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Carlos Mena

Portland State University

Martin Christopher

Cranfield University

Mark Johnson

Cranfield University

Fu Jia

Cranfield University

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Innovation in Logistics Services

30 November 2007

Carlos Mena, Martin Christopher, Mark Johnson
and Fu Jia

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Contact Details:

Dr Carlos Mena

Cranfield School of Management

Cranfield, Bedford

MK43 0AL

Tel. +44 (0) 1234 751122

Fax. +44 (0) 1234 751712

Email. carlos.mena@cranfield.ac.uk

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Innovation in Logistics Services

Executive Summary

The logistics industry manages the flows of products, services and information across customers and suppliers, allowing the integration of supply chains. Innovations in logistics can therefore help improve efficiency and effectiveness across many sectors of the economy. Furthermore, innovation can also have a major impact in reducing the environmental burden of this industry, particularly in terms of pollution and greenhouse gas emissions.

This overall aim of this report is to understand how the government can encourage and facilitate innovation in the logistics industry. The study focuses mainly on the UK and on the role of third party logistics providers (3PLs). However, in order to reflect the global and interconnected nature of the sector; references are made to other countries and industries.

The report starts by providing an overview of the industry, outlining the factors that are driving and obstructing change and innovation. An analysis of the types of innovation that are shaping the industry is then provided alongside examples of some of the most influential innovations.

Measuring innovation in a service industry like logistics is fraught with difficulties. However, it is possible to provide an indication of the general trends using traditional methods such as patents and surveys. On the one hand, trends indicated that compared to other industries in the UK, logistics is not amongst the most innovative, arguably because it is a mature industry where change is evolutionary rather than revolutionary. On the other hand, at an international level, the UK logistics industry appears to be very amongst the top in terms of innovation.

Innovation is a primary concern of industry, and companies are constantly looking for ways to innovate in order to gain competitive advantage. The government can also engage with industry and play a role by providing the right environment for companies to innovate. The analysis led five specific recommendations for the government which are briefly outlined below:

- Research, development and implementation support: to achieve higher levels of effective research and development activity in the logistics industry, particularly regarding technology implementation.
- Collaboration, awareness and dissemination of innovative practices: leading to a more dynamic and better coordinated government activity in facilitating learning and knowledge transfer in the logistics industry, accelerating the diffusion of innovation.
- Supporting the development of standards: to have a coordinated approach to dealing with logistics standards in areas such as infrastructure, logistics assets, information exchange and environmental management.
- People and skills: to reduce the shortage of skilled people and ensure that the industry has people with capabilities for developing, implementing and sustaining innovation.
- Government commitment to cross-departmental strategic thinking for the development of suitable infrastructure and enabling funding to promote sustainable, energy efficient communities that rely so heavily on logistics efficiency.

A general recommendation that applies to the five specific recommendations is the development of coherent government policies and regulations that show consistency at both national and local levels and across different government departments.

1. Introduction

The logistics industry is central to economic, social and environmental sustainability. It is closely linked to issues such as globalisation, employment, economic development, international security, pollution, greenhouse gas emissions, congestion and traffic accidents among others. Furthermore, it is essential to the operation of many other industries, having an impact on key performance indicators such as cost, service delivery, responsiveness and reliability.

Logistics has evolved from being a tactical requirement into a strategic activity that links customers and suppliers by managing the flows of goods, services and information from point of origin to point of consumption. The most common activities associated with logistics are transport and warehousing. However, other activities such as forwarding, customs clearance, packaging, labelling and various aspects of information management are also considered part of logistics.

Although logistics is commonly associated with manufacturing industries, all industries need logistics services; some, like banking, health services and retail require very sophisticated logistics systems. This puts logistics at the centre of economic activity and makes innovation in logistics a key element to improve efficiency and effectiveness across all industries.

This report focuses on innovation in logistics services with particular emphasis on the role of third party logistics providers (3PLs) in the UK. The research is based on a systematic review of the literature and a series of interviews with leading academics and practitioners in the field. The report includes a brief description of the logistics services industry, and presents an analysis of the drivers and barriers of change and the key innovations in the industry. The report concludes with a discussion of the potential role of the government in promoting innovation in this sector.

2. The Logistics Service Sector

2.1. Size

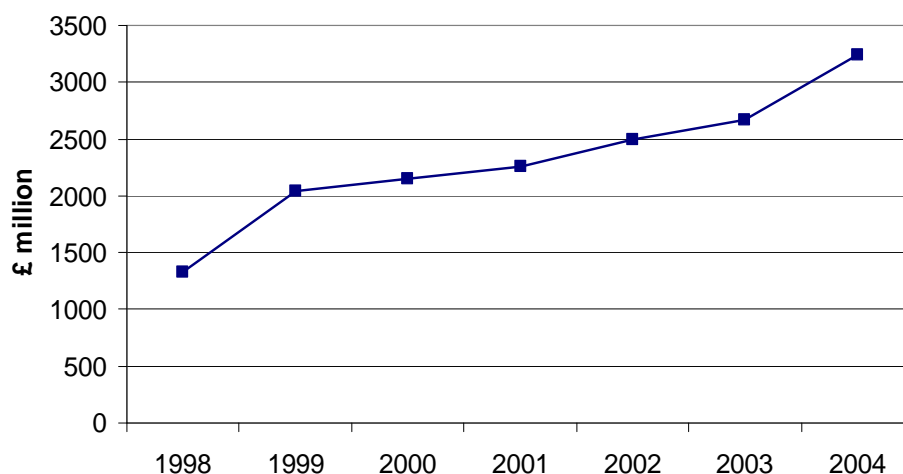
An accurate estimation of the size of the sector in the UK is problematic due to the way statistics are reportedⁱ and the fact that many firms classified as retail or manufacturing undertake logistic activities. As a result, substantial differences exist between figures reporting on the size of the industry. Some reports estimate revenues for the entire UK logistics industry between 5-6% of gross domestic product (GDP), with figures estimating the total revenues for the UK's logistics industry ranging between £66bn and £130bnⁱⁱ. A recent report estimated the total UK market for freight transport and distribution services for 2006 at £74.45bnⁱⁱⁱ.

2.2. Growth and Activity

Traditionally logistics activities were conducted by the user organisation. This changed dramatically in the early 80s with the emergence of third-party logistics providers (3PLs), which offered innovation in logistics through a number of means including information technology. The 3PL industry has grown substantially since then and, according to a recent survey, 64% of all logistics costs in the UK are directed to 3PLs^{iv}. Yearly growth for the industry has been estimated at 6.1%^v.

The trends in terms of total economic output associated with distribution can also be examined by looking at gross value added (GVA)^{vi}. Figure 1^{vii} shows the total GVA of the 'Storage & Warehousing' sector (which is only one component of logistics) from 1998 to 2004, which indicates a consistent upwards trend and a total growth of almost 150% over the 7-year period.

Figure 1: Gross Value Add (GVA) of Storage and Warehousing



Transport trends provide a similar picture. The vast majority of freight moved by road (95%) is transported using vehicles over 3.5 tonnes and Table 1 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 this 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 1 also confirms that rail freight has increased over the same fourteen-year period, but not at the same rate as road freight.

Table 1: Key road freight transport statistics

All vehicles over 3.5 tonnes	Year 1990	Year 2004	Units	% Increase
Road freight moved	131,000	152,000	Million 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	Million tonne km	12.50%

Source: Transport Statistics Bulletin, Transport of Goods by Road and Rail, DfT

2.3. Industry structure

The UK logistics sector is mature and fragmented, with an estimated 80,000 companies operating in the sector^{viii}. Some of the major players such as DHL, Wincanton, Christian Salvesen, TNT and Kuehne + Nagel tend to dominate the market and offer the most sophisticated and innovative services, while a large number of small and medium companies are dedicated to serving niche markets or providing commodity services such as transport. It is estimated that over two thirds of all companies in the industry have a turnover of less than £250,000 per year^{ix}.

Increasing competition and the need to counter the buying power of retailers and manufacturers has fuelled a spurt of mergers and acquisitions in the industry such as the merger of Deutsche Post (DHL) with Exel and the acquisitions of ACR by Kuehne + Nagel and Hammond Logistics Group by Bibby Distribution^x. This new breed of firms can achieve higher efficiencies through economies of scale and have more resources to invest in innovation. It is expected that this trend will continue

with major players looking for expansion in functional and geographic scope in order to offer end-to-end global services.

Third party logistics providers serve a variety of industries with diverse requirements and characteristics. Figure 2 presents a breakdown of the European logistics market by sector showing that the consumer/retail, automotive and high-tech sectors represent over 75% of the market.

Figure 2: European Logistics Market by Sector (Source: Translogistica, 2005)

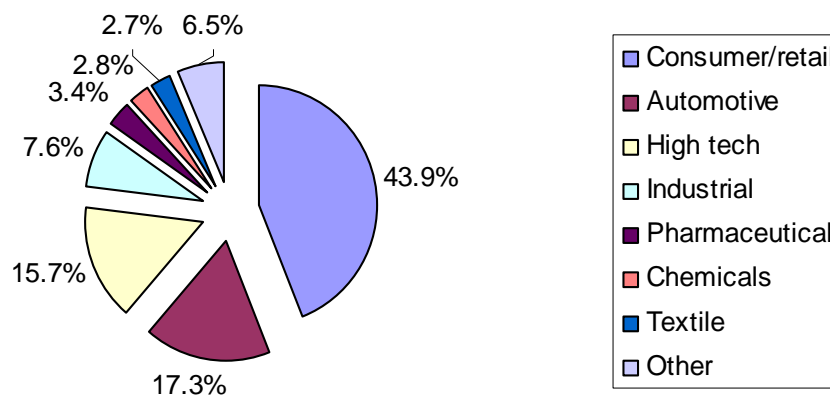


Table 2 expands on the sectoral breakdown by presenting some generic trends of the type of relationships between 3PLs and their customers in each of the main sectors. It shows that the consumer/retail sector tend to use open book arrangements, which offer low margins to 3PLs but also lower risks. Other industries prefer closed book arrangements allowing higher margins but exposing 3PLs to greater risks.

Table 2: Trends in different sectors

	Consumer/ retail	Automotive	High tech	Healthcare/ pharma	Fashion
Growth	Low - upward	Volatile	Volatile	Medium - upward	Regional – downward International – s. upward
Typical contract type	Open book	Closed book	Closed book	Closed book	Closed book
Network/facility	Dedicated	Shared user	Shared user	Shared user	Shared user
Value add potential	Low	Medium	High	High	High
Margin potential	Low	Low-medium	High	High	Medium
Risk potential	Low	Medium-high	High	Low	Low

Source: Translogistica, 2005

2.4. Employment

The logistics industry is important in terms of employment although figures vary significantly between different reports ranging between 1 and 2.5 million^{xi}. Some reports rank it the 5th largest industry in the UK in terms of employment. Figure 3^{xii} shows employment levels and trends in the distribution and warehousing sectors.^{xiii}

Figure 3: Employment trends in the manufacturing and warehousing sectors

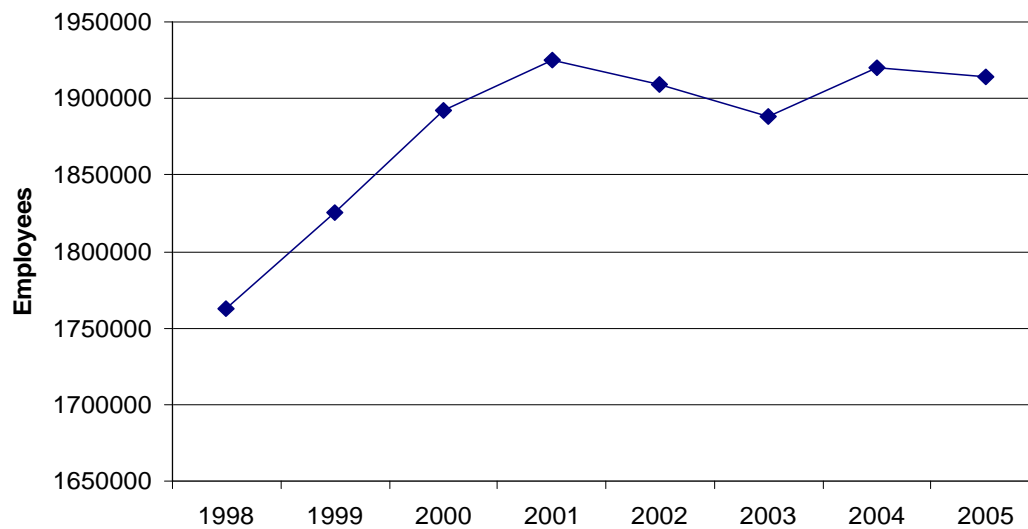


Figure 3, shows substantial growth in employment in the sector until 2001; since then it appears to have stabilised at around 1.9 million employees.

Growth in the sector has created a shortage of drivers and contributed to an increase in the number of female and foreign drivers. The Chartered Institute of Logistics and Transport (CILT - UK) has argued that the industry is facing a possible skills shortage in general if it does not engage young people more effectively. The industry needs a steady stream of fresh talent into the sector and so needs to raise its profile.

2.5. The UK's Logistics Infrastructure

Demand for logistics and transport services is directly linked to economic development. However, to cope with increasing demand logistics, service providers require an appropriate transport infrastructure capable of handling more traffic through ports, roads and airports. Failures and delays in developing the necessary transport infrastructure can have major consequences in terms of delayed deliveries and higher inventory levels, congestion, CO₂ emissions and pollution. Below we present a brief review of the current state of the relevant infrastructure:

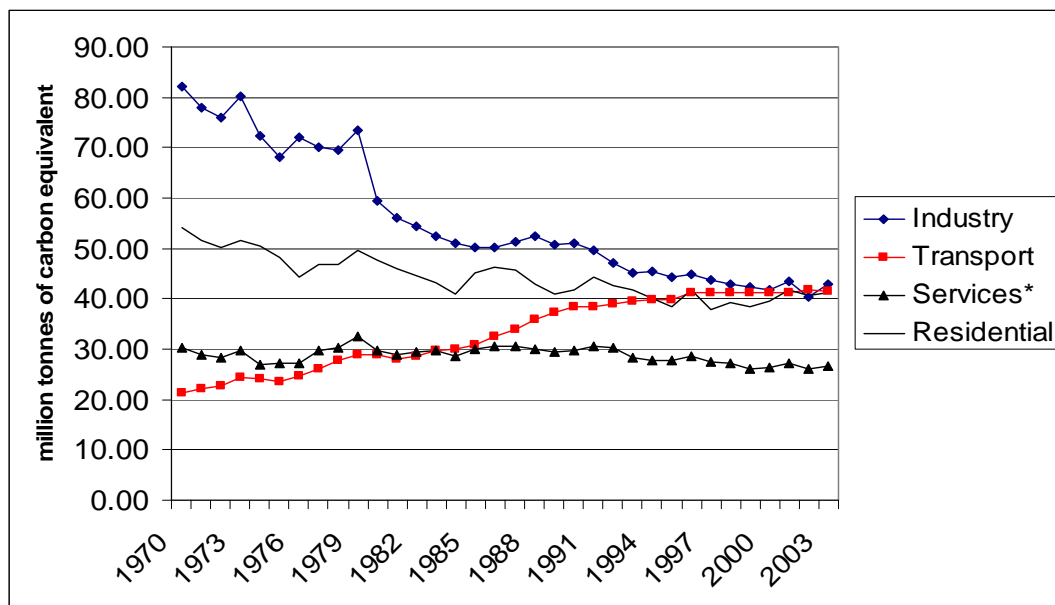
- **Roads:** New roads are expensive to build at estimated costs of £11-15m per mile. However, some projects, like the widening of the M1 between J6a and J10, are going ahead. On the other hand, the RAC Foundation has priced UK road congestion at a potential £30b a year. The Commission for Integrated Transport forecasts a 65% rise in congestion by 2010 and is reporting traffic jams of 3 hours or more per day on more than 11% of key roads. The EC believes that road transport true costs must include pollution, effects on climate change, infrastructure costs and congestion. The DfT has set up the “Sensitive Lorry Mile” measure to assess the social damage caused.
- **Ports:** Between 1985 and 2004 there was a 138% increase in container traffic and a 182% increase in roll-on/roll-off freight movements by weight^{xiv}. Container ports such as Southampton and Felixstowe, which between them handle over 50% of container flows^{xv}, are struggling to cope with growing imports. This has fostered the growth of regional ports and companies locating distribution centres close to ports^{xvi}. It is expected that by 2020, demand at UK ports will reach between 13.1 and 16.1m TEU^{xvii}. 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. However, recent planning decisions in favour expansions at Felixstowe, Bathside Bay and London Gateway will help to address this problem^{xviii}. These expansions will need to be followed by appropriate investments in roads and rail infrastructure to prevent nodal congestion.
- **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^{xix}. One important issue to point out is the high concentration of airfreight volume moving through London airports. Around 55% of the 2.3 million tonnes of airfreight in 2005 was moved through Heathrow airport, with Gatwick and Stansted accounting for around 10% each. These three London airports account for almost 75% of all airfreight volume in the UK.
- **Telecommunications:** Telecoms infrastructure has enabled many of the technological innovations in logistics such as telematics. One example of this kind of infrastructure is the Galileo Positioning System (GPS) currently being developed by the European Union (EU) and European Space Agency (ESA),

which will enable innovative applications such as speed control and road pricing which will help to reduce congestion^{xx}.

2.6. Logistics and the Environment

Logistics activities can have an impact on the environment through the emission of greenhouse gases and pollutants. In recent years, greenhouse gas emissions, believed to cause climate change, have emerged as a particularly difficult problem for logistics service providers. Figure 4 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 other 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 by 50% by 2020^{xxi}.

Figure 4: UK Greenhouse gas emissions

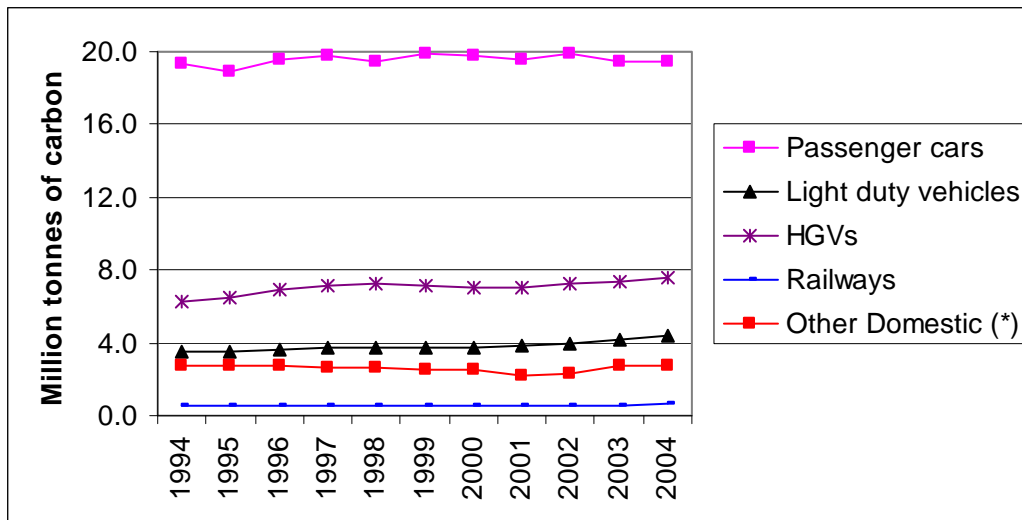


* Services include emissions from commerce, agriculture, exports, land use change and other emissions.

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 is related to passenger cars, which account for over 55% of all domestic transport emissions (see Figure 5). Nevertheless, both HGVs and Light Duty Vehicles, which are responsible for most freight moved, indicate growing trends and contribute 21% and 12% of total domestic emissions respectively.

Figure 5: UK Greenhouse gas emissions for domestic transport

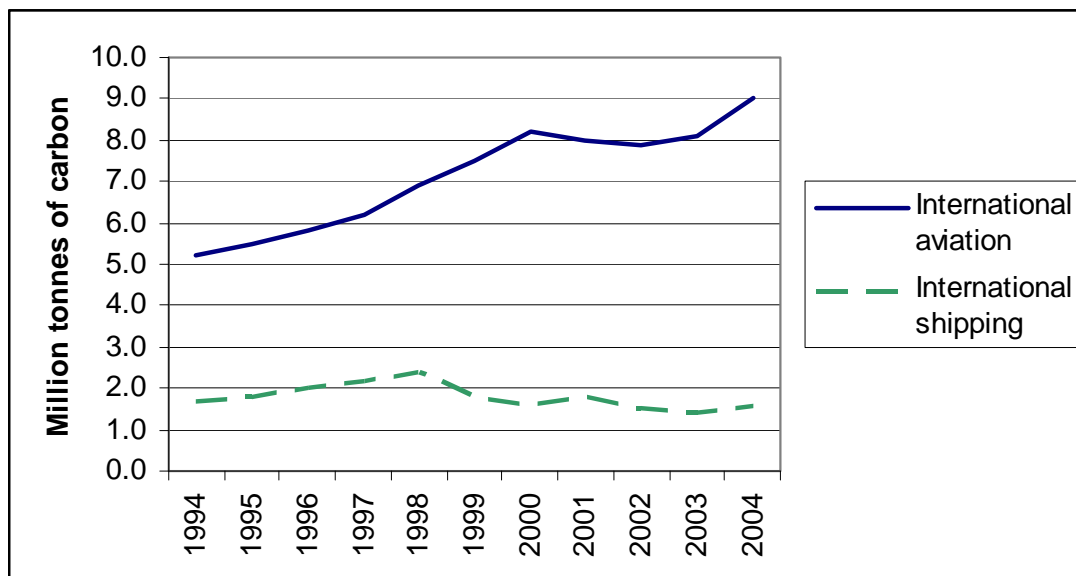


* Other domestic includes buses, mopeds, motorcycles, civil aircraft and domestic shipping

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

Greenhouse gas emissions from international aviation and shipping can also be associated with the logistics industry. Trends for these two variables are plotted in Figure 6 which shows that international aviation has an increase of almost 80% in the period 1994-2004. International shipping on the other hand, shows a relatively stable trend. However, there have been recent reports that shipping emissions have been underestimated and could account for up to 5% of global CO₂ emissions^{xxii}.

Figure 6: UK-International Aviation and Shipping emissions



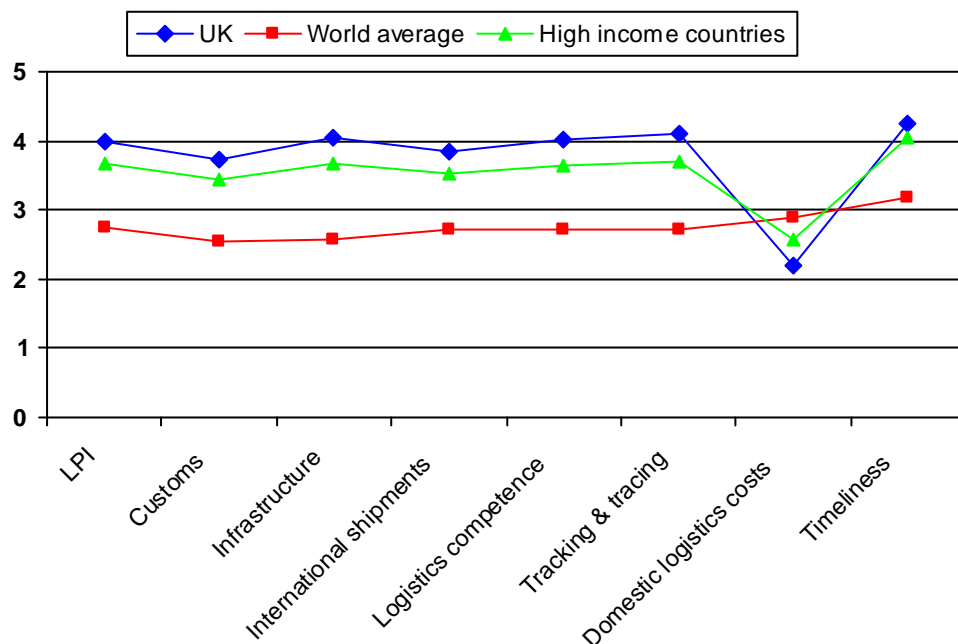
Source: DfT (2006) Transport Statistics for Great Britain, Edition 32, Department for Transport; DEFRA (2006) Sustainable Development Indicators

Environmental issues and particularly emissions of carbon dioxide are one of the major challenges the logistics services industry is currently facing. Decisions related to network design, transport mode selection and vehicle utilisation can have a substantial impact on the environment and companies are looking for innovative ways to improve their environmental footprint.

2.7. International Comparison

A recent study by the World Bank ranks the UK as 9th out of 150 countries in terms of logistics performance^{xxiii}. This study breaks down logistics performance into seven dimensions: customs, infrastructure, international shipments, logistics competence, tracking and tracing, domestic logistics costs, and timeliness. The UK performs strongly in international shipments (6th place), tracking and tracing (6th) and logistics competence (7th). However, it ranks in 143rd place in terms of domestic logistics costs. Appendix 1 presents a breakdown of the results for the top 20 countries in this survey. Figure 7 presents a comparison of the UK with the world's average and the average for high-income countries across the seven dimensions. A complete breakdown of the top 20 countries in the study is included in Appendix 1.

Figure 7: International Comparison



Source: World Bank, 2007 (Arvis, Mustra, Panzer, Ojala and Naula, 2007)

3. Drivers and Barriers to Change

The drivers of change and competition in the industry have been assessed using the PESTLE model which breaks down the analysis into Political, Economic, Social, Technological, Legal and Environmental factors. Table 3 presents the main drivers under each of these categories.

Table 3: Logistics Services Industry PESTLE analysis

<p>Political</p>	<ul style="list-style-type: none"> ▪ Transport and communications infrastructure sets limits for logistic activities. Governments play an important role as investors and promoters of investment ▪ Transport planning at a national and regional level. To reduce congestion and provide efficient transport corridors using policies such as road pricing. ▪ Land use issues (e.g. Planning Policy Statement 1 [PPS1] ‘Delivering Sustainable Development’) ▪ Risk and security at ports, roads, trains and airports is increasingly important ▪ Taxation: Fuel and road pricing
<p>Economic</p>	<ul style="list-style-type: none"> ▪ Globalisation is increasing the volumes of goods traded across borders changing logistical flows, inventory levels and the nature of services required ▪ Price and cost driven industry. The majority of customers of logistics services have price as the most important factor in selecting a provider ▪ Longer and more complex chains are decreasing visibility and increasing risk ▪ Migration of clients from commoditised transport, freight forwarding and warehousing companies to integrated supply chain specialists ▪ Increasing regionalisation of demand that favours larger companies providing a wider range of services ▪ Value-adding activities such as packaging and postponement are seen as a route to escape commoditisation ▪ Fragmented and competitive market leading to falling margins ▪ Low margins leading to underinvestment and risk aversion ▪ Balance of power tends to lie with the customers of logistics services ▪ Mergers and acquisition are creating large global players, allowing economies of scale and increasing bargaining power ▪ Search for economies of scale promoting the use of larger warehouses, cross-docking and consolidation centres (Case Study 3 presents an example of a consolidation centre) ▪ Costs and margins are highly dependent on fuel prices ▪ Trends to increasing outsourcing of logistics services affect industry structure

Social	<ul style="list-style-type: none"> ▪ Customers' and consumers' changing needs drive change in the industry, e.g.: <ul style="list-style-type: none"> ○ Growth in home delivery ○ Demand for quick response ○ Demand for fresh produce ○ Carbon footprints (more social conscience about environmental issues) ○ Increasing returns of products, increasing the need for reverse logistics ▪ High employment rates in certain areas leading to difficulties in finding sufficient personnel and increasing rotation ▪ Congestion and accidents and their social impact
Technological	<ul style="list-style-type: none"> ▪ Some of the main technologies affecting the industry include^{xxiv}: <ul style="list-style-type: none"> ○ Visibility tools (shipment tracking/tracing/event management) including telematics, GPS and RFID technologies ○ Web-enabled communications ○ Warehousing / distribution centre management ○ Transport management for both planning and execution ○ Transport technologies (e.g. more efficient vehicles)
Legal	<ul style="list-style-type: none"> ▪ Working time directive ▪ Road transport directive ▪ Deregulation and liberalisation of EU transport ▪ Environmental regulations (see below) ▪ Lorry Road User Charging (LRUC) [scrapped] and other proposals for taxation
Environmental	<ul style="list-style-type: none"> ▪ Global warming: Increasing contribution of transport to CO₂ emissions ▪ Contribution to air, water and noise pollution ▪ Impacts of transport include congestion and traffic accidents ▪ Reverse logistics: Increasing importance of recycling / reuse of material has led to increase in the importance of warehouses and reverse logistics operations. ▪ Directives such as End-of-Life Vehicle Life (ELV) legislation and the Waste Electrical and Electronic Equipment (WEEE) directive have an impact on the industry ▪ Oil and gas are not sustainable. There is a need for alternative solutions.
Sources: Fenn, D, 2007, Johnson and Harrison, 2007; Capgemini, 2006	

4. Innovation in Logistics

Logistics innovation has been defined as “*any logistics related service from the basic to the complex that is seen as new and helpful to a particular focal audience. The audience could be internal where innovations improve operational efficiency or external where innovations better serve customers.*”^{xxv}

Innovations are usually classified into two broad groups: technical / technological and administrative / non-technological. The former refers to technologies for data acquisition, information management, warehousing and transportation; the latter to changes in structures, business processes, customer and supplier relationships management and knowledge management issues that lead to innovation^{xxvi}. The following two sub-sections summarise the most influential technical and administrative innovations respectively.

4.1. Technological Innovations in Logistics

“...innovation is gaining importance in the logistics industry. The advent of new technologies and globalization has inspired firms to look for new solutions for the challenge of business in today’s competitive landscape.”

Nagarajan and White, 2007

It could be argued that Information and Communication Technologies (ICTs) have played a key role in driving change in logistics over the last 25 years; however ICT includes many different technologies, ranging from transport planning and scheduling software through to radio frequency identification (RFID) and telematics. Furthermore, other areas of technology such as transport technologies can also have a substantial impact in the industry. Below we describe some of the most influential technologies of recent years alongside case studies that exemplify their use.

- Telematics refers to a set of technologies used to monitor and control remote devices (e.g. shipment tracking and tracing, vehicle diagnosis and driver hours monitoring). For instance, satellite tracking systems can enable operators to position and track vehicles to assist real-time planning. Case study 1 presents an example of an application of telematics in vehicle tracking and Case study 2 discusses some of the potential benefits of the technology.

Vignette 1: Vehicle Tracking at Marshalls Plc

Marshalls is manufacturer of natural stone and concrete paving products, for the construction, home improvement and landscape markets. The company owns its own quarries and manufacturing sites and distributes from a network of 12 manufacturing and service centres.

In 2004 Marshalls piloted a telematics solution from Cybit and later rolled it out to a fleet of 150 vehicles. This system has enabled them to monitor the fleet in real time improving efficiency by over 20 percent and allowing them to be more responsive to changes in the environment.

“If anything goes wrong on the road - be it traffic, a breakdown, a hold up at a customer’s site or an accident - we are aware of it within five minutes... This knowledge allows us to re-plan, re-prioritise and reschedule our delivery workload, to meet our customers’ needs and maintain maximum delivery output.”

Stewart Potter, Group Logistics Manager at Marshalls

- Information technology infrastructures that integrate information systems between organisations in a supply chain. This is also leading to the development of control towers and web-based services which provide real time end-to-end visibility of the supply chain.
- Radio Frequency Identification (RFID) can be used to track-and-trace merchandise/assets throughout the supply chain. Although few companies have implemented this technology into their supply chains a recent survey revealed that a third of companies were actively evaluating the technology for supply chain applications and a further 12% will implement it within the next two years^{xxvii}.
- Vehicle routeing, scheduling and transport management systems as well as warehousing automation and management systems are helping to improve efficiency and effectiveness in the industry. These systems can help in both planning and executing transport activities and are particularly useful for multi-drop deliveries which have increased with internet retailing. In combination with telematics, routeing and scheduling systems can react to real-time information, improving service while reducing time and cost. Some of these systems can be programmed to minimise CO₂ emissions.
- Digital administration, such as electronic signatures for proof of delivery. An example of this is Eurotunnel who introduced an automatic check-in system which is today used by more than 80% of its truck customers¹ with a proven reliability. The system reduces the average transaction time to just 45 seconds for

¹ Eurotunnel transported 1,296,269 trucks in 2006

each truck. The equipment is made up of touch screens which offer information for drivers at check-in in nine European languages, automatic number plate readers and sensors which measure vehicle size.

Vignette 2: Telematics

Telematics is the result of several technological advancements in the fields of satellite navigation, digital mapping and telecommunications which are allowing a more efficient and effective operation of the supply chain. For this reason telematics is sometimes referred to as Intelligent Transport.

Telematics covers a range of applications, some of the most common uses of telematics include:

- **Tracking and tracing:** allowing visibility of shipments making the entire supply chain more responsive by permitting efficient routing of trucks. In addition these systems can be used to keep customers informed of any problems with delivery of their consignments and to monitor customer service performance. The benefits can be substantial. For example, United Biscuits has recently equipped its fleet with a tracking and tracing system and estimate the benefits at approximately £100,000 per year without considering customer service benefits.
- **Routeing and Mapping:** giving drivers a visual representation of their progress helping them to make the best use of time and fuel.
- **Geofencing:** this kind of application can alert users when a vehicle enters a particular facility, goes out of its operating area or goes into a prohibited area. This can be used for security purposes.
- **Advanced traffic management applications:** other applications such as automatic toll-collection devices, "smart" roadside signs linked to sensors monitoring traffic volumes and automatic vehicle control systems are currently being explored.

The cost of developing and implementing telematics systems is high but the cost of congestion can be even higher. Public spending programmes supporting telematics could potentially increase the capacity of road and rail networks and this is a very attractive proposition when compared to building new transport infrastructure.

Sources: Batchelor, 1999 and FDT, 2005

- Transport technologies such as electric vehicles, use of alternative fuels, double decks, improved aerodynamics are helping to make logistics greener and more efficient. Most of the emphasis in the field of green logistics in recent years has focused on the reduction of CO₂ emissions from transport.

4.2. *Administrative Innovations in Logistics*

Administrative innovations have also had an important impact on the logistics industry. Arguably the most influential has been Just-in-Time (JIT). However, many other administrative innovations are shaping the industry. Some authors have argued that this type of innovation, which involves people and processes, leads to more

sustainable competitive advantages for the companies developing them because they tend to be more difficult to copy than technologies which are usually provided by external suppliers. Some of the most influential administrative innovations of recent years are described below.

- Just in Time (JIT) has had a major impact on logistics because it has promoted the use of smaller and more frequent deliveries. Furthermore, JIT uses a *Kanban* (signalling) system to pull products from the supply chain rather than a traditional push system based on demand forecasts. JIT has already been implemented by many firms in the UK. However, it is a good example of administrative innovation in logistics which continues to have an impact today.
- Value added services such as warehousing, co-packing, co-manufacturing, labelling, postponement and mass-customisation are expanding the role and importance of logistics providers in the supply chain. These can also be interpreted as attempts to escape commoditisation in the industry.
- The concept of fourth party logistics (4PL) is an extension of the traditional third party logistics (3PL) which involves outsourcing logistics services to a company that does not necessarily own the assets and resources. These companies own the computer systems and intellectual capital and tend to offer end-to-end logistics services on a global scale.
- Collaboration with customers, suppliers and even competitors (sometimes called Coopetition), has been described as an important innovation in the industry which can help to minimise waste and increase responsiveness (e.g. backhauling to reduce empty running). An example of this is the use of shared services such as warehousing, transport and consolidation which is helping groups of logistics companies to use their resources more effectively (Case study 3 presents the example of Heathrow Airport consolidation centres).
- Another form of collaboration amongst competitors is the formation of alliances among SMEs in order to compete. For instance, the development of pallet networks which are groups of independent logistics providers that collaborate to distribute small consignments and provide other value added services.
- Green logistics have recently become a fertile area for administrative innovation. For instance efforts are being made to achieve a better integration of forward and

reverse chains to improve vehicle utilization and reduce emissions. Another example is the progress made in dealing with end-of-life and returned product in terms of sorting, testing, brokering, forwarding and recycling products. Similarly, innovative solutions are emerging to deal with supply chains that involve decontamination, waste treatment, such as the integration of tray washing for major food retailers with waste treatment and energy generation being undertaken by logistics providers.

Vignette 3: Heathrow Airport Consolidation Centres

BAA plc is the world's largest airport company which owns and operates seven UK airports handling over 100 million passengers each year. BAA is also one of the UK's largest commercial landlords, providing over 1 million m² of commercial accommodation and is one of the construction industry's largest clients.

Heathrow airport represents a particular challenge for the company due to the dramatic increase in activity over the past ten years without major changes to infrastructure. Congestion around airport roads and at loading bays became a significant problem causing lengthy and unpredictable deliveries for both retail outlets and for construction sites within the airport, including Terminal 5. BAA's challenge was to find an innovative logistics approach that would improve efficiency and reduced congestion and pollution.

The solution was to establish a series of off-airport consolidation centres. The first of these – a dedicated retail operations consolidation centre – opened in 2001. This was followed by a construction consolidation centre serving projects in Terminals 1-4 and later by two consolidation centres supporting the construction of Terminal 5.

These consolidation centres act as shared distribution centres for the retail and construction companies operating at Heathrow. This involves collaboration not only between BAA and the logistics providers running the centres but also with all the retail and construction users.

The most direct benefit from the operation of the consolidation centres at Heathrow has been the reduction in the number of vehicles travelling to the terminals, thereby reducing congestion and the associated environmental impact. However, most stakeholders at Heathrow airport have obtained additional benefits:

- Retail and construction companies have benefited from faster, more frequent and more reliable deliveries as well as potential reductions in costs
- Suppliers now have a single point delivery which doesn't suffer from time and vehicle size restrictions.
- BAA has been able to increase security and improve efficiency of flight operations such as aircraft refuelling, baggage handling, flight catering.
- Passengers and the community as a whole have benefited from the reduction in congestion and improvements in air quality, waste management and recycling

The consolidation centres at Heathrow have been very successful both commercially and environmentally, winning both the Chartered Institute of Logistics and Transport Environmental Award and the Sustainability in Construction award. They are a good example of how an innovative approach to logistics can deliver benefits to multiple stakeholders.

Sources: DFT, 2003; BAA, 2007; Bastien, 2007

- Changes in organisational structure are also forms of innovation. For instance, some logistics companies have re-organised their businesses into vertical sector specific business units, which allows them to focus on specific industry requirements, build long-term relationships and have more targeted marketing and brand development activities.
- Other administrative innovations include cross-docking (i.e. bypassing storage), the use of alternative modes of transport (e.g. use of inland waterways) and the use of Combined Import Processing and Distribution Centres (CIPDCs) at ports.

5. Enablers of Innovation in Logistics

This section presents an evaluation of the enablers of innovation in logistics. The initial analysis included both enablers and inhibitors. However, when all the information was synthesized it became clear the inhibitors were a mirror image of the enablers. For instance, if collaboration is an enabler, the lack of collaboration would be an inhibitor. The results, presented in Table 4, have been classified into Industry / Environmental factors and Organisational factors.

Table 4: Enablers of Innovation in Logistics^{xxviii}

<p>Industry / Environmental</p>	<ul style="list-style-type: none"> ▪ Customers: changing customer needs present new challenges encouraging the industry to innovate ▪ Competition: efforts to remain competitive by reducing cost and delivering better value to the customer create a need for continuous innovation ▪ Collaboration: working together with customers, suppliers and competitors can lead to learning, knowledge creation and innovation. There is evidence that many logistics innovations are driven and enabled by customers ▪ Technology development: technology from various other industries such as ICT and transportation has enabled innovation in logistics ▪ Infrastructure: Logistics services are heavily dependent on transport and telecommunications infrastructure. Appropriate infrastructure has an impact on efficiency and innovation ▪ Government: discussed in more detail in the final section
<p>Organisation</p>	<ul style="list-style-type: none"> ▪ Leadership: visionary leaders open to innovative ideas and willing to manage risks ▪ Long-term focus: Innovative services tend to deliver results in the medium and long term ▪ Financial Resources: Organisation have to devote financial resources and be realistic with payoff scenarios in order to innovate ▪ People and Skills: a critical mass of people with the right skills and attitude to drive innovation ▪ Organisational structure and size: cross-functional teams and decentralised structures can accelerate the distribution of knowledge in an organisation. Larger organisations tend to have more resources to devote to innovation ▪ Organisational culture and incentives: a collaborative, open culture with incentives and performance measures that reward challenging the status quo ▪ Process and tools: a systematic approach and supporting tools to enable idea generation and elaboration, project management and portfolio management ▪ Information and Communication Technology (ICT): the use of ICT can drive innovation by enhancing communication, processing information and improving cooperation. ICT is considered the key enabler in this process allowing new service design and implementation)

6. Measuring Innovation in Logistics

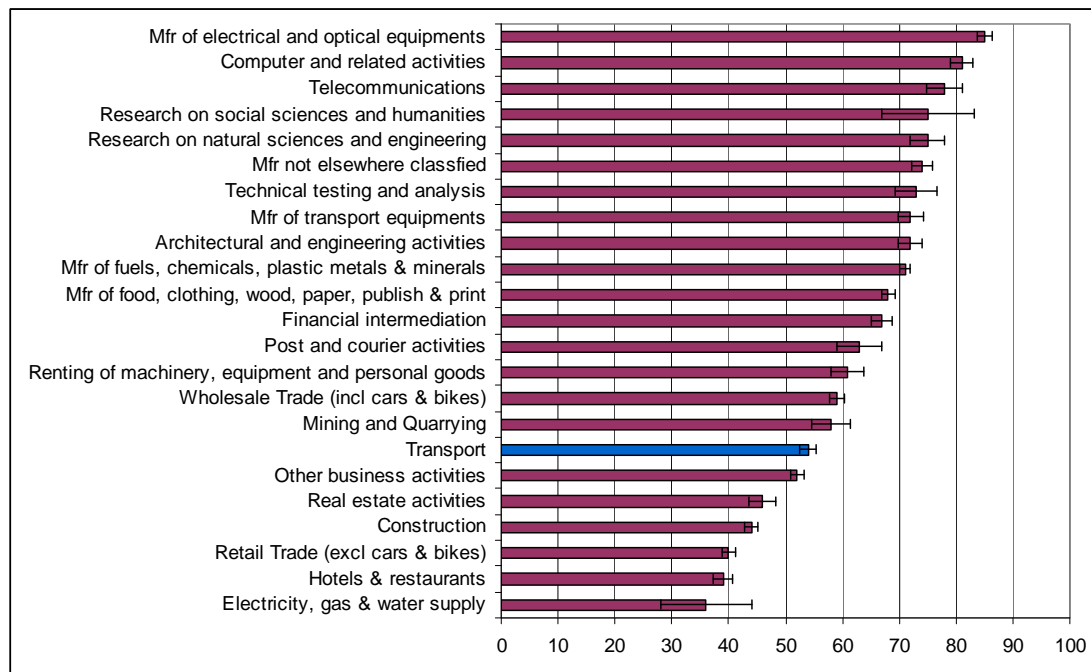
The management of innovation at any level requires a systematic and reliable measurement system which can help to: identify trends, compare different industry sectors, compare regions and countries, identify promising practices and assess the impact of policies and industry initiatives. However, measuring innovation in service industries such as logistics is problematic.

This section presents some results and statistics on the current state of innovation in logistics measured through surveys and patents. The section concludes with a discussion of the problems and limitations of current measurement systems for innovation.

6.1. The UK Innovation survey

Innovation surveys are conducted in the UK on a regular basis^{xxx}, the last of which was carried out in 2005^{xxx}. Using statistics from this survey Figure 8 presents the results for innovation activity in different sectors of the economy. The chart indicates that in the transport division^{xxxi}, only 54% of firms consider themselves as innovation active, placing it below the overall average of 63%.

Figure 8: Percentage of Innovation Active firms in the UK by industry sector



The survey also indicates that innovation activity in the sector tends to concentrate on activities such as investments in equipment and software, training and marketing

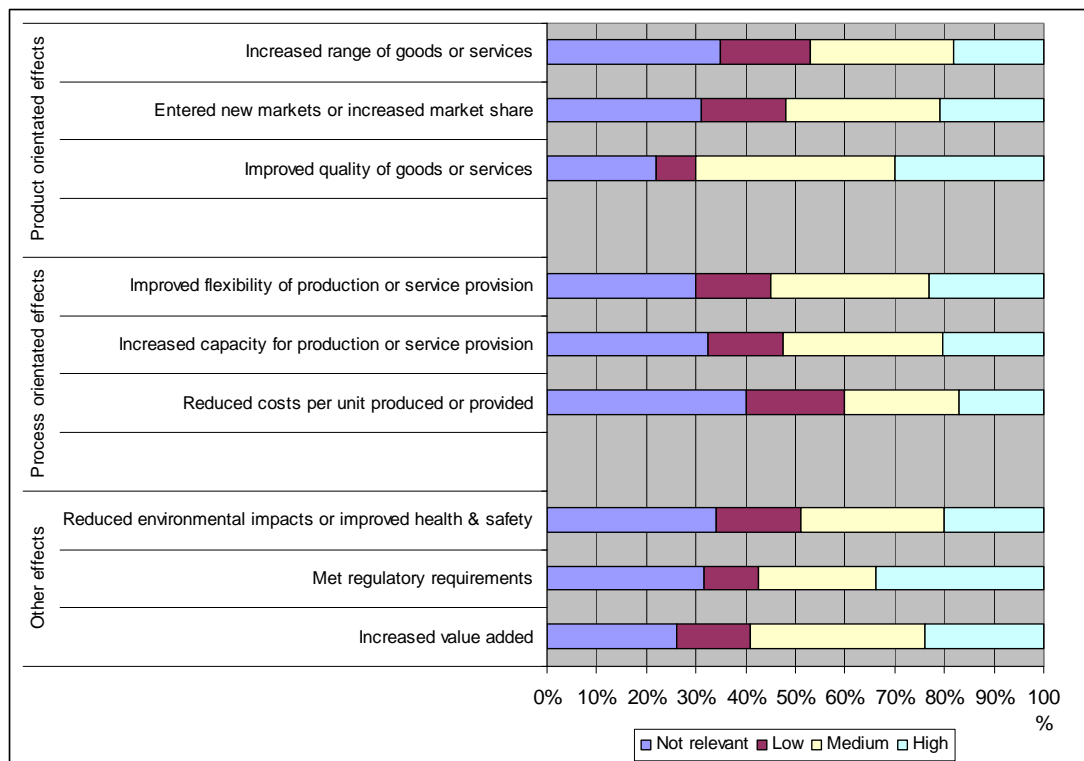
while research and development activities are limited. This is consistent with the views from industry as exemplified by the following quote:

“As a pure service provider the company does not engage in research and development activities in the strict sense, and therefore has no significant expenses to report in that regard.”

Leading logistics provider, 2007

The UK innovation survey also analyses the effects of innovation in the different industries. Figure 9 presents the results of the survey for the transport sector in terms of the effects of innovation on products, processes and other activities. The chart shows that the most significant effects tend to be on improved quality, increased value and meeting regulatory requirements, while the areas of lowest impact are cost reduction and increased range of goods and services.

Figure 9: Effects of Innovation in Transport related industries (2002-2004)



One final issue that is worth noting from the Innovation survey is the fact that only 9% of firms in the transport sector have cooperative agreements with other stakeholders in the industry. This is low compared to industries such as Computing (32%), Telecommunications (25%), but similar to industries like Retail (9%) and Construction (10%). The survey also indicates that cooperative agreements tend to

focus on customers and suppliers and that cooperation with universities and government or public research institutes is limited.

6.2. *Patents in Logistics*

The World Intellectual Property Organization (WIPO)^{xxxii} holds data for patents filed worldwide and researchers have used this data to identify patents in logistics during the period between 1990 and 2004^{xxxiii}. Results show that patent filing on logistics and supply chain products was negligible before 1996; however, numbers increase significantly between 1997 and 2001, reaching almost 500 patents filed worldwide in 2001. Following the internet stocks' crash and 9/11, the number of patents declined slightly and has ranged between 300 and 400 per year between 2002 and 2004. The study also revealed that more patents are being assigned to solution providers who develop software and hardware to improve supply chain performance than to users and providers of logistics services.

The UK plays a significant role in patent applications. From 1990 to 2004 a total of 150 patents were filed by British inventors, ranking third in the world behind USA and Germany. When measured by country of assignee, the UK ranks second only behind the USA. Nevertheless, trends show that patent applications involving more than one country are increasing, indicating that cross-border collaboration is taking place. This is not surprising considering the global nature of the industry.

Patents are undoubtedly an important indicator of innovation. However they tend to be appropriate for technological rather than for administrative innovations. Since many of the innovations led by logistics providers are administrative, they tend to use other less traditional methods for protecting innovation, such as faster introduction of innovations (lead-time advantage) secrecy and confidentiality agreements^{xxxiv}.

6.3. *Problems with measuring innovation in logistics*

The Commission of the European Communities^{xxxv} claims that there is a lack of adequate data, indicators and methods to analyse services and service innovation because services are simply too big to measure and because there are inherent difficulties in studying the intangible aspects of services. Furthermore, the currently accepted methodology for collecting and using documented R&D statistics tends to

focus on technological R&D, overlooking the administrative / non-technological aspects which are an important element for innovation in service sectors.

The lack of metrics, indicators and data has crucial policy implications. The EC noted the serious deficiencies in their understanding of the structure of the services sector and factors influencing the growth of services enterprises remain.

The research conducted has provided some possible metrics for innovation in the industry. These can be classified into input and output measures:

- **Input measures:**

- Investment into R&D
- Investment in technology or innovative techniques
- Investment in training activities associated with innovation
- % of total employees dedicated to R&D related activities

- **Output measures:**

- Number of patents (applicable only to some technological innovations)
- Number of innovative services introduced by organisations
- % of clients using innovative services
- % of revenues coming from innovative services

These proposed measures are the result of discussions with academics and logistics professionals and more work is required to assess their accuracy, feasibility and value. This area merits further research. However, it can be concluded that measuring innovation in services is multidimensional and requires a 'dashboard' of indicators looking at different aspects of the innovation process and different timeframes^{xxxvi}.

7. The Role of the Government in Logistics Innovation

Innovation is a primary concern of businesses who invest time and money in developing new technologies and methods. Governments can play a supporting role in this effort by providing the appropriate environment for innovation to take place. Based on this research it has been possible to identify some of the actions the UK Government can take to influence innovation in logistics which are described in this section.

A general recommendation that can be derived from the analysis is the development of coherent government policies and regulations that are consistent at both national and local levels and across different government departments. In addition to this general recommendation, five themes for specific recommendations are proposed:

- Research, development and implementation support
- Collaboration, awareness and dissemination of innovative practices
- Supporting the development of standards
- People and skills
- Infrastructure development and spatial planning

Each of these themes is expanded in the following pages providing evidence behind the recommendations, describing some specific actions, indicating the possible consequences of such actions, and detailing some of the potential barriers, costs and risks of implementing them.

A. Research, development and implementation support

Aim	To achieve higher levels of effective research and development activity in the logistics industry, particularly regarding technology implementation.
Evidence	<p>The logistics industry does not generally invest in research and development in a conventional way and most firms lack an R&D budget. However, technological innovations such as telematics and RFID need substantial testing, development and training to be adopted and this requires investment.</p> <p>Various sources of research funding are available for logistics firms, but they tend to focus on transport. The Technology Strategy Board (TSB) is currently supporting two innovation platforms with a potential impact on logistics: intelligent transport systems and low carbon vehicles. The DfT has funded projects on subjects such as reverse logistics, green logistics and global sourcing. Transport is also one of the central themes of the 7th European Framework Programme^{xxxvii}. The EU has funded over 400 projects in the area of logistics since 1990 focusing on issues such as sustainable surface transport, multi-modal transport and the European system for global satellite navigation.</p> <p>The use of tax credits to promote R&D is an alternative solution and one that has been used in the UK and in many other OECD countries and it is believed to have a positive effect on innovation, particularly for SMEs^{xxxviii}.</p>
Specific Actions	<ul style="list-style-type: none"> • To provide more effective promotion of funding opportunities at a regional, National and European level, particularly for SMEs. • Consider broadening the scope of funding and tax credits to cater for the needs of SMEs involved in developing and implementing innovations. • Consider broadening the scope of funding and tax credits to include new business models and services, not only technology. • The use of terms such as development and implementation of solutions might be more appropriate than R&D for this particular industry.
Potential impacts	<ul style="list-style-type: none"> • Higher levels of investment in R&D and technology implementation leading to more effective and efficient logistics. • More industry experiments, academic research and initiatives from private sector supported at a Regional, National and European level. • More involvement of SMEs in testing and implementing new technologies. • More interaction with organisations nationally and internationally.
Implication of not taking action	<ul style="list-style-type: none"> • Reduction in the number of patents originating in UK. • Delays in technology implementation vs. other countries. • Potential loss in competitiveness in the long term.
Barriers	<ul style="list-style-type: none"> • Scope of current programmes tends to focus on transport, which is only one element of logistics. • SMEs' lack of resources and expertise required to prepare proposals for funding and engage in research activities. • Difficulties in measuring innovation in logistics services are a barrier for R&D investment because it is difficult to show a cost/benefit relationship.
Risks and Costs	<ul style="list-style-type: none"> • There are direct costs associated with supporting R&D. However, substantial funding is already available from the EU and UK firms could make better use of these funds. • The main risk involved in R&D in this industry is associated with the potential failure of some projects. However, innovation requires a diversity of ideas to be tested and only some will survive.

B. Collaboration, awareness and dissemination of innovative practices

Aim	A more dynamic and better coordinated government activity in facilitating learning and knowledge transfer in the logistics industry, accelerating the diffusion of innovation.
Evidence	<p>Only a small number of firms are innovators and early adopters; the majority tend to be cautious and take longer in adopting innovations. The government can play an important role in identifying and disseminating innovative practices across the industry to accelerate the diffusion process. Furthermore, the government can also facilitate closer collaboration in the industry, promoting the cross-fertilisation of ideas.</p> <p>The DfT funds a programme called Freight Best Practice aimed at promoting operational efficiency in freight operations by offering free information about topics such as fuel saving, skills development, equipment and systems^{xxxix}. Other initiatives such as Knowledge Transfer Networks (KTN), promoted by the TSB^{xl}, can facilitate networking and foster collaboration and knowledge transfer across industry sectors. Other initiatives such as Knowledge Transfer Partnerships (KTP) promote collaboration between industry and academia and can help develop skills, knowledge and technology.</p> <p>The UK government is involved in facilitating the diffusion of innovation and promotes activities that directly and indirectly affect the logistics industry. However, a coordinated strategy for the logistics and transport industry appears to be lacking.</p>
Specific Actions	<ul style="list-style-type: none"> • The recognition of logistics as an industry in its own right would be a first step in targeting a coordinated action towards the industry as a whole. • To promote greater visibility of programmes being conducted by government departments, RDAs and trade bodies to avoid duplication and increase effectiveness. • Encourage closer international collaboration with EU and other important trading partners such as USA, Japan, China and India. • To continue promoting programmes that enable the diffusion of innovation such as Freight Best Practice and that foster collaborative endeavours such as Knowledge Transfer Networks (KTNs), e.g. the “Intelligent Transport Systems” KTN, which promote development and technology transfer in transport. • Target SMEs specifically possibly through collaboration with RDAs and trade organisations such as the CILT, FTA, RHA and Rail Freight Group.
Potential impacts	<ul style="list-style-type: none"> • The development of active communities of logistic providers, users and suppliers of technology that allows an exchange of ideas, leading to the joint development of innovations. • Access to information about promising practices, particularly for SMEs, to enable faster adoption of innovation. Freight Best Practice claims savings of £83 million over two years and a reduction of 240,000 tonnes of CO₂ being emitted into the environment.
Implication of not taking action	<ul style="list-style-type: none"> • Lower levels of collaboration and information exchange in the industry leading to slower development and diffusion of innovation.
Barriers	<ul style="list-style-type: none"> • Innovation is a source of competitive advantage and firms might be sceptical of sharing their developments, particularly with competitors.
Risks and Costs	<ul style="list-style-type: none"> • Costs drivers would be promotion and dissemination activities (internet and print) as well as networking events. For instance the Intelligent Transport Systems KTN, secured funding for £ 6.5 million over 5 years. • No apparent risks.

C. Supporting the development of standards

Aim	To have a coordinated approach to dealing with logistics standards in areas such as infrastructure, logistics assets, information exchange and environmental management
Evidence	<p>Research shows that standards can enable the effective dissemination of technology and that firms can make effective use of standards to drive innovation^{xli}. On the other hand, there is also evidence that multiple standards can create unnecessary costs and cause inefficiencies^{xlii}.</p> <p>In the UK, BSI considers Transport and Logistics as one of the main industrial sectors and provides a wide variety of standards. A simple search for the term “logistics” in the BSI database finds 176 related standards and documents^{xliii}. Other organisations such as the International Standards Organization (ISO) and initiatives such as GS1 (Auto-ID standards) and the World Forum for Harmonisation of Vehicle Regulations (WP.29)^{xliiv} are currently working in the development of global standards.</p> <p>There is no lack of standards for logistics; however, this does not guarantee their adoption or effectiveness. Furthermore the existence of multiple regional standards is often in conflict with the global nature of the logistics industry.</p>
Specific Actions	<ul style="list-style-type: none"> • Efforts should focus in supporting industry in developing appropriate international standards that meet the needs of users and logistics providers. • Better coordination of government departments around the development and implementation of environmental standards, particularly those concerning emissions of greenhouse gases.
Potential impacts	<ul style="list-style-type: none"> • Development of industry-led standards that take into consideration the global nature of the industry and encourage innovation and efficient adoption of technologies. • Environmental standards that help reduce CO₂ emissions and motivate the industry to develop innovative solutions to environmental problems.
Implication of not taking action	<ul style="list-style-type: none"> • Multiple standards can create inefficiencies, delay progress of new technologies and hinder innovation.
Barriers	<ul style="list-style-type: none"> • Many bodies, representing multiple interests, are involved in the development of standards. Government needs to engage with users, trade associations and international organisations.
Risks and Costs	<ul style="list-style-type: none"> • Costs of coordination, networking and dissemination. • It is difficult to determine which will be the dominant standards. Hence there is a risk of supporting “losing” standards.

D. People and skills

Aim	To reduce the shortage of skilled people and ensure that the industry has people with capabilities for developing, implementing and sustaining innovation.
Evidence	<p>Like many industries, the logistics and transport sector faces a challenge in securing people with the appropriate skills and it needs to engage young people more effectively. However, the industry has one of the lowest proportions of graduates compared to other industries (9%^{xlv}). Furthermore, according to figures compiled by Skills for Logistics there is a drivers shortfall of around 46,000 and people are leaving the profession at a rate of nearly 7% <i>per annum</i>^{xlvi}.</p> <p>The UK logistics industry needs a steady stream of fresh talent. In addition the role of traditional sources of training and education, such as colleges and universities, organisations such as Skills for Logistics and the CILT and GS1 are taking steps to develop logistics professionals at different levels. This, in combination with the inflow of qualified professionals and operators from abroad could satisfy the industry requirements.</p>
Specific Actions	<ul style="list-style-type: none"> • Promoting training and education in logistics at all levels through trade organisations and higher education institutions. • Recognition of professional qualifications across the sector will enable the free flow of logistics professionals fostering the exchange of ideas.
Potential impacts	<ul style="list-style-type: none"> • Increased inflow of talent into the industry which will allow innovation to take place. Diversity of backgrounds and skills will promote cross-fertilisation of ideas. • Resolve current labour shortage issues in the industry.
Implication of not taking action	<ul style="list-style-type: none"> • The industry will fail to attract new talent and will continue to struggle with labour shortages.
Barriers	<ul style="list-style-type: none"> • Industry needs to see the benefits to invest in training and education.
Risks and Costs	<ul style="list-style-type: none"> • Costs associated with promoting training and education institutions. For instance, the recent development of the Hull Logistics industry at the University of Hull has a project value of £23 million. This project has been supported by Yorkshire Forward, the Humber Economic Partnership and the European Regional Development Fund (ERDF)

E. Infrastructure development and spatial planning

Aim	Government commitment to cross-departmental strategic thinking for the development of suitable infrastructure and enabling funding to promote sustainable, energy efficient communities that rely so heavily on logistics efficiency.
Evidence	<p>Statistics indicate the UK's transport infrastructure is struggling to cope with demand and investment is needed to keep current standards of service. Furthermore, the lengthy and costly planning process affects the development of logistics systems and makes short and long-term changes in the industry more difficult to organise.</p> <p>Spatial planning also plays an important role in the location of distribution hubs which have an impact on congestion, pollution and CO₂ emissions as well as on the effectiveness of the logistics system as a whole. Warehouses are getting bigger as UK inventories have grown due to more and more product being sourced from abroad. If major distribution centres fail to be constructed in appropriate locations congestion will increase, inefficiencies will occur in the supply chain and the cost of products will increase.</p>
Specific Actions	<ul style="list-style-type: none"> • Possible recommendation for the Sustainable Development Commission to consider an in-depth analysis of how to develop a sustainable infrastructure for the movement of goods into and across the UK, for one of their thematic reviews. • Some of the recommendations proposed in the Planning White Paper such as the formation of an independent planning commission and a new planning regime for significant national infrastructure projects may help resolve some of the current infrastructure problems, particularly if the new system results in quicker planning decisions.
Potential impacts	<ul style="list-style-type: none"> • More efficient planning processes delivering an appropriate infrastructure for the industry and enabling fast reconfiguration of logistic networks. • More options for logistics providers to deliver products in the most effective manner. • Reduction in congestion and CO₂ emissions.
Implication of not taking action	<ul style="list-style-type: none"> • Slow and ineffective planning processes that hinder change and innovation in the industry. • Congestion at critical network nodes and the associated increase in CO₂ emissions.
Barriers	<ul style="list-style-type: none"> • Adopting changes in the planning process can take some time
Risks and Costs	<ul style="list-style-type: none"> • Costs of planning for government and companies should be reduced if the system is simplified. • Risks will still exist for developers and planning bodies in balancing trade-offs between local, regional and national infrastructure requirements.

Appendix 1: Benchmarking (World Bank Logistics Performance Index)

LPI Rank	Country	LPI	Customs	Infrastructure	International shipments	Logistics competence	Tracking & tracing	Domestic logistics costs	Timeliness
1	Singapore	4.19	3.9	4.27	4.04	4.21	4.25	2.7	4.53
2	Netherlands	4.18	3.99	4.29	4.05	4.25	4.14	2.65	4.38
3	Germany	4.1	3.88	4.19	3.91	4.21	4.12	2.34	4.33
4	Sweden	4.08	3.85	4.11	3.9	4.06	4.15	2.44	4.43
5	Austria	4.06	3.83	4.06	3.97	4.13	3.97	2.24	4.44
6	Japan	4.02	3.79	4.11	3.77	4.12	4.08	2.02	4.34
7	Switzerland	4.02	3.85	4.13	3.67	4	4.04	2.26	4.48
8	Hong Kong, China	4	3.84	4.06	3.78	3.99	4.06	2.66	4.33
9	United Kingdom	3.99	3.74	4.05	3.85	4.02	4.1	2.21	4.25
10	Canada	3.92	3.82	3.95	3.78	3.85	3.98	2.84	4.19
11	Ireland	3.91	3.82	3.72	3.76	3.93	3.96	2.65	4.32
12	Belgium	3.89	3.61	4	3.65	3.95	3.96	2.62	4.25
13	Denmark	3.86	3.97	3.82	3.67	3.83	3.76	2.52	4.11
14	United States	3.84	3.52	4.07	3.58	3.85	4.01	2.2	4.11
15	Finland	3.82	3.68	3.81	3.3	3.85	4.17	2.22	4.18
16	Norway	3.81	3.76	3.82	3.62	3.78	3.67	2.08	4.24
17	Australia	3.79	3.58	3.65	3.72	3.76	3.97	2.8	4.1
18	France	3.76	3.51	3.82	3.63	3.76	3.87	2.34	4.02
19	New Zealand	3.75	3.57	3.61	3.77	3.82	3.68	2.86	4.05
20	United Arab Emirates	3.73	3.52	3.8	3.68	3.67	3.61	2.8	4.12

Source: Arvis, Mustra, Panzer, Ojala and Naula (2007) Connecting to Compete: Trade Logistics in the Global Economy - The Logistics Performance Index and Its Indicators, World Bank (<http://siteresources.worldbank.org/INTTLF/Resources/lpireport.pdf>)

Endnotes

- ⁱ The logistics sector falls across many of the Standard Industrial Classification (SIC) groupings, therefore the focus of many studies tends to be upon only a narrow component of logistics activities.
- ⁱⁱ Johnson, M. and Harrison, A. (2007) *Making and Moving: The Future Prospects for British Industry*, Cranfield School of Management, January 2007.
- ⁱⁱⁱ Fenn, Dominic [Ed] (2007) *Market Review 2007: Distribution Industry*, 11th Edition, Keynote, 14.
- ^{iv} Capgemini (2006) *2006 Third-party Logistics: United Kingdom Findings* (available from www.3plstudy.com), 8.
- ^v Fenn, Dominic [Ed] (2007) *Market Review 2007: Distribution Industry*, 11th Edition, Keynote, 14.
- ^{vi} GVA is a measure of national income and output used to estimate the value of goods and services produced in an economy.
- ^{vii} Based on Johnson and Harrison (2007) using data from ONS (2006) *United Kingdom National Accounts: The Blue Book 2006*. London: Office for National Statistics.
- ^{viii} Fenn, Dominic [Ed] (2007) 22.
- ^{ix} Fenn, Dominic [Ed] (2007) 22.
- ^x Based on discussions from the Logistics SIG (BERR)
- ^{xi} Fenn, Dominic [Ed] (2007) and Johnson and Harrison (2007).
- ^{xii} Based on Johnson and Harrison (2007) using data from ONS (2006) *Labour Force Survey*. London: Office for National Statistics.
- ^{xiii} The sector analysed here is the distribution, warehousing and communication sector quantified in the UK Labour Force Survey (LFS) as a composite.
- ^{xiv} DfT 2006b. *Focus on ports: 2006*, Department for Transport (available at www.dft.gov.uk).
- ^{xv} Eddington, Rod, (2006). *The Eddington Transport Study; The case for action: Sir Rod Eddington's advice to government*, December 2006, HMSO, Norwich, UK.
- ^{xvi} Based on discussions from the Logistics SIG (BERR)
- ^{xvii} DfT (2006a). *Felixstowe South Reconfiguration Inspector's Report*, Department for Transport (available at www.dft.gov.uk).
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- ^{xx} Galileo European Satellite Navigation System (http://ec.europa.eu/dgs/energy_transport/galileo)
- ^{xxi} Baumert, Herzog, and Pershing (2005). *Climate Data: A sectoral perspective*, Pew Center on Global Climate Change, USA.
- ^{xxii} Vidal, J. (2007) *CO2 output from shipping twice as much as airlines*, *The Guardian*, March 3, 2007
- ^{xxiii} Arvis, Mustra, Panzer, Ojala and Naula (2007) *Connecting to Compete: Trade Logistics in the Global Economy - The Logistics Performance Index and Its Indicators*, World Bank (<http://siteresources.worldbank.org/INTTLF/Resources/lpireport.pdf>).
- ^{xxiv} Capgemini (2006)
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- ^{xxvi} Lin, C. (2006) *A Study on the Organizational Innovations in Taiwan's Logistics Industry*. *The Business Review, Cambridge* 5(1), 270; Lin, C. (2007) *Factors affecting innovation in logistics*

technologies for logistics service providers in China. *Journal of Technology Management in China* 2(1); Commission of the European Communities (2007).

^{xxvii} Based on discussions from the Logistics SIG (BERR)

^{xxviii} Based on interviews and on the following literature Boer, et al. (2001) Knowledge and continuous innovation The CIMA methodology. *International Journal of Operations & Production Management* 21(4), 490; Evangelista, P., McKinnon, A., and Sweeney, E. (2007) Logistics Innovation in Small 3PLs. What is the Role of ICT? Logistics Research Network 2007 Conference Proceedings. U.K., The Chartered Institute of Logistics and Transport (UK); Lin (2006); Lin (2007); Panayides, P. (2006). Enhancing innovation capability through relationship management and implications for performance. *European Journal of Innovation Management* 9(4), 466; Russell, Dawn M and Hoag, Anne M. (2004). People and information technology in the supply chain: Social and organizational influences on adoption. *International Journal of Physical Distribution & Logistics Management* 34(1/2), 102; Loewe, P. and Dominiquini, J. (2006). Overcoming the barriers to effective innovation. *Strategy & Leadership* 34(1); Swink, Morgan (2006) Building Collaborative Innovation capability. *Research Technology Management* 49(2).

^{xxix} This survey follows the guidelines of the OECD Oslo manual [OECD (2005) Oslo Manual, <http://www.oecd.org/dataoecd/35/61/2367580.pdf>]

^{xxx} DTI (2005) Innovation in the UK: Indicators and Insights, DTI Occasional Paper No. 6, July 2006

^{xxxi} The Transport Division groups a number of industry sectors such as those that are closely related to the logistics industry such as Freight transport by road, Freight sea & coastal transport, Inland water transport, Air transport, Cargo handling and Storage & warehousing. However, it also includes other industry codes which are only marginally related to logistics such as Urban passenger underground metro, Taxi operation, Passenger sea & coastal transport, Passenger inland water transport, Travel agents and Tour guides.

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