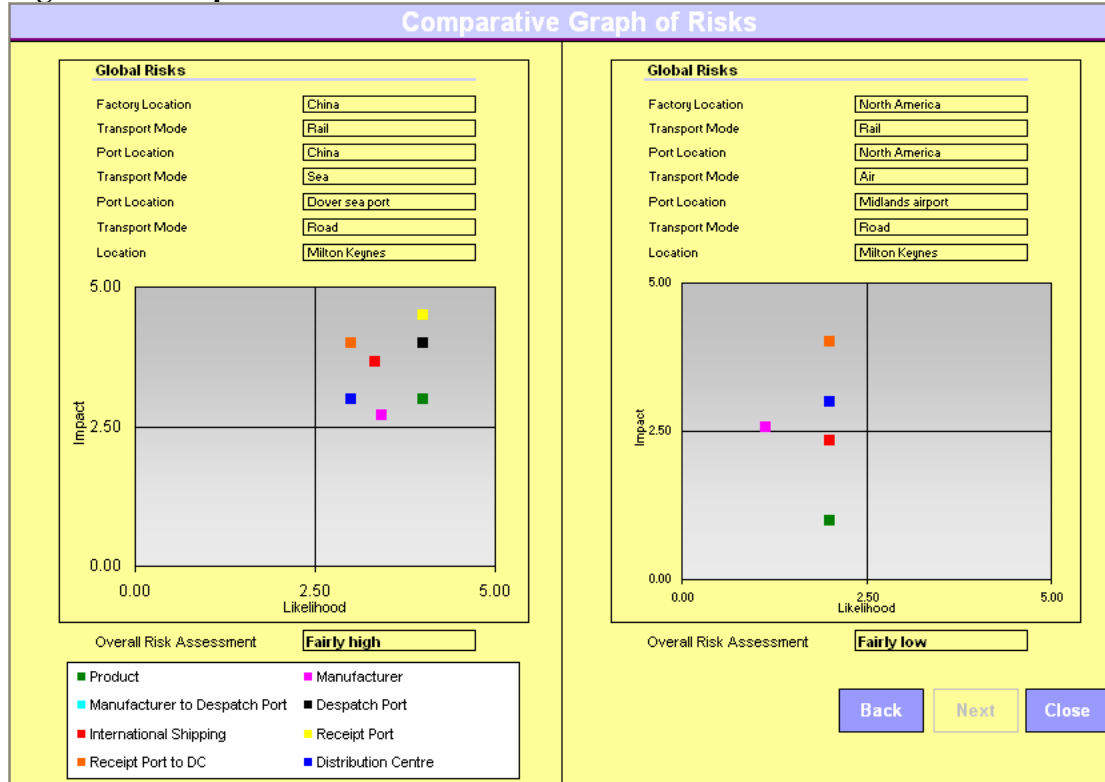
The “Next” button displays a graph of these results, shown in Figure 20. There is an option to display either cost or carbon dioxide for each of the facilities and transport modes spread over the days travelled to move the goods from the manufacturing location to the distribution centre in the UK.

For clarity, each of locations and transport modes are displayed above the graphs. Below the graphs, the total cost, carbon dioxide emissions from transport and days are shown. There is also a cost including carbon dioxide emissions using the cost per tonne specified in the “Costs” data entry worksheet.

Figure 20: Graphical representation of the results



The “Next” button displays the final graph, shown in Figure 21, and represents an assessment of the risks. The graph is a 5 x 5 analysis of likelihood and impact. Each of the risk elements under the appropriate supply chain element have been amalgamated to produce a single risk factor and displayed by its appropriate colour on the graph. Below the graph all the risks have been assessed to produce an overall risk assessment for sourcing from each of the two manufacturing locations. For clarity, each of locations and transport modes are displayed above the graphs.

Figure 21: Graph of risks

5.4. Assumptions

Embedded within the model are a number of values that have been derived from analysis or sourced from experts. These are used to make the calculations of the model.

5.4.1. Carbon Dioxide Emissions

There are a number of sources providing information about carbon dioxide emissions from different transport modes. Table 7 shows four sources of information and the estimated values of CO₂ emissions per metric tonne kilometre from air, sea, road and rail. Two of those sources split air into long medium and short haul, sea into inland coastal and ocean going, and rail into diesel and electric locomotives. There are some similarities between these studies but estimating CO₂ emissions is extremely complex and it is inevitable that there will be differences. For instance, to estimate CO₂ for an electric locomotive the electricity source must be identified and this could be coal, gas, oil or nuclear powered, each producing different levels of CO₂. Similarly, in order to estimate the emissions per tonne kilometre, a typical carrying capacity for the

transport has to be assumed. According to Boeing, 70% of freight arrives on passenger aircraft (DfT, 2000:12), in which case it is difficult to apportion CO₂ between passengers and freight.

Table 7: Comparison of carbon dioxide emissions by transport mode

| <u>Gms CO₂ per metric tonne km</u> | Air (short haul < 452kms) | Air (medium haul 452 to 1600 kms) | Air (long haul > 1600 kms) | Sea (inland ship) | Sea (ocean ship) | Road (40 tonne HGV - diesel) | Rail (Diesel loco) | Rail (Electric loco) |
|---|---------------------------|-----------------------------------|----------------------------|-------------------|------------------|------------------------------|--------------------|----------------------|
| WRI-WBCSD GHG Protocol Initiative, June 2003 | 1,580 | 800 | 570 | 35 | 10 | 30 | 20 | 40 |
| NTM, Sept 2005 | 1,925 | 867 | 633 | - | 15 | 33 | 17 | 1 |
| INFRAS/Univ. of Karlsruhe (TRENDS1 database) - External Costs of Transport, Oct 2004 | | 673 | | 31 | | 91 | 38 | 19 |
| IFEU, 2004 quoted in AEA Technology, Environmental Costs of Rail Transport, Aug, 2005 | | 671 | | 34 | | 29 | 34 | |
| Calculation based on 2.7kgs CO ₂ /litre & 8 mpg (29.4 l/100km) | | | | | | 28 | | |
| Calculation based on 2.7kgs CO ₂ /litre & 6 mpg (29.4 l/100km) | | | | | | 38 | | |
| Values to be used in GSP model | 1,580 | 800 | 570 | 33 | 13 | 30 | 20 | |

The sources of information used to construct Table 7 are described below.

- GHG Protocol Initiative:** The Greenhouse Gas Protocol Initiative was established to develop an internationally accepted standard for accounting and reporting of greenhouse gas emissions by two organizations. These were the World Resources Institute (WRI) which is an environmental think tank and the World Business Council for Sustainable Development (WBCSD) which involves 180 companies from 30 countries and 20 industrial sectors, as well as more than 50 business councils, all in a shared commitment to sustainable development through economic growth, ecological balance and social progress. They have developed a spreadsheet which allows specific emissions to be estimated for different transport modes (<http://www.ghgprotocol.org/DocRoot/7NmWvnZLTBdCB73po4tL/co2-mobile.xls>).
- The Network for Transport and Environment (NTM):** is a Swedish non-profit organisation, which began in 1993, with the aim of establishing a common base of values on how to calculate the environmental

performance for various modes of transport. NTM offers a calculation method and relevant environmental data (<http://www.ntm.a.se/ntmcalc/MainP.asp>).

- **TRENDS1 Database:** A study of the external costs of transport by two independent institutes, INFRAS (Zurich) and IWW (University of Karlsruhe) was commissioned by the UIC (International union of railways) and the CER (Community of European railway and infrastructure companies) in 2004. The results involved an assessment of carbon dioxide emissions by various transport modes (INFRAS & University of Karlsruhe, 2004).
- **Environmental Costs of Rail Transport Report:** AEA Technology undertook a study in 2005 for the Office of Rail Regulation (ORR). This was part of ORR's overall review of the structure of Network Rail's costs and charges. The purpose was to understand the current state of knowledge that exists about the environmental impact of rail transport. It commissioned this scoping study to examine and report on these impacts and the potential implications of introducing a charge to reflect environmental costs (IFEU, 2004).
- The final two calculations were based on a road vehicle with typical fuel consumption, from which CO₂ can be estimated using a figure of 2.7 kgs. of CO₂ per litre of diesel fuel (Australian Greenhouse Office, 2003))

Values were selected from this range of options, to be used within the model, as shown in the last line of the table in Table 7.

5.4.2. *Transport Costs*

The model allows for the use of annual transport costs as input by the user, or alternatively synthesised costs. For the synthesised costs, two major international carriers supplied estimated transport costs for shipping goods by air and sea, and for selected road movements, from the offshore locations specified in the model, to the UK.

Where there are omissions, road transport costs have been estimated using UK values from Motor Transport Cost Tables, for a 38 tonne vehicle carrying a 20 tonne load.

These costs have been modified by applying an estimated country factor to reflect typical transport operating costs within each country as follows:

| | |
|-------------------|-----|
| • United Kingdom | 1.0 |
| • Africa | 0.3 |
| • China | 0.3 |
| • Czech Republic | 0.7 |
| • Hungary | 0.7 |
| • India | 0.5 |
| • North America | 0.9 |
| • Poland | 0.7 |
| • Slovakia | 0.7 |
| • South America | 0.4 |
| • South East Asia | 0.3 |
| • Sri Lanka | 0.4 |
| • Turkey | 0.7 |

Rail costs have been derived from MDS Transmodal – Intermodal Rail Costs (MDST, 2001), which provided cost values for traction, wagon, UK and continental track cost and terminal lifts. These costs have been inflated by 25% to reflect current day costs.

5.4.3. Distance Calculations

The sea-based distances are actual figures but the air, road and rail distances have been estimated using calculation based on the latitude and longitude coordinates of the two locations. The estimate respects the curvature of the earth and has been multiplied by a factor of 1.2 to reflect additional topography.

5.4.4. Time Calculations

The number of days to move goods, internationally, by sea, have been obtained from a major shipping line. Other days have been estimated as follows:

- Air: All movements take 1 day
- Rail: All international and offshore internal movements take 1 day for each 400km travelled, or part thereof, plus 1 further day

- Road: All international and offshore internal movements take 1 day for each 400km travelled, or part thereof
- Rail: All movements within the UK take 1 day for each 500 km travelled, or part thereof, plus 1 further day
- Road: All movements within the UK take 1 day for each 500 km travelled, or part thereof

6. Conclusions

This study has utilised a range of data sources to explore the challenges of global sourcing. Firstly a detailed Systematic Literature Review was conducted to explore the current state of the theory and practice of global sourcing. Whilst there is a growing body of literature available today on the topic of global sourcing, it still seems that there is a gap between theory and general practice. This is particularly evident when considering frameworks such as the ‘Total Cost of Ownership’ which has been widely advocated in the literature but only rarely applied in practice.

The Systematic Literature Review was supplemented by official statistics from governmental and other sources which highlighted the fact that global trade has expanded significantly faster than the growth of the global economy, hence confirming the dramatic increase in global sourcing. Published statistics also point to the continued trend for the increase in the distance that goods travel. Evidence was also gathered on some of the environmental and infrastructure impacts of this increase in global trade – in particular on carbon emissions and the issues of port and road congestion.

It was clear from both the literature and the subsequent case studies that were conducted that the primary motivation for global sourcing was cost reduction. However, the definition of cost generally was somewhat limited – often only including the purchase price, transportation and customs duties. The use of the ‘Total Cost of Ownership’ concept whereby all supply chain costs, risk costs and transaction costs are included was conspicuous by its absence. Even more evident was the lack of consideration of the impact that global sourcing might have on the carbon footprint of the supply chain.

Other motivations for global sourcing include the desire to be closer to emerging markets, although this was often a secondary consideration. A further driver for global sourcing has been the growing UK demand for fresh produce to be available throughout the year. Interestingly, whilst awareness of the so-called ‘food-miles’ issue has clearly grown, so too has the demand for these globally sourced products.

As supply chains continue to become global rather than local or regional, there is an inevitable impact on their risk profile. It is almost always the case that global

sourcing will result in longer pipelines than the local or regional equivalent. Quite apart from the cost of financing the additional inventory that extended pipelines require, the likelihood of variability in the flow and of disruptions to the flow is increased. It is paradoxical that in an era of 'just-in-time' the typical lead-times for re-ordering and replenishment of goods and materials has been increasing as a result of global sourcing.

In the light of the above it is perhaps surprising that the use of formal supply chain risk management procedures in the context of global sourcing decisions is not the norm. Our research identified that more often than not the potential impact of these decisions on supply chain continuity is not formally considered.

Our case studies also revealed that whilst there is a growing awareness of the environmental implications of global sourcing decisions, there are usually no formal mechanisms in place to attempt to measure these effects. However, there seemed to be an emerging groundswell of opinion that the external impacts of supply chain decisions – both the 'carbon footprint' and the congestion efforts - do need to be taken more seriously.

These findings, based as they are on a limited number of case studies, encouraged the research team to explore the opportunities for the development and application of a total cost model that could take into account not just the 'Total Cost of Ownership' as previously defined, but also the potential environmental impact – at least in terms of the carbon effect.

The model enables managers to compare alternative sourcing options and transport modes in terms of the total supply chain cost, including the carbon dioxide emissions that those options create. The model also includes a risk appraisal for each supply chain option. A key feature of the model is the way in which it requires the user to consider all the costs that are involved in global sourcing decisions.

6.1. *Global Sourcing and Supply Chain Sustainability*

There has been considerable concern for some time amongst many academics, businesses and government and non-governmental organisations about the so-called

‘carbon footprint’ of supply chains, however it is only recently that the debate has really taken off.

There is now a growing realisation that in the not-too-distant future, organisations and even individuals will probably have to pay for the carbon impact of their activities. For the business sector, this penalty may take the form of taxes, levies or the capping of allowable emissions under carbon trading regimes. Potentially, these additional costs may bring the commercial viability of their operations into question. Hence the argument is starting to be heard that companies should review their current carbon footprint and identify strategies for its reduction.

For any organisation it is not just the carbon impact of its in-house activities that needs to be understood, but rather the total carbon effect of its wider supply chain. With the current trend to off-shore sourcing continuing apace, the implications for total carbon impact are significant. To understand the true carbon footprint of a supply chain for any product requires the ability to conduct a ‘Through Life’ analysis of the emissions generated from cradle to grave: what is the total environmental cost from raw material sourcing through manufacturing and distribution to consumption and disposal?

This new focus on carbon has served to bring the supply chain into greater prominence – in particular, the decisions that organisations are taking regarding manufacturing and sourcing locations. The significant trend to low-cost country sourcing over the last 10 years or so has transformed the shape of many supply chains, particularly through the creation of longer and more transport-intensive pipelines. It can be argued that, as a result, in some cases, the true costs of global sourcing may be considerably more than companies realise.

It is not only the logistics costs that must be borne by the company that have risen as a result of this trend, but also the external costs in the form of an often enlarged carbon footprint. Because transport represents such a large proportion of total worldwide green house gas emissions – about 20% and growing – it is inevitable that supply chains will be under increasing scrutiny in the future. Put very simply, the search is on for ways to make supply chains less transport intensive.

6.2. *The Way Forward*

It has long been recognised that ‘what gets measured gets managed’. It is now acknowledged by specialists in change management that a powerful means of initiating changed behaviour is through changes in the performance metrics that are utilised. At the moment there are few recognised measures that are utilised to assess the true economic and environmental impact of supply chain strategies.

Our recommendation therefore is that consideration be given to the development of a ‘balanced scorecard’ approach which will enable organisations to better monitor the wider impact of their sourcing strategies as well as providing a means of establishing ‘mileposts’ for improvement targets. In particular it is important that the ‘transport intensity’ of supply chains be better understood and hence the need to include appropriate measures in the scorecard.

Opportunities for reducing the transport intensity of global supply chains may come from a greater focus on load consolidation and the use of logistics ‘platforms’ at both ends of the supply chain. Closely connected with this idea is the concept of postponement whereby generic products are sourced in low-cost locations, shipped in the most carbon-efficient way, for final assembly, configuration or localisation at their final destination. Already many UK companies are exploring these ideas, often in conjunction with using feeder routes from continental ports into less congested ports around the UK. We believe that these ideas should be investigated further.

During the research project it became evident that there are many lessons that could be learned from best practice companies. It is our recommendation that a wider, global review of best practice for sustainable supply chain management be undertaken and that these findings be widely disseminated.

7. References

- Australian Greenhouse Office 2003. Fuel consumption guide 2002/2003. Environment Link Pty Ltd for the Australian Government
- Baumert, Kevin and Pershing, Jonathan 2004. Climate Data: Insights and Observations, Pew Center on Global Climate Change, USA
- Baumert, Kevin, Herzog, Timothy and Pershing, Jonathan 2005. Climate Data: A sectoral perspective, Pew Centre on Global Climate Change, USA
- Bernstein, P.L. 1996. Against the Gods: the Remarkable Story of Risk. John Wiley and Sons: New York
- Bettis, R.A. and Thomas, H. 1990. Risk, Strategy, and Management. JAI Press
- Bhatnagar, R and Sohal, A. S. 2005. Supply chain competitiveness: measuring the impact of location factors, uncertainty and manufacturing practices. Technovation 25/5, p 443-456
- Blackhurst, J, Craighead, CW, Elkins, D, and Handfield, RB. 2005. An empirically derived agenda of critical research issues for managing supply-chain disruptions. International Journal of Production Research 43/9, p4067
- Boge, Stephan 1995. The well-travelled yogurt pot: lessons for new freight transport policies and regional production, World Transport Policy and Practice, 1/1, pp. 7-11
- Bovet D. 2005. Balancing global risk and return. Harvard Business Online. Aug 1st
- Braithwaite A. 2003. The Supply Chain Risks of Global Sourcing. LCP Consulting Supply Chain Strategy and Trends - Globalisation
- Braithwaite, A. and Wilding, R. 2005. The supply chain risks of global sourcing. Working paper of Cranfield School of Management
- Brown, D and Wilson, S. 2005. The Black Book of Outsourcing. John Wiley & Sons: New Jersey
- CAA 2006. Freight Tonnes and DfT 2006. Transport Trends 2006 Edition, DfT (<http://www.dft.gov.uk/pgr/statistics/datatablespublications/trends/current/transporttrends2006>)
- Christopher, M. and Lee, H. 2004. Mitigating supply chain risk through improved confidence, International Journal of Physical Distribution & Logistics Management, 34/5, p 388.
- Cousins P, Lamming R, Bowen, F. 2004. The role of risk in environment-related supplier initiatives. International Journal of Operations & Production Management 24/6
- Cox, A., Townsend, M., 1998. Strategic Procurement in Construction: Towards Better Practice in the Management of Construction Supply Chains. Thomas Telford Publishing, London.
- Das, A. and Handfield, R. B. 1997. Just-in-time and logistics in global sourcing: an empirical study, International Journal of Physical Distribution & Logistics Management, 27, 3/4, p 244.

- DEFRA 2006. Sustainable development indicators in your pocket 2005 – A baseline for the UK Government Strategy indicators', Department for Environment, Food and Rural Affairs, Defra Publications, London (available at http://www.sustainable-development.gov.uk/progress/data-resources/documents/sdiyp2006_a4.pdf) Last visited April 18, 2007
- DfT 2000. UK air freight study report, Department for Transport, December 2000 (available at <http://www.dft.gov.uk/162259/165217/ukairfreightPDF>) Last visited April 18, 2007
- DfT 2006a. Felixstowe South Reconfiguration Inspector's Report, Department for Transport (available at www.dft.gov.uk) Last visited April 18, 2007
- DfT 2006b. Focus on ports: 2006, Department for Transport (available at www.dft.gov.uk) Last visited April 18, 2007
- DfT 2006c. Transport Statistics Report: Maritime Statistics 2005, Department for Transport, September 2006 (available at www.dft.gov.uk) Last visited April 18, 2007
- DfT 2006d. Transport Statistics for Great Britain, Edition 32, Department for Transport (available at http://www.dft.gov.uk/pgr/statistics/datatablespublications/tsgb/coll_transportstatisticsforgreat/transportstatisticsgreatbrit1857) Last visited April 18, 2007
- Eddington, Rod [Sir] 2006. The Eddington Transport Study; The case for action: Sir Rod Eddington's advice to government, December 2006, HMSO, Norwich, UK
- Eisenhardt, K.M. 1989. Making Fast Strategic Decisions in High-velocity Environments. *Academy of Management Journal*. 32/3, p543-576
- Eisenhardt, K. M. b. 1989. Building Theories from Case Study Research. *The Academy of Management Review* 14/4, p532.
- Ellis, J.H., Harris, N.R.P., Lister, D.H. and Penner, J.E. 1999. Aviation and the Global Atmosphere, Intergovernmental Panel for Climate Change (available at: <http://www.grida.no/climate/ipcc/aviation/index.htm>)
- Embleton, PR, Wright PC. 1998. A practical guide to successful outsourcing. *Empowerment in Organizations* 6/3, p94
- Engardio, P. 2001. Why the Supply Chain Broke Down; Their fancy tools blinded tech's wizards to the slowdown. *Business Week*. 3724; p41
- Ettlie, J. E. and Sethuraman, K. 2002. Locus of supply and global manufacturing, *International Journal of Operations & Production Management*, 22/3, p349.
- Evans, M. 2000. The use of Risk Management in the Procurement Selection Process for Engineering Projects. Thesis submitted to UMIST. Manchester University.
- Fagan, M.L. 1991. A Guide to Global Sourcing. *The Journal of Business Strategy* 12/2, p21
- Fitzgerald KR. 2005. Big Savings but Lots of Risk. *Supply Chain Management Review*, 9/9, p16
- Frear, C, Metcalf, L., and Alguire, M. 1992. Offshore sourcing: its nature and scope, *International Journal of Purchasing and Materials Management*, 28/3, p2-11
- Frosdick, S. 1997. The techniques of risk analysis are insufficient in themselves, *Disaster Prevention and Management*, 6/3, p165–177

- Ghauri, P. 2004. Designing and Conducting Case Studies in International Business Research. In Marschan-Piekkari, R. and Welch, C. Handbook of Qualitative Research Methods for International Business. 109-124. UK and USA, Edward Elgar Publishing.
- Giunipero, L. and Eltantawy, R. 2004. Securing the upstream supply chain: a risk management approach. International Journal of Physical Distribution & Logistics Management. 34/9
- Harland C, Brenchley R, and Walker H. 2003. Risk in supply networks. Journal of purchasing & supply management 9, p51-62
- Harvey, F. and Rigby, E. 2007. M&S vows to spend Pounds 200m going green Financial Times [LONDON 1ST EDITION] London (UK): Jan 15, 2007. p. 18
- Howell, R.A. and Soucy, S.R. 1991. Determining the real cost of doing business in a global market. National Productivity Review 10/2, p157-165
- IFEU 2004. *Umweltmobilcheck (Environmental Mobility Check)*, Institut für Energie und Umweltforschung (IFEU) Heidelberg quoted in AEA Technology (Aug 2005): *Structure of costs and charges review – the environmental costs of rail transport*. Final report to the Office of Rail Regulation)
- IMF 2006. Direction of Trade Statistics Yearbook, International Monetary Fund. Statistics Dept; Published: November 24, 2006
- INFRAS & University of Karlsruhe 2004. External costs of transport - update study. Zurich/Karlsruhe
- Intergovernmental Panel on Climate Change (IPCC). 1996. Guidelines for national greenhouse gas inventories – Greenhouse gas inventory reference manual. IPCC WGI Technical Support Unit, Bracknell, UK.
- IPCC 2007. Climate Change 2007: The Physical Science Basis, Summary for Policymakers, IPCC Secretariat, Geneva, Switzerland (available at www.ipcc.ch)
- James, B. 1990. Reducing the Risks of Globalization. Long Range Planning, 23/1, p80
- Jin, B. 2004. Achieving an optimal global versus domestic sourcing balance under demand uncertainty. International Journal of Operations & Production Management 24(11/12), p1292.
- Johnson, J.C. and Wood, D.F. 1996. Contemporary Logistics. 6th Edition. Prentice-Hall: Englewood Cliffs, NJ.
- Jüttner, U., Peck, H. and Christopher, M. 2003. Supply Chain Risk Management: Outlining an Agenda for future Research, International Journal of Logistics, 6/4, p197-210
- Kahneman, D. and Tversky, A. 1997. Prospect Theory: An Analysis of Decision under Risk, Econometrica, 47/2, p 263-292
- Kahneman, D. and Tversky, A. 1992. Advances in prospect theory: Cumulative representation of uncertainty. Journal of Risk and Uncertainty. 5/4. p297-323
- Karjalainen, J; Haatehla, M. P. and Salminen, V. 2003. Risk Sharing in Partnerships Embracing New Product Development. One View, One World of OM? Euroma-POMS Conference, Como, Italy

- Kotabe, M. 1998. Efficiency vs effectiveness orientation of global sourcing strategy: A comparison of U.S. and Japanese multinational companies, *The Academy of Management Executive*, 12/4, p107
- Kotabe, M. and Murray, J.Y. 1990. Linking product and process innovations and modes of international sourcing in global competition: a case of foreign multinational firms, *Journal of International Business Studies*, 21/3, p383-408.
- Kraljic, P. 1983. Purchasing Must Become Supply Management. *Harvard Business Review* (Sept-Oct), 61/5, p109-117
- Lee, H. and Wolfe, M. 2003. Supply chain security without tears. *Supply Chain Management Review* (January/February), 7/1, p12-20
- Levy, D. 1995. International Sourcing and Supply Chain Stability. *Journal of International Business Studies*. 26/2
- Lonsdale, C. 1999. Effectively Managing Vertical Supply Relationships: A Risk Management Model for Outsourcing' *Supply Chain Management: An International Journal*. 4/4, p176-183
- Lowrance, W.W. 1980. The Nature of Risk' in Schwing, R.C. and Albers, W.A. (eds.) *How Safe is Safe Enough?* Plenum Press, New York. NY
- Lowson, R. 2001. Offshore sourcing: An optimal operational strategy? *Business Horizons*, 44/6, p61
- Maersk 2006. Maersk Line takes delivery of EMMA MÆRSK - the world's largest container vessel, 1 September 2006 (source: <http://www.maerskline.com/link/?page=news&path=/news/news20060901>)
- March, J.G. and Shapira, Z. 1987. Managerial perspectives on risk and risk taking *Management Science*. 33 /11, p1404 - 1418
- Markides, C. and Berg, N. 1988. Manufacturing offshore is bad business, *Harvard Business Review*, 66/4, p113-120
- Mcgillivray, G. 2000. Commercial risk under JIT, *Canadian Underwriter*, 67/1, p 26–30.
- McKinnon, Alan 2007. Road transport optimization, in Ed. Waters, Donald, *Global Logistics, New Directions in Supply Chain Management*, Kogan Page: UK
- MDST 2006. UK Port Demand Forecast to 2030, MDS Transmodal Limited, prepared for the Department for Transport (May 2006)
- Meixell, M.J, Garjeya V.B. 2005. Global Supply Chain Design: A Literature Review and Critique. *Transportation Research Part E* 41
- Mesure, Susie 2007. Tesco invests £ 500m to create 'green consumer revolution', *The Independent, BUSINESS* [4TH Edition] London (UK): Jan 19, 2007. pg. 42
- Miles, M. B. and Huberman, A. M. 1994. *Qualitative Data Analysis*. London, Sage.
- Miller, K.D. 1992. A Framework for Integrated Risk Management in International Business. *Journal of International Business Studies*, 23/2, p 311-331
- Min, H. 1994. International supplier selection: A multi-attribute utility approach. *International Journal of Physical Distribution & Logistics Management*. 24/5, p24

- Mitchell, V. W. 1999. Consumer Perceived Risk: Conceptualisations & Models. *European Journal of Marketing* 33 (1/2), p163-195
- Mol, M. 2000. Creating Wealth through Working with Other: Inter-organizational Relationship. *Academy of Management Executive*. 15, p150-2
- Monczka, R.M. and Morgan, J.P. 2000. Outsourcing: Key to many competitive battles. *Purchasing*, 129/3, p85
- Monczka, R. M. and Giunipero, L. C. 1984. International Purchasing: Characteristics and Implementation. *Journal of Purchasing and Materials Management*. 20/3
- Monczka, R., Handfield, R., Frayer, D., Ragatz, G. and Scannell, T. 2000. *New Product Development: Supplier Integration Strategies for Success*. ASQ Press: Milwaukee WI.
- Monczka, R.M. and Trent, R.J. 1991. International Sourcing: a Development Approach. *International Journal of Purchasing and Materials Management*. 27/2, p2-6
- Moore, P. G. 1983. *The Business of Risk*. Cambridge University Press
- Murray, J. Y. 2001. Strategic alliance--based global sourcing strategy for competitive advantage: A conceptual framework and research propositions, *Journal of International Marketing*, 9/4, p 30
- Noy, E. and Ellis, S. 2003. Corporate Risk Strategy: - Does it Vary across Business Activities. *European Management Journal*, 21/1, p119-128
- Penton Publishing 2005 "Port Congestion Likely to Continue Throughout 2005." *Logistics Today*. 37.
- Petersen, K. J., Frayer, D. J. and Scannell, T. V. 2000. An empirical investigation of global sourcing strategy effectiveness, *Journal of Supply Chain Management*, 36/2, p29
- Preston S. 2004. Lost in migration: offshore need not mean outsourced. *Strategy & Leadership*, 32/6, p32
- Quinn, J. P. 2005. European ports tackle congestion. *Logistics Management*. 44/1
- Ramanujam, V. and Varadarajan, P. 1989. Research on Corporate Diversification: A Synthesis. *Strategic Management Journal*, 10/6, p523-551
- Ritchie, B., Brindley, C., Morris, J. and Peet, S. 2000. Managing Risk within the Supply Chain. Cited in Harland, C. Brenchley, R. & Walker, H. 2003. 'Risk in Supply Networks', *Journal of Purchasing and Supply Management*.
- Ritter RC, Sternfells RA. 2004. When Offshore Manufacturing Doesn't Make Sense. The Royal Society Group. 1992. 'Risk: Analysis, Perception and Management, Report of a Royal Society Study Group'. The Royal Society. London.
- Rondinelli, D. and Berry, M. 2000. Multimodel Transportation, Logistics, and the Environment: Managing Interactions in a Global Economy. *European Management Journal*. 18/4
- Rowe, W.D. 1980. Risk assessment approaches and methods, in Conrad, J. (Eds), *Technology and Risk Assessment*, Academic Press: London
- Royal Society Study Group. 1992. *Risk Analysis Perception Management*. London: Royal Society

- Ruefli, T.W.C. and James, T. 1999. Risk Measures in Strategic Management Research: Auld Lang Sync? *Strategic Management Journal*. 20, P 167
- Ryan, L. 2006. The Box that Transformed the World. *Canadian Transportation Logistics*. 109/6
- Samli, A. C., Browning, J. M. and Busbia, C. 1998. The role of international sourcing in corporate strategy, *American Marketing Association. Conference Proceedings*, 9
- Samli, A. C., Browning, J. M. and Busbia, C. 1998. The status of global sourcing as a critical tool of strategic planning: Opportunistic versus strategic dichotomy, *Journal of Business Research*, 43/3, p177.
- Sheffi, Y. and Rice, J. 2005. A Supply Chain View of the Resilient Enterprise. *MIT Sloan Management Review*. 47/1
- Sheffi, Y. 2001. Supply chain management under the threat of international terrorism. *International Journal of Logistics Management*, 12/2
- Simon, P., Hillson, D. and Newland, K. 1997. *Project Risk Analysis and Management Guide (PRAM)*. Association for Project Management: Norwich.
- Simons, R. 1999. How Risky is your Company? *Harvard Business Review*, 77/3, p85-94.
- Smallman, C. 1996. Risk and Organisational Behaviour: A Research Model. *Disaster Prevention and Management*, 5/2, p12-26
- Smith, C., Smithson, C. and Wilford, S. 1990. *Managing Financial Risk*. Harper & Row : New York
- Snow, C.C and Miles, R.E. 1992. Managing 21st Century Network Organisations. *Organisational Dynamics*. Winter, P5-20
- Spekman, R.E, Davis, E.W. 2004. Risky business: expanding the discussion on risk and the expended enterprise. *International Journal of Physical Distribution & Logistics Management*, 34/5, p414-433
- Spekman, R.E. 1991. US Buyers' Relationships with Pacific Rim Sellers. *International Journal of Purchasing and Material Management*. 27/1, p 2-10
- Stern, Nicholas [Sir] 2006. *The Economics of Climate Change: The Stern Review*, Cabinet Office - HM Treasury, UK
- Tchankova, R. 2002. Risk Identification- Basic Stage in Risk Management. *Environmental Management and Health*. 13/3, p 290-297
- Ting, Wenlee. 1988. *Multinational risk assessment and management*. Westport, Conn.: Greenwood Press.
- Trent, R.J, and Monczka, R.M. 2003. Understanding integrated global sourcing. *International Journal of Physical Distribution & Logistics Management*, 33/7, p 607
- Trent, R.J. and Monczka, R.M. 2005. Achieving Excellence in Global Sourcing. *MIT Sloan Management Review*, 47/1, p24
- Turnbull, P. Ford, D. and Cunningham, M.T. 1996. Interaction, Relationship and Networks in Business Markets: An Evoking Perspective. *Journal of Business and Industrial Marketing* 11 (3/4), p 44-62

- Vestring, T., Rouse, T., and Reinert, U. 2005. Hedge Your Offshoring Bets. MIT Sloan Management Review, 46/3
- Vidal, John 2007. CO₂ output from shipping twice as much as airlines, The Guardian, March 3, 2007
- Voss, Chris, Tsikriktsis, Nikos, and Frohlich, Mark. 2002. Case research in operations management. International Journal of Operations & Production Management 22(2), p195.
- Warburton, R.D.H. and Stratton, R. 2002. Questioning the Relentless Shift to Offshore Manufacturing. Supply Chain Management: An International Journal, 7/2, p101-108
- Watkiss, Paul 2005. The Validity of Food Miles as an Indicator for Sustainable Development”, AEA Technologies, Final Report produced for Defra, July 2005
- WTO (World Trade Organization) 2005. International Trade Statistics 2005, World Trade Publications, Geneva: Switzerland
- World Trade Organization. 2005. International Trade Statistics 2005. (http://www.wto.org/english/res_e/statis_e/its2005_e/its05_toc_e.htm)
- Yates, J. and Stone, E. 1992. The Risk Construct’ in Yates, J. F. (Ed) Risk Taking Behaviour. John Wiley & Sons, New York.
- Yin, Robert 2003. Case Study Research: Design and Methods, Applied Social Research Methods Series, Vol. 5, USA: SAGE
- Zheng, J. Johnsen, T. Harland, C.M. and Lamming, R.C. 2001. Taxonomy of Supply Networks’. Cited in Harland, C. Brenchley, R. & Walker, H. 2003. ‘Risk in Supply Networks’. Journal of Purchasing and Supply Management.
- Zhu, Q., Sarkis, J. and Geng, J. 2004. Green Supply Chain Management in China: Pressure, Practice and Performance. International Journal of Operation and Production Management. 25 (5/6)
- Zsidisin, G. A. 2003a. Managerial perceptions of supply risk, Journal of Supply Chain Management, 39/1, p14.
- Zsidisin, G. A. 2003b. A grounded definition of supply risk. Journal of Purchasing and Supply Management, 9/5, p217-224(8)
- Zsidisin, G.A. 2004. An analysis of supply risk assessment techniques, International Journal of Physical Distribution & Logistics Management, 34/5, p397-413.
- Zsidisin, G.A., Panelli, A., and Upton, R. 2000. Purchasing organization involvement in risk assessments, contingency plans, and risk management: an exploratory study. Supply Chain Management: An International Journal. 5/4. pp. 187 – 198

Appendices

7.1. Appendix 1: An Example of the use of search Strings

Subject: Global sourcing & Environment

Database: Proquest

Filter: Only scholarly articles ticked

| | | | | | | | | |
|-----|----------------------------------|-----|-----|----|----|---|----------|----------|
| OR | sourcing | x | x | | x | x | x | x |
| | purchasing | | | | | | x | x |
| OR | "Supply <i>chain</i> management" | x | x | x | x | x | x | x |
| OR | outsourcing | x | | | x | x | x | x |
| AND | Risk | x | x | x | | | x | x |
| | "Risk management" | | | | x | | | |
| | " <i>risk</i> analysis" | | | | | x | | |
| AND | intangible | | | | | | | |
| | Hidden | | | | | | x | |
| AND | dynamic | | | | | | | |
| | responsive* | | | | | | x | x |
| | | | | | | | | |
| | Number of hits | 383 | 149 | 59 | 87 | 5 | 0 | 8 |

7.2. Appendix 2: Paper Review Form

Authors:

Date:

Title:

Abstract:

| Element | Level | | | | |
|---|------------|--------|------------|----------|----------------|
| | 0- Absence | 1- Low | 2 – Medium | 3 - High | Not applicable |
| 1. Implication for project | | | | | |
| 2. Contribution. | | | | | |
| 3. Generalisability | | | | | |
| 4 Methodology. Data Supporting arguments. | | | | | |
| 5. Theory robustness | | | | | |
| OVERALL RELEVANCE TO THE PROJECT | | | | | |

Scope:

Methodology:

Concepts:

Main Findings / Contributions / Arguments:

Evidences of best practice:

Key quotes:

Additional sources of information:

DATE

- 140