GREEN LOGISTICS

WM10: Developing innovative and more sustainable approaches to reverse logistics and the collection, recycling and disposal of waste products from urban centres

Literature Review

Preparation Date: 29th January 2007

A.J. Hickford and Dr. T.J. Cherrett
Transportation Research Group
University of Southampton

ABSTRACT

Purpose – To review recent research in reverse logistics, with particular emphasis on the aspects of Green Logistics, City Logistics, urban retailing and waste management.
Design/methodology/approach – The review is based on over 50 selected journal papers, other documents and online sources, including documents which offer substantial and comprehensive reviews of reverse logistics issues, case studies and modelling approaches.
Findings – Issues of reverse logistics affecting retailers are different from those affect other actors in the supply chain. Recent legislation regarding electronic goods and packaging will impact directly on the reverse logistics process involved with urban retailers. The environmental impact of logistics is most severe in urban centres, but research into 'City Logistics' has largely focused on the forward supply chain.
Research limitations/implications – The findings suggest that there is a lack of research into reverse logistics issues specific to the urban environment. The role that waste management can play in future reverse logistics systems is also yet to be addressed. Considerable work has been carried out elsewhere regarding the different frameworks and modelling techniques of reverse logistics; these topics were not covered in this review.
Practical Implications – One of the objectives of WM10 is to address the gaps identified in this review; the results will offer practical solutions to problems encountered by urban retailers, and will be applicable to a wider audience of reverse logistics operators.
Originality/value – The combined focus of reverse logistics with Green Logistics and urban retail waste management gives an alternative viewpoint to the traditional approach regarding reverse logistics.
Keywords – Reverse Logistics, Green Logistics, Product Returns, Packaging and Waste Management, E-commerce

INDEX

FIGURES

TABLES

WM10: Developing innovative and more sustainable approaches to reverse logistics and the collection, recycling and disposal of waste products from urban centres

Literature Review

Introduction

Research into sustainable distribution has largely focussed on improving the delivery of products through the supply chain from manufacturer to end customer by developing fundamental understanding of the various supply chain operations at work in an urban centre. Of particular interest has been the potential for multi-user urban transhipment centres to reduce the impacts of large freight vehicles in central areas, and the scope for home delivery and 'local collect' systems to reduce the numbers of vehicle trips made. Little research has been undertaken to understand the logistics which support the running of retail establishments in urban areas, the return of damaged, unsold or returned consumer products to manufacturers, and the consolidation, handling and disposal of waste products generated by the retail process. With the introduction of the Waste Electronic and Electrical Equipment (WEEE) Directive, and the new classification of hazardous waste products under the Hazardous Waste Regulations, the onus is on retailers and manufacturers to participate in specific waste product take-back schemes. There is therefore a need to address the associated transport impacts these acts could have and how any negative impacts could be mitigated within an urban environment.

Urban sustainability may be improved by co-ordinating the collection and movement of customer returns and waste products generated by the different retail supply chains in urban centres. Work Module 10 is focused on developing fundamental understanding of how new technologies and innovations can contribute to sustainable solutions in this area. It will identify areas where new approaches are required, develop the concepts and the science that underpins the new approaches and promote the new approaches in the practical context of a case study city that will enable stakeholder issues to be addressed in a clear and inclusive way.

1. Definitions of Logistics and Reverse Logistics

The term ‘logistics’ originated in a military context, referring to how personnel acquire, transport, and store supplies and equipment. In the business community, the term was adopted in the 1960s, and is used to refer to how resources are acquired, transported and stored along the supply chain.

The US-based Aberdeen Group Benchmark Report (2006) defines reverse logistics simply as “the return, exchange, repair/refurbishment, remarketing, and disposition of products.” Yet there are other aspects of reverse logistics systems that even this broad definition does not encompass.

Lummus *et al.* (2001) suggest that the terms “logistics” and “supply chain management” are often confused and viewed as overlapping, depending on the definition used by a particular organisation. The Council of Supply Chain Management Professionals (CSCMP, 2006), in their definition of supply chain management, state that it “encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all Logistics Management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies.”

Based on an early definition of logistics from the Council of Logistics Management, Rogers and Tibben-Lembke (1999) provided a definition of reverse logistics as “the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal.”

However, products may not necessarily be returned to their point of origin, but to any point of recovery (De Brito *et al.*, 2003), and as the characterisation of reverse logistics has evolved, there is an increasing need to address issues of sustainability and integration with other aspects of the supply chain (DfT, 2004). In particular,

integrative waste management can help to combat environmental problems. The shipment of materials back to disposal sites is a natural extension of reverse logistics.

2. Reverse Logistics in the Context of Green Logistics

With growing demands for “green” products, logistics systems that deliver these products to consumers’ hands should themselves be “green” (Wu *et al.*, 1994). There is a potential confusion that exists between reverse logistics and Green Logistics (Rogers *et al.*, 1999; Lourenço *et al.*, 2002). The energy and pollution reduction associated with better transportation planning, and the use of less packaging materials, could be considered as a part of the Green Logistics agenda; as Rogers points out, “if no goods or materials are being sent ‘backward,’ the activity probably is not a reverse logistics activity.”

De Brito *et al.,* (2003) also briefly consider the differences between reverse logistics and Green Logistics; the latter considering the environmental aspects to all logistics activities, focused specifically on forward logistics from the producer to the customer. One of the underlying principles of reverse logistics, to offer effective methods of disposition of end-of-life products and returned goods, with associated benefits of reductions in vehicle kilometres, lies firmly within the auspices of Green Logistics.

The new environmental era represents a fresh challenge to manufacturing and production enterprises worldwide. The challenge is to develop ways in which industrial development and environmental protection can symbiotically coexist. Fleischmann *et al.* (1997) note that economic and environmental issues are often intertwined. For example, increasing disposal costs make waste reduction more economical, and environmentally conscious customers represent new market opportunities. Ideally, one would like to combine both ecological and economic advantages, as suggested by the concept of a 'sustainable' economy.

The UK Government’s Sustainable Distribution Strategy (DETR, 1999) provides a framework to deliver a modern, efficient freight transport system across all modes. Its objectives include minimising congestion, making better use of transport infrastructure, minimising pollution and reducing greenhouse gas emissions, managing development

pressures on the landscape, and reducing noise and disturbance from freight movements.

Sustainable distribution has a number of interdependent outcomes (Figure 1):

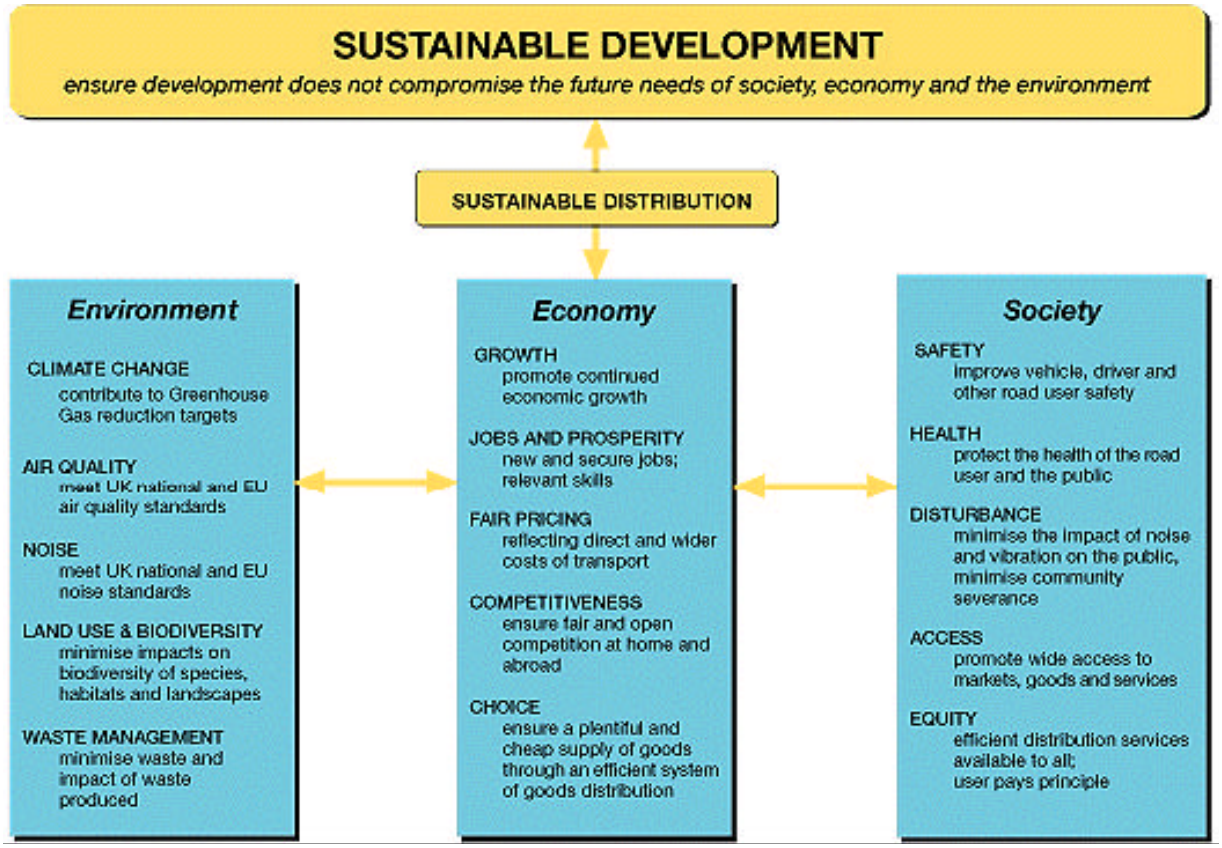

Figure 1: Sustainable Distribution: A Strategy (from DETR, 1999)

Transport of goods backwards up the supply chain is the main impact of reverse logistics affecting sustainable distribution in terms of fuel consumption, kilometres travelled, air quality, noise pollution, safety and health.

Source-reduction strategies should be used to minimise waste and environmental effects while gaining possible competitive advantages (Wu *et al.*, 1994; Marien, 1998). The basic source-reduction principles entail:

- making things smaller and lighter, thus resulting in lower logistics costs;
- minimizing production and distribution operations, to reduce the amount of waste materials generated;
- reusing materials and containers more than once;
- substituting materials that are environmentally friendlier.

These source-reduction strategies actually can increase end user satisfaction while reducing costs and waste.

In the News, 15th Jan 2007: ***M&S unveils carbon-neutral target***

High Street chain Marks & Spencer has announced a £200m, five-year plan to make the company carbon neutral.
Under its "eco-plan", the company says it will cut energy consumption, stop using landfill sites and stock more products made from recycled materials. Chief executive Stuart Rose, who has overseen a recovery in M&S's fortunes, said the project would "change beyond recognition" the way it operated. He insisted extra costs under the plan would not be passed on to customers. Mr Rose, who took over as chief executive three years ago, told the BBC that it was "a massive plan".
"I don't say it's not without risk," he said.
"What we're saying, effectively, is look, we believe responsible business can be profitable business."

Local food
Businesses or homes which offset the carbon emissions they produce, by planting trees for example, are described as being carbon neutral. M&S said the carbon savings it aimed to achieve under its plan would be like taking 100,000 cars off the road each year. As well as cutting energy and using more renewable materials, M&S will aim to source its food from the UK and the Republic of Ireland as a "priority" in an attempt to reduce air freight. Labels will identify food that has been flown into the UK.
"We don't have all the answers but we are determined to work with our suppliers, partners and government to make this happen," said Mr Rose. "Doing anything less is not an option."
He added: "We will become carbon neutral, only using offsetting as a last resort. We will ensure that none of our clothing products or packaging needs to be thrown away."
M&S was advised on its new environmental policy by former Friends of the Earth director Jonathon Porritt.
"This plan raises the bar for everyone else - not just retailers but businesses in every sector," said Mr Porritt.

Powered by waste
Under its plan, much of the chain's polyester clothing will be made from recycled plastic bottles, instead of oil, and millions of garments will be made from fair trade cotton, he said.
M&S will also trial the use of food waste to power its 500-plus stores across the UK.

Source: BBC website
http://news.bbc.co.uk/1/hi/business/6261939.stm viewed 15/01/07

Lave *et al.* (1999) offer an economic-environmental criterion which states that recycling is good policy only if environmental discharges and the resources used to collect, sort, and recycle a material are less than the environmental discharges and resources needed to provide an equivalent virgin material, plus the resources needed to dispose of the material safely. Beamon (1999) suggests that the first step in meeting this challenge is to redefine the basic structure of the entire supply chain, by accommodating environmental concerns associated with waste and resource use minimization.

In proposing an extended supply chain which includes mechanisms for product recovery, Beamon (1999) suggests a list of potential measures to describe supply chain performance (Table 1).

Performance Measure Classification	**Performance Measure** (Measured over Product and Process Life Cycle, except where indicated)
Resource Use	• Total energy consumed • Total material consumed (e.g., water, timber, steel, etc.)
Product Recovery **Remanufacturing** **Reuse** **Recycling**	• Time required for product recovery • % recyclable/reusable materials (volume or weight) available at end of product life • % product volume or weight recovered and reused • Purity of recyclable materials recovered • % recycled materials (weight or volume) used as input to manufacturing • % product disposed or incinerated • Fraction of packaging or containers recycled • Material Recovery rate (MRR) • Core Return Rate (CRR) • Ratio of virgin to recycled resources • Ratio of materials recycled to materials potentially recyclable • Materials Productivity: economic output per unit of material input
Product Characteristics	• Useful product operating life • Total mass of products produced
Waste Emissions and Exposure Hazard	• Total toxic or hazardous materials used • Total toxic or hazardous waste generated • Solid waste emissions • % product (weight or volume) disposed in landfills • Concentrations of hazardous materials in products and by-products • Estimated annual risk of adverse effects in humans and biota • Waste ratio: the ratio of wastes to all outputs.
Economic	• Average life-cycle cost incurred by the manufacturer • Purchase and operating cost incurred by the consumer • Average total life-cycle cost savings associated with design improvements
Economic/ Emissions	• Eco-efficiency: adding the most value with the least use of resources and the least pollution. Generally, the ability to simultaneously meet cost, quality, and performance goals, reduce environmental impacts, and conserve valuable resources

Table 1: Extended Supply Chain Performance Measures (Beamon, 1999, adapted from a number of sources)

Rodrigue *et al.* (2001) argue that, while technological and spatial developments have improved the cost, efficiency and reliability of freight and passenger transport systems, at the same time, the negative environmental impacts of transportation have gained wide recognition and are at the core of issues of sustainability, especially in urban areas.

Table 2 summarises the issues of green logistics and the environmental paradoxes created in terms of transportation modes, terminals and activities.

Dimension	Outcome	Paradox
Costs	Reduction of costs through improvement in packaging and reduction of wastes. Benefits are derived by the distributors.	Environmental costs are often externalized.
Time / Flexibility	Integrated supply chains, Just-in-Time and Door-to-Door provide flexible and efficient physical distribution systems.	Extended production, distribution and retailing structures consuming more space, more energy and producing more emissions (CO_2, particulates, NO_x, etc.)
Network	Increasing system-wide efficiency of the distribution system through network changes (hub-and-spoke structure).	Concentration of environmental impacts next to major hubs and along corridors. Pressure on local communities.
Reliability	Reliable and on-time distribution of freight and passengers.	Modes used, truck and air transportation, are the least environmentally efficient.
Warehousing	Reducing the needs for private warehousing facilities.	Inventory shifted in part to public roads (or in containers), contributing to congestion and space consumption.
E-Commerce	Increased business opportunities and diversification of the supply chain.	Changes in physical distribution systems towards higher levels of energy consumption.

Table 2: Paradoxes of Green Logistics (from Rodrigue *et al.*, 2001)

3. Driving Forces of Reverse Logistics

Legislative, economic and social factors all contribute to an organisation's decision to adopt reverse logistics activities as part of their supply chain management processes. Reasons for adopting reverse logistics systems have tended to be mainly regulatory-

driven in Europe and profit-driven in North America. Such systems are still in development in other parts of the world, where consumer awareness and globalization are likely to lead to greater economic, consumer and regulatory pressures in the future. The following sections list some of the factors involved.

3.1 Producer Responsibility and Legislative Factors

The UK Government promotes a "producer responsibility" policy which underlies the approach taken in implementing the EC Directives described below (Defra, 2006a). All these producer responsibility directives were identified in the European Union's Fifth Environment Action Programme as "priority waste streams" because of growing concern about their impact on the environment. In these Directives, responsibility is clearly placed on producers to bear the costs of collection, sortation or treatment and recycling or recovery.

Such legislative actions can drive companies to utilise reverse logistics to recover products and certain types of waste from downstream supply chain stakeholders, and ensures the compliance with existing and future legislation (Bettac *et al.*, 1999).

The EC Directive on **Packaging and Packaging Waste** (94/62/EC) seeks to reduce the impact of packaging and packaging waste on the environment by introducing recovery and recycling targets for packaging waste, and by encouraging minimisation and reuse of packaging. The Directive set Member States mandatory recovery and recycling targets, the first of which were to be met in 2001. A revised Packaging Directive (2004/12/EC) was published in February 2004, which set new recovery and recycling targets, as a percentage of all packaging waste arising in the UK, to be met by 31 December 2008.

These regulations affect any business which handles more than 50 tonnes of packaging per annum and has a turnover of more than £2 million per annum, if it is involved in one or more of the following activities:

- manufacturing raw materials for packaging – raw material manufacturer;
- converting raw materials into packaging – convertor;
- filling packaging (i.e. putting goods or products into packaging) – pack/filler;
- selling packaged goods to the final user (which can be other businesses or the public) – seller;

- performs a "service provision" – service provider;
- importing packaging / packaging materials / packaged goods into the UK for any of the above activities – importer.

In the News, 30th Nov 2006: ***Non-recycling packaging producers caught out***

Companies that produce or use significant amounts of packaging to sell their goods are still being caught avoiding their legal obligations to pay for recycling.
Almost a decade after producer responsibility for packaging was brought in to UK law, "free riders" – firms that avoid their recycling requirements under the legislation – are still coming out of the woodwork.
A wine and spirit merchant in Essex was landed with fines and costs amounting to nearly £55,000 last week for failing to pay for packaging waste recovery from 1997 to 2004.
Oxfordshire hamper company Clearwater Hampers was fined £4,000 this week for failing to meet the producer responsibility regulations in 2004.
And, Dorset food company DB Foods Ltd was ordered to pay £3,000 for not registering as a producer with the Environment Agency in order to carry out its producer responsibility.

Source: letsrecycle.com website
http://www.letsrecycle.com/materials/packaging/news.jsp?story=6309 viewed 17/01/07

The EC Directives on **Waste Electrical and Electronic Equipment (WEEE)** (2002/96/EC) and on the **Restriction of the Use of Certain Hazardous Substances (RoHS)** in Electrical and Electronic Equipment (2002/95/EC) aim to reduce the quantity and environmental impact of waste from electrical and electronic equipment and increase its reuse, recovery and recycling. The Directives affect producers, distributors and recyclers of electrical and electronic equipment – including household appliances, IT and telecoms equipment, audiovisual equipment (TV, video, hi-fi), lighting, electrical and electronic tools, toys, leisure and sports equipment.

Increased recycling of such electrical and electronic equipment will limit the total quantity of waste going to final disposal. Producers will have responsibility for taking back and recycling electrical and electronic equipment. There is an incentive for manufacturers to design electrical and electronic equipment in an environmentally more efficient way, which takes waste management aspects fully into account (Europa, 2006).

A proposal for a UK National Clearing House (NCH) to be set up to organise producer responsibility for WEEE was given strong support by industry stakeholders during the third round of consultation carried out by the Department for Trade and Industry (DTI), which concluded at the end of October 2004 (DTI, 2004a). However, the DTI

considered the proposal to be too complex, and have since issued further consultation including the development of a network of Designated Collection Facilities (DCFs), possibly utilising the 1400 or so Civic Amenity (CA) Sites and Household Waste Recycling Centres (HWRCs) (Bridgwater and Anderson, 2003). In order to free up space and resources for these new recycling activities, it might be advantageous if a subset of the waste categories handled by the HWRC, such as green waste, could be collected locally through bring-sites, or enhanced kerbside schemes (Cherrett *et al.*, 2006).

The implementation of the WEEE Directive would also include, among other features, a distributor take back scheme for retailers, which would establish a network of designated collection facilities (NetRegs, 2006). Retailers who sell or distribute electrical and/or electronic equipment onto the UK market would have an obligation under the WEEE Directive to ensure take-back of these products at the end of their lives from consumers. It is proposed that retailers should be given a choice of methods to meet this obligation, either through offering in-store take-back of old products when a direct replacement was sold to a customer, or through joining a retailer take-back compliance scheme which must offer alternative take-back arrangements. The latter would be expected to accept all WEEE and not just on a like-for-like basis and would therefore have greater implications in terms of transport. Businesses which collect WEEE from private householders (e.g. at the same time as making a delivery) and transport it will, as now, need to be registered with the Environment Agency as waste carriers.

Such facilities could ease the problems associated with handling and tracking the return of goods to manufacturers via retail outlets, which are generally designed to send products out, not to pull them back in. However, to meet the requirements set out in this legislation there are additional transportation impacts and added complexities involved in the distribution process, including the need for extra warehousing space, extra sorting and recycling work, the possible need to break goods down into their component parts, and the requirement to track each aspect of the process (DfT, 2004). Nevertheless, case-study analyses imply that effective reuse of certain electrical and electronic equipment can be highly profitable and commercially viable (Bettac *et al.*, 1999).

The EC **End-of-life Vehicle (ELV)** Directive (2000/53/EU) is concerned with cars, vans and certain three-wheeled vehicles. It aims to reduce the amount of waste from vehicles (cars and vans) when they are finally scrapped. In particular, it includes tightened environmental standards for vehicle treatment sites, requires that last owners must be able to dispose of their vehicles free of charge from 2007 (and requires producers to pay all or a significant part of the free take-back from this date), sets rising reuse, recycling and recovery targets and restricts the use of hazardous substances in both new vehicles and replacement vehicle parts.

Another EC Directive which will impact on the transportation and other requirements of reverse logistics is the Directive on **Distance Contract** (97/7/EC), which stipulates that anyone who makes a purchase on the Internet or by phone, fax or via mail order is able to change their mind about the purchase during a “cooling-off” period of seven working days after the goods are received; no explanation for the rejection of goods is required. The onus of returning such goods is likely to lie with the potential customer, and many of these returned goods will be transported back to the original retailer or manufacturer by traditional delivery services. However, it is likely that more of these rejected items will be recovered through dedicated reverse logistics processes as they become more prevalent, particularly in response to the WEEE Directive and others described above.

3.2 Economic Factors

The question whether product recovery is economically attractive or not has to be viewed within the legal framework in which the firm operates. However, as Buellens (2004) points out, a company that is considering adopting a reverse logistics or product recovery programme may be able to overcome any technical or legal difficulties, but might be dissuaded from adopting such processes due to the financial implications. Resources make reverse logistics programs more efficient and more effective, but there is recompense only when the resources are used in such a manner as to develop innovative capabilities/approaches to handling returns (Richey *et al.*, 2005). Nevertheless, late entrants into reverse logistics have the advantage that they can utilise knowledge and experience from early adopters, and should be able to manage available resource in a more profitable way (Richey *et al.*, 2004). Conservative estimates put overall reverse logistics costs at $100 billion annually in the U.S. (Aberdeen Group, 2006).

However, the existence of a reverse logistics programme has been shown to bring direct monetary gains to companies by reducing the use of raw materials, by adding value with recovery, or by reducing disposal costs (Rogers *et al.*, 2001; De Brito *et al.*, 2003). Marien (1998) cites Eastman Kodak (reusable cameras) and Hewlett-Packard (printer toner cartridges returned for refilling) as early examples of companies using reverse logistics as part of 'investment recovery'.

Some other retail-related issues that reverse logistics can affect in a financially beneficial way are (DfT, 2004):

- customer service – good returns policies may give a retailer an advantage over less liberal competitors
- effective inventory utilisation – removing old or slow-moving stock and replacing with newer, more desirable products can help promote sales
- recapturing product value – if unsold products can be quickly and effectively disposed of (for example, sold on by auction, or to Jobbers – someone who buys surplus or unwanted merchandise from one source, and profits by selling it on), some of the value may be reclaimed
- security of technology – by recovering all its own products, a company can prevent competitors accessing sensitive technologies, and thus may retain an advantage in the marketplace

3.3 Social Factors and Extended Responsibility

"Extended Responsibility", or "Corporate Citizenship" concerns a set of values or principles that drive an organisation to become responsibly engaged with particular activities, including reverse logistics. An enhanced "green" reputation – being seen to be concerned about, and proactive towards environmental issues – has become an important marketing element and can improve customer relations. Many companies now have extensive programs on responsible corporate citizenship where both social and environmental issues become the priorities.

During their review of reverse logistics case studies, De Brito *et al.* (2002) identified eight non-economic incentives to stimulate or enforce the acquisition or withdrawal of products for recovery, including:

- **'New for old'** – a new version of a product is only available if the original is returned
- **Lease or rent contracts** – products are not sold, and ownership remains with the supplier
- **Easy and simple method of supply** – a combination of pick-up systems, where (parts of) products to be recovered are collected at the location where they are disposed, and bring systems where the disposer has to bring the goods to dispose at a certain location
- **Timely and clear information** – appropriate information regarding the methods of returning products can help raise the level of product returned
- **Appeal to the environmental consciousness of people** – usually requiring high levels of advertising for little return
- **Appeal to the charity's consciousness of people** – if an organisation receives some monetary reward for collecting product returns, consumers might be more likely to donate such items

4. Reverse Logistics in Retailing

Retailers in an urban centre have particular issues to address regarding reverse logistics, some of which differ from those of manufacturers or distributors. They have to be able to deal with obsolete, damaged or unsold stock, and to have facilities in place to manage products returned by customers for a variety of reasons, as well as for the proper disposition of packaging and other waste products.

Table 3 shows a comparison of how various features of logistics systems differ for forward and reverse logistics processes in a retail environment (adapted from Tibben-Lembke *et al.*, 2002).

Forward	Reverse
• Forecasting relatively straightforward • One to many transportation • Product quality uniform • Product packaging uniform • Destination/routing clear • Standardized channel • Disposition options clear • Pricing relatively uniform • Forward distribution costs closely monitored by accounting systems • Inventory management consistent • Product lifecycle manageable • Negotiation between parties straightforward • Marketing methods well-known • Real-time information readily available to track product	• Forecasting more difficult • Many to one transportation • Product quality not uniform • Product packaging not uniform • Destination/routing unclear • Exception driven • Disposition not clear • Pricing dependent on many factors • Reverse costs less directly visible • Inventory management not consistent • Product lifecycle issues more complex • Negotiation complicated by additional considerations • Marketing complicated by several factors • Visibility of process less transparent

Table 3: Differences in forward and reverse logistics (from Tibben-Lembke *et al.*, 2001)

Retailers have a variety of options to manage obsolete or damaged stock. Short life products, such as fresh produce, are generally disposed of once the shelf-life expiry is reached, thus recovering none of the value of the product. Sales and mark-downs are especially common in fashion retail, to sell overstocked or out-of-season products; this usually entails a much lower margin, but at least some capital recovery is made. There may also be agreements in place with suppliers or manufacturers to return unsold goods. Rogers *et al.* (1999) give estimates of product returns by industry (Table 4).

Industry	***Percent***
Magazine Publishing	50
Book Publishers	20-30
Book Distributors	10-20
Greeting Cards	20-30
Catalogue Retailers	18-35
Electronic Distributors	10-12
Computer Manufacturers	10-20
CD-ROMs	18-25
Printers	4-8
Mail Order Computer Manufacturers	2-5
Mass Merchandisers	4-15
Auto Industry (Parts)	4-6
Consumer Electronics	4-5
Household Chemicals	2-3

Table 4: Sample Return Rates by Industry (from Rogers *et al.*, 1999)

Return rates obviously vary according to the types of retail, but Rogers *et al.* (2001) estimate that overall, customer returns account for six percent of all product returns across the retail sector.

In their review of over 60 case studies involving reverse logistics, De Brito *et al.* (2002) found that, once the cases were categorised according to the United Nations classifications for Industry, around 60% were in manufacturing, about 20% in the wholesale and retail trade, and about 10% in construction. With regard to the products involved, almost half the cases dealt with metal products, machinery and equipment. Around 30% of the products being processed were transportable goods like wood, paper and plastic products. Around 20% were food products, beverages, tobaccos, textiles and apparel and less than 10% fell into the category of ores and minerals. The majority of the cases involved high value products.

When it comes to customer returns, uncertainty prevails. It is difficult to predict which products are likely to be returned, where they will originate or where they will need to

be sent. However the relative certainties are that most annual returns will occur in January and February, after the Christmas and New Year sales season.

The following sections highlight some of the general reasons for product returns, and the overall characteristics of those returns.

4.1 Reasons for Product Returns

The reasons for products being returned are discussed by a number of authors. De Brito *et al.* (2003) categorise returns under three headings:

- **Manufacturing returns** – raw material surplus, quality-control returns, production leftovers or by-products;
- **Distribution returns** – product recalls, commercial returns (unsold products and wrong or damaged deliveries), stock adjustments, functional returns (distribution items, carriers, packaging); and
- **Customer returns** – reimbursement guarantee returns, warranty returns, service returns, end-of-use, end-of-life returns.

While the latter two categories clearly apply to retailers, manufacturing returns are less likely to have an impact on reverse logistics in the urban environment.

Rogers *et al.* (1999) place reasons for returns within a basic framework (Table 5), based on whether the goods in the reverse flow are coming from the end user or from another member of the distribution channel such as a retailer or distribution centre; and whether the material in the reverse flow is a product or a packaging material.

Source of Reverse Flow		
	Supply Chain Partners	**End Users**
Products	Stock Balancing Returns Marketing Returns End of Life/Season Transit Damage	Defective/Unwanted Products Warranty Returns Recalls Environmental Disposal Issues
Packaging	Reusable Totes Multi-Trip Packaging Disposal Requirements	Reuse Recycling Disposal Restrictions

Table 5: Characterisation of items in the reverse flow (from Rogers *et al.*, 1999)

In the DfT (2004) report *The Efficiency of Reverse Logistics*, the results of examining a variety of company supply chains are discussed, including the main drivers of product returns. While these are often regarded as resulting from consumers returning faulty products, there are also many internal drivers that lead to product returns. Indeed, for some product groups, consumer returns account for only a small proportion of total returns.

Fast Moving Consumer Goods (FMCG) are products that have a quick turnover and relatively low cost, generally including toiletries, soaps, cosmetics, teeth-cleaning products, shaving products and detergents, as well as other non-durables such as glassware, bulbs, batteries, paper products and plastic goods. The factors reported as causing product returns for FMCG retailers are:

- **Forecast accuracy** and **demand variability** – imbalances between forecast supply and demand will lead to a stock-out situation, or overstocking of goods which will have to be returned
- **Promotional activities** – overstocking can result from sales of limited period discounted items, 'Buy one get one free' offers, etc.
- **New product introduction** – it is often difficult to determine the success of new products, and overstocking may result if this is over-assessed
- **Product range and safety stock policy** – consumer expectations of available choice mean that companies tend to provide a wide range of stock keeping units (SKUs), and there is inevitably overstocking of some SKUs
- **Product life cycles** – short product life cycles, especially in the electronics and high-tech market can provide a competitive advantage, but may lead to high levels of product returns if not managed appropriately
- **Logistics trade-offs** – the cost of manufacturing and logistics are relatively low compared to lost revenue from not having shelf availability, which can lead to excessive stock holding
- **Purchasing policies** – products are often purchased ahead of seasonal demand to minimise the prices paid for goods, which can affect the logistics processes within the supply chain
- **High on-shelf availability** – consumer expectations and the desire for stock to be continuously available can lead to problems of overstocking, resulting in greater levels of returns

- **Legislative factors** – discussed above, producers and retailers are likely to have to take back products they sell post consumer use
- **Cash flow management** – retailers may take advantage of existing agreements regarding the return of goods to suppliers or manufacturers in exchange for credit, in order to ease their cash-flow position
- **Liberal returns policies** – typically for defective goods, such policies result in damaged or non-resalable stock being returned to the retailer, which then has to be dispositioned appropriately
- **Customer 'no-faults found'** – high levels of products are returned by customers unable to follow the instruction manual, who then assume there is a fault with the product; for many such items, the cost of returning to "grade-A" for re-sale is uneconomical, so products tend to be sold to Jobbers at a significant reduction.

4.2 Characteristics of Returned Products

De Brito *et al.* (2003) consider the fundamentals of reverse logistics from four viewpoints: why, what, how and who. Regarding *what* is being returned, they argue that the characteristics of the product have more effect on the methods required during the reverse logistics process than the product itself. They distinguish seven product types with differing characteristics, which would require different treatment during the reverse logistics process:

- consumer goods (apparel, furniture, and a vast variety of goods)
- industrial goods (e.g. military and professional equipment);
- spare-parts;
- packaging and distribution items;
- civil objects (buildings, dikes, bridges, roads, etc.);
- ores, oils and chemicals;
- other materials (e.g. pulp, glass and scraps)

Some of these categories are unlikely to appear to any great degree in an urban retail reverse logistics system. Consumer goods and packaging are the categories which will be mostly involved, while retail-related waste could be considered to be part of the 'other' category, items which have to be removed from urban centres for disposition. Nevertheless this gives a good indication of the complex nature of any reverse

logistics system, and the variety of process required to manage returns in an effective manner.

4.3 Managing Product Returns

The costs and other implications of managing product returns can be problematic for retailers. Some retailers manage returns themselves, while others prefer outsourcing these responsibilities as a means of controlling the management of returns in a cost-effective and efficient manner.

Third party logistics suppliers (3PL) provide multiple, integrated logistics services, such as transportation, warehousing, cross-docking, inventory management, packaging, and freight forwarding. Some third parties solely put forward reverse logistics as their core competence, offering specialised expertise, facilities and systems, and often offer alternative channels of disposition from the traditional ones available. The failure of some 3PLs to move beyond their core commodity service to become true multi-service providers has led to the emergence of 4PL service providers, which is a business process outsourcing (BPO) provider; “a supply chain integrator that synthesizes and manages the resources, capabilities, and technology of its own organization with those of complementary service providers to deliver a comprehensive supply chain solution” (Mukhopadhyay *et al.*, 2006).

Warehouse Management System software can also help to alleviate the problems associated with returns; a properly organized process, supported by the latest hardware and software technologies, can produce a competitive advantage, attract new suppliers and control the returns process (Parvenov, 2005).

As legislation such as the WEEE Directive comes into force, and organisations have to be able to deal with an increasing volume and variety of returns, there are opportunities for the small or medium-sized retailers to cooperate with other organisations to create sufficient volumes to justify the development of reverse logistics programmes (Shih, 2001).

Other ‘non-traditional’ secondary channels to markets are becoming more prevalent (DfT, 2004); the growth of online auction sites such as EBay have given a new lease of life to products that might traditionally have entered the waste stream.

It is suggested (Dowlatshahi, 2000; DfT, 2004) that if organisations managed product returns holistically, with an integrated supply chain approach, then the current levels of returns would be reduced significantly, and would lead to enhanced profitability for retailers, and have a positive effect on sustainable distribution.

Carter *et al.* (1998) proposed a hierarchy of disposition (Figure 2) which suggests that resource reduction – the minimisation of materials used in a product, and the minimisation of the waste and energy achieved through the design of more environmentally efficient products – ought to be the goal in the reverse logistics process. Consequently, both the forward and reverse flows of materials will be minimised.

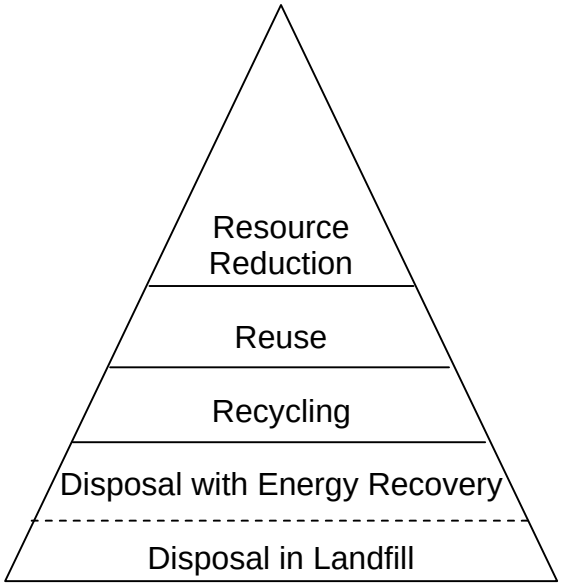

Figure 2: Hierarchy of product disposition (Carter *et al.*, 1998)

This approach is adapted in later literature (DfT, 2004), where in order to minimise the impact of product returns, a simpler hierarchy of product disposition is suggested:

- Reduce
- Reuse
- Recycle

Reduction of returns could be attained through better management of the supply chain.

Reuse of returns will maximise their asset value through effective refurbishment programmes;

Recycling refers to the best route for material recovery of products that cannot be re-sold. Products that cannot be managed through these three elements will enter the waste stream.

In order to be effective in utilising this hierarchy of disposition, organisations should aim to adopt the following management approaches:

- Integration
- Collaboration
- Evaluation

Integration embraces supply chain strategy, network infrastructure, process management and outbound/inbound logistics.
Collaboration embraces asset management, specialist service providers, shared services and competitors.
Evaluation embraces sustainability, cost and performance measures. Utilisation of a framework involving these elements will provide an opportunity for retailers, together with other parts of the supply chain, to work towards the objectives of economic performance and sustainable development.

Guide *et al.* (2003) highlight the alternative approaches to obtain used products from consumers for reuse. The *'Waste Stream Approach*' relies on diverting discarded products from land-fill by making producers responsible for the collection and reuse of their products. The *'Market-Driven Approach*' relies on end users returning their products to a firm specialising in their reuse. End users are motivated by financial incentives, such as deposit systems, credit towards a new unit, or cash paid for a specified level of quality. A combination of the market-driven and waste stream approaches is also possible. Product returns may be mandated or encouraged by legislative acts, but firms may still encourage the returns of products in known condition by offering incentives.

The authors go on to propose a three-stage closed-loop hierarchical model framework to aid in the designing, planning and controlling of logistics and related activities. The model allows a planner to investigate which method(s) of product returns is the most profitable.

In the News, 8th Sep 2006: ***Shopping centres unite with tenants to cut waste***

Three major UK shopping centres have teamed up with Envirowise to roll-out a campaign aimed at increasing profits by reducing unnecessary waste and improving their environmental performance. Retail outlets at the Meadows Centre in Chelmsford, the Kirkgate Centre in Bradford and one of the UK's longest-standing shopping centres, the Whitgift Centre in Croydon, will work in partnership with centre management to implement a range of waste saving and recycling measures.

Participating retailers will receive a free, environmental efficiency review, a tenant support pack and advice from an Envirowise expert on the store's waste, energy and water use. A key element of this year's campaign is the development of a toolkit that will enable shopping centres to drive forward their own resource efficiency initiatives. Last year, four shopping centres involved in the programme identified cost savings worth more than £300,000, mainly through simple measures that cost little or nothing to put into place.

Neil Avis, Operations Manager at the Whitgift Centre said: "With the general public becoming increasingly aware of retailers' environmental policies, our aim is to demonstrate a commitment to improving environmental performance and encourage other local businesses to take a similar approach. We believe this initiative will also help us strengthen our relationship with tenants and offer practical solutions that will really make a difference to resource efficiency - and bottom line profits."

Chris Hodgson, Envirowise project manager, commented: "These three shopping centres and their tenants are paving the way in environmental good practice. With energy and utility costs currently on the increase, our experience has shown that shopping centres can reap significant commercial benefits by working in partnership with tenants to reduce their environmental impact."

Source: Resource Recovery Forum email notification 08/09/06

Beamon (1999) suggested that organisations must develop procedures that focus on operations analysis, continuous improvement, measurement, and objectives, including the following tasks:

- **Identify Processes.** For each product within the supply chain, identify all inputs, outputs, by-products, and resources.
- **Develop a Performance Measurement System.** Given the complexity of most supply chains, a single performance measure will likely be inadequate in assessing the true performance of the supply chain. Thus, a system of performance measures will be necessary. Such a performance measurement system must include measures for the three environmental categories given above, as well as existing operational measures.
- **Measure the Supply Chain System.** Calculate the actual composite performance at each step in the supply chain process for each product. The composite performance, as calculated at each supply chain process step, will be a function of the performance measures.

- **Prioritise.** After all processes for all products have been measured, prioritise the process steps in order of increasing composite performance.
- **Develop Alternatives and Select Approach.** Develop alternatives for performance improvement (targeting first those process steps exhibiting the worst composite performance, based on prioritisation), and select a preferred approach.
- **Establish Auditing and Improvement Procedures.** Establish schedules and procedures for auditing and continuous improvement, including emergency and non-compliance procedures.

Rogers *et al.* (1999) also focus on the process of monitoring returns: "one of the biggest challenges facing firms dealing with reverse logistics is a lack of information about the process … Poor data collection leads to uncertainty about return causes. In the long run, the most valuable outcome of sound reverse logistics management is the accumulation of data."

5. Reverse Logistics in the Urban Environment

In the literature available on logistics in an urban environment, or 'City Logistics', to which it is often referred, little mention is made of reverse logistics. City logistics implies that goods transport to the inner city is consolidated in a distribution terminal outside the city and thereafter distributed by one logistics provider to urban areas (DETR, 1999).

Environmental impacts of logistical activities are most severe when population densities are highest; i.e. in cities. Urban freight transport deals largely with the distribution of goods at the end of the supply chain, so deliveries are likely to be frequent, but limited to carrying small loads. Possibilities for the extension of the traffic infrastructure within cities are limited and unsustainable.

Taniguchi *et al.* (2003) proposed three basic pillars as the guiding principles for green city logistics: mobility, sustainability and liveability (Figure 3). These pillars ought to support and enhance the goals and objectives of logistics, such as efficiency, congestion alleviation and energy conservation. The harmonization of efficiency,

environmental friendliness and energy conservation is vital for ensuring sustainable development of freight transport in urban areas (Geroliminis *et al.*, 2005). Thus, the goal of city logistics should be to deliver and collect the goods for activities produced in a city in an efficient way, without disrupting the sustainable, mobile, liveable and environmental friendly character of the city.

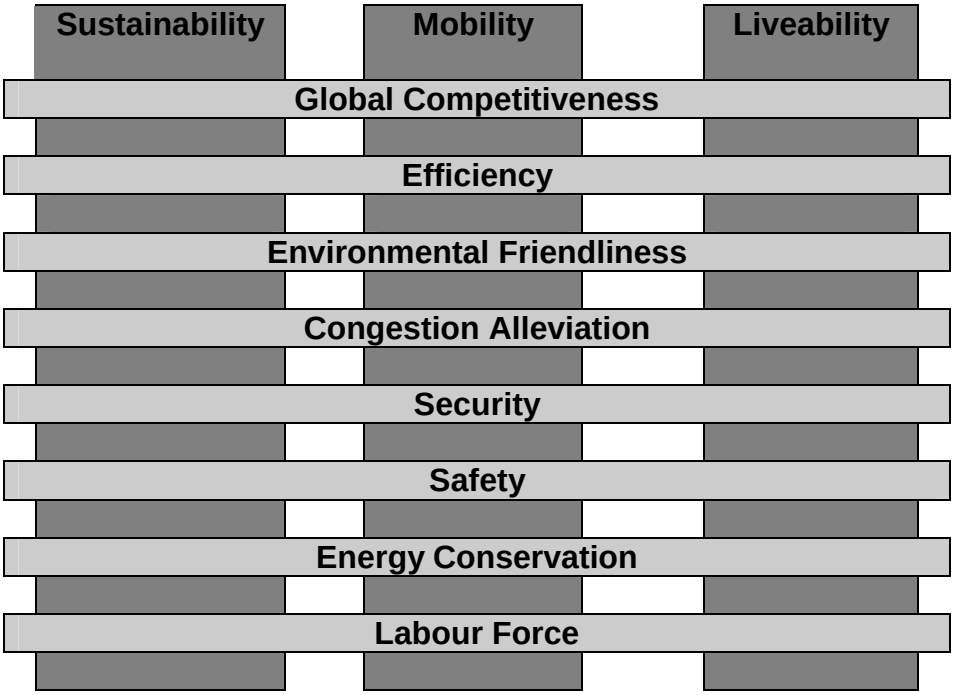

Figure 3: Structure of visions for city logistics (Taniguchi *et al.*, 2003)

The environmental impact of the transportation requirement of logistics can be alleviated somewhat by consolidating freight and balancing 'back-haul' movements (Shakantu *et al.*, 2002). Making use of spare capacity on the return leg of a delivery journey makes more efficient use of valuable resources such as fuel and driver time by finding loads that need to be shipped between similar areas as those visited by the returning vehicle. Higher load balance helps reduce the number of empty trucks on the road, alleviate traffic congestion and cut down pollutant emissions (DfT, 2005).

Four basic physical network types for retail organisations to handle returns were identified by the authors of *The Efficiency of Reverse Logistics* study (DfT, 2004). Different elements of each of these basic forms might be utilised by retailers to obtain a full solution to their returns management issues:

Type A: *Integrated outbound and returns network*

Utilising backhauling, a companies own fleet takes returns from retail outlets to the Regional Distribution Centre (RDC). The sortation and potential refurbishment processes are carried out at the RDC. This works well if the frequency of delivery to stores is high, and volume of returns is also high.

Type B: *Non-integrated outbound and returns network*

A separate network is used for managing returns, typically a third party logistics supplier (3PL) taking returns (on an 'as and when' required basis) from stores to a separate location where the reverse logistics activities are undertaken by the retail organisation. This works well if the level of returns varies in volume but is generally low.

Type C: *Third party returns management*

Total management of returns is outsourced to a third party contractor. The retailer benefits in that no expertise is required to be developed in-house – the 3PL provides the necessary returns management processes, with supporting technologies and refurbishment and disposition programmes.

Type D: *Return to suppliers*

Goods returned to the suppliers are exchanged for credit. Retailers have little responsibility for returns in this scenario. However, there may be additional costs in terms of vehicle kilometres, as the goods have to return to the supplier before disposition.

Geroliminis *et al.* (2005) present several examples of sustainable city logistics and green logistics schemes that have been used in various cities around the world. Of the 17 examples cited, five have particular relevance to this review:

Copenhagen – City Goods Ordinance for capacity management

In early 2002, Copenhagen implemented a compulsory certification scheme (City Goods Ordinance) in the medieval city centre with requirements of capacity utilisation and engine technology. The aim was to reduce the environmental impact from goods traffic in the city centre and make the narrow medieval streets more accessible by increasing the utilisation of vans driving into the heart of the city, thus reducing the number of vehicles.

Zurich – Cargo Tram

Cargo Tram operates where the city's waste disposal and recycling department wants to move household waste. A tram with two trailers is converted into a mobile rubbish collection station, which, in March 2005 was making nine stops around the city (Figure 4). The main objective was to move waste collection away from the road and as close to the clients as possible, and also to provide facilities at a time when the working population was not at work.

Figure 4: Cargo Tram in Zurich

Cargo Tram is cheaper, faster and produces fewer pollutants than the traditional waste collection system. It is a technology moving a commodity of low intrinsic value and which is largely indifferent to time sensitivities.

Berlin – Goods Traffic Platforms (Public Private Partnership)

Within Berlin city limits, 45 million tonnes of goods are distributed by trucks and smaller delivery van each year, with an expected future increase in these figures. The main objective of this project was to reduce the frequency of deliveries through cooperation between various recipients (e.g. adjacent shops being supplied by the same carrier) and a combination of deliveries to a single recipient. Results indicate that Goods Traffic Platforms are successful tools, as they contribute to the reduction of congestion during loading or unloading of vehicles.

Stockholm – logistical centre for coordinated transport

The logistical centre was set up in 2003; its main objectives were to reduce energy use and CO_2 emissions through coordinated transport to the district residents, municipal institutions such as schools, day-care and elderly-care centres, as well as private companies operating in the district.

The centre is responsible for delivering online purchased goods, dry cleaning services, and food and beverages. Reports indicate that the centre has the potential for becoming an integrated distribution system for locally produced food, coming directly from approximately 300 local farmers.

Tokyo – Advanced Information System

Although parcel delivery companies can efficiently implement full-load transport of large trucks between cities, the delivery and pick-up of cargo within the city is relatively inefficient. To improve the existing situation, a cooperative parcel pick-up system using the internet was tried in Otemachi (Tokyo downtown area) in 2002. Requests were made online, and a logistics service provider collected the bundled demand for each building. The demand on roadside parking was reduced as were the numbers of kilometres travelled by freight vehicles.

The EC's *Urban Freight Transport and Logistics* brochure gives an overview of research from the Fourth and Fifth Framework programmes, together with policy implications and requirements for future research (EC, 2006).

One outcome of the "Best Urban Freight Solutions" project (BESTUFS, 2003) was a series of recommendations on the following themes:

- Statistical data, data acquisition and analysis regarding urban freight transport
- City access, parking and access time regulations and enforcement support
- E-Commerce and urban freight distribution (home shopping)
- Road pricing and urban freight transport
- Urban freight platforms (single company platforms, freight villages, urban distribution centres)
- Intelligent transport systems
- Public Private Partnerships

Building on the structure and experience gained from this project, BESTUFS II aims to strengthen and extend the promotion and dissemination of “City Logistics Solutions” in Europe and beyond, e.g. by establishing new links with other networks, groups and other international experts that interface with urban freight transport issues (BESTUFS, 2006). While some aspects of reverse logistics are implicit within the scope of this project, no explicit mention is made of the impact of reverse logistics on city logistics.

The START project (Short-Term Actions to Reorganize Transport of goods) has partners in the cities of Bristol, Göteborg, Ljubljana, Ravenna and Riga. The project deals with making goods distribution more energy efficient by combining access restrictions, incentives and the development of consolidation centres (START, 2006). The Exel/DHL transhipment centre trial in Bristol is being continued under this programme which has seen a successful reverse logistics system created for the return of recyclables (packaging, cardboard and paper) from retail business in the city centre.

6. The Role of Reverse Logistics in Packaging and Waste Management

An Environment Agency survey in 2002/3 (EA, 2005) suggested that approximately half of all commercial and industrial waste in England and Wales was produced by small to medium sized enterprises (SMEs), making up around 1/3 of industrial wastes and 2/3 of commercial wastes. The difficulty that small businesses face in terms of recycling opportunities was also highlighted in the recent waste strategy review (Defra, 2006) where it was suggested that only 37% of commercial waste was recycled. The review recognised that smaller businesses often had particular difficulties in obtaining affordable recycling and recovery services, and suggested that co-ordinating operations across different waste streams was a potential way to improve efficiency and performance.

Currently, the overwhelming majority of waste is moved by road, and the impact of road freight transport in terms of congestion, local environmental impact, and climate change is clearly recognised. De Brito *et al.* (2003) point out that reverse logistics

differs from waste management, since the latter is mainly concerned with the collection and processing of waste (i.e. products for which there is no new use) efficiently and effectively. The definition of waste in this context is crucial, especially with regard to the potential legal implications, e.g. it is often forbidden to import “waste” (Fleischmann, 2001). However, there are similarities between the processes involved in waste management and some of those used in reverse logistics, especially in an urban environment (Shakantu *et al.*, 2002).

Fleischmann *et al.* (2000) consider the relation between product recovery networks and waste disposal networks. There are obvious analogies between these networks with respect to the ‘supply' side – used products are collected from many, possibly widespread sources and need to be consolidated for further processing and transportation. However, there are major differences between these network types on the ‘demand' side, while a flow of recovered products is directed towards a reuse market, waste streams eventually end at landfill sites or incineration plants.

The EC Directive on Packaging and Packaging Waste (94/62/EC) seeks to reduce the impact of packaging and packaging waste on the environment by introducing recovery and recycling targets for packaging waste, and by encouraging minimisation and reuse of packaging. The overall targets for recovering and recycling used packaging are 60% and 55-80% respectively (Defra, 2006b). Minimum material-specific recycling targets are glass 60%, paper/board 60%, metals 50%, plastics 22.5% and wood 15%.

Traditionally, cardboard boxes are used as secondary packaging (material used for packaging products during transport from a sender to a recipient). Since cardboard boxes can be used only once, they are defined as one-way packaging material. In contrast, returnable packaging is a type of secondary packaging that can be used more than once in the same form.

One factor contributing to the costs of reusing packaging is the separation and stock keeping of different types of packaging in the redistribution chain. The redistribution of reuse packaging has to be minimised for environmental and economic reasons. One solution to minimise these costs is standardisation (Golding, 1999). Using a common type, reusable packaging could be exchanged between several companies (Kroon *et al.,* 1995; DfT, 2005).

In the News, 29th Aug 2006: ***New national packaging waste database proposed***

Proposals to introduce a new electronic online data system for the packaging industry have been issued for consultation by the UK Government's Department for Environment, Food and Rural Affairs (Defra), the Welsh Assembly Government and the Scottish Executive.

A proposed National Packaging Waste Database and electronic Packaging Waste Recovery Notes (PRNs) and Packaging Waste Export Recovery Notes (PERNs) would:

- Speed up data collection, enabling reprocessors and exporters to report electronically and allow data to be released to industry more quickly
- Enable producers/schemes to submit registration applications electronically
- Enable reprocessors and exporters to issue PRNs and PERNs electronically.

The packaging Regulations have increased packaging waste recycling from around 27 per cent in 1997 to more than 54 per cent in 2005 (almost 6. 2 million tonnes last year) significantly reducing the amount of packaging waste going to landfill. The consultation also contains a number of proposed technical changes to the current regulations.

The proposed changes in this paper can be summarised as:

- **technical changes -** including amending some references in the 2005 Regulations to reflect the policy intention, and making some technical changes.
- **changing the Regulations** to allow for electronic Packaging Waste Recovery Notes (PRNs) and Packaging Waste Export Recovery Notes (PERNs); this is discussed along with a proposed increase in Agency fees to enable further development of the National Packaging Waste Database in 2007/2008.

Source: Resource Recovery Forum notification email, 29/08/06

Returnable packaging may appear to increase the logistics cost due to the requirement for extra handling equipment and storage space. However, since manufacturers factor in the costs of packaging into their prices to customers, the total cost of the supply chain is likely to be reduced, since such materials can be used many times and the disposal costs minimized (Wu *et al.,* 1994).

Simply using back-loading can allow manufacturers to reduce costs and meet some of the above targets (a distribution vehicle picks up pallets or other packaging and distribution materials previously deposited at the delivery location). The return trip adds value to the process by returning back to their point of origin those recovered materials that are re-usable (Shakantu *et al.*, 2002, Fernie *et al.*, 2003). It is important that the processes of producing and disposing of returnable containers, together with the additional return logistic activities, should not be more harmful to the environment than the use of one-way packaging material (Kroon *et al.*, 1995).

In a review of the impacts of legislation on food retailers, Fernie *et al.* (2001) noted that while large retail chains maximise vehicle utilisation with backhauls from suppliers, including trays and other re-usable, recycled material, wholesalers have to deliver small loads to many small shops. For hygiene and cost considerations, it is impracticable to recover packaging waste from these shops.

A review of case studies carried out by De Brito *et al.* (2002) found that certain public reverse logistics networks were created in order to comply with legislation to reduce waste. However, their review did not include case studies regarding networks set up purely for waste disposal; such cases did not in their opinion consider what to do with the waste and were not considered typical reverse logistic activities involving sorting, disassembly and recycling.

6.1 Trade Waste Operations

Local authorities can set up their own trade waste collections and under the Controlled Waste Regulations, they can charge businesses for these services. 'Trade waste' has been defined as "the commercial element of municipal waste" and covers the waste products produced by retail establishments, offices, hotels and restaurants. Under Section 34 of the 1990 Environmental Protection Act, commercial premises have a 'duty of care' to make satisfactory arrangements for their waste collection (Defra, 1990). Generally, businesses will arrange a collection contract with a private waste management company but some authorities have started up rival services. Research into waste production by 100 retailers in Winchester (Miracles, 2006) suggested that 75% of the average commercial bin consisted of paper and cardboard and that 68% of businesses did no recycling. The evidence suggested that there was considerable scope for returning such recyclables back through the supply chain for reuse.

A key driver is the Landfill Allowance Trading Scheme (LATS) which sets challenging targets for the reduction of biodegradable municipal waste sent to landfill (Defra, 2005a). Trade wastes count against an authority's LATS targets and there is therefore an incentive for authorities to better address the recycling or composting of biodegradable trade waste and divert it from landfill. This will not only help them meet their LATS targets but also increase their overall recycling rates. Recent research by Enviros Consulting (2005) showed that nearly 22% of the co-collected waste stream is made up of recyclable paper and cardboard and if such percentages were diverted

away from landfill in London, this would equate to over 100,000 tonnes as a contribution towards the Capital's LATS targets.

By setting up trade waste collection schemes, local authorities can also reduce heavy vehicle traffic and improve local collection services. Commercial and retail premises in a typical business district may receive waste collections from both the collection authority and private contractors' vehicles. Often a number of different contractors may visit the same premises to collect the occupants' commercial or trade wastes. Using a collection authority vehicle could minimise the number of separate visits made and make the transport process more efficient.

Local authorities who offer trade waste collections can do so as a separate entity, using a separate fleet of dedicated vehicles and hiring out their own bins to businesses as part of the contract (e.g. Southampton City Council). Others collect trade waste as part of the domestic residual round (e.g. New Forest District Council), where local traders register with the council and put waste out on specific collection days in specified sacks or bins.

Enviros Consulting (2005) report various case study examples of local authority trade waste schemes and their charging structures. Peterborough City Council offers an 1100 litre recyclables bin collection contract for £300 per annum which entitles businesses to a weekly collection. The same service for normal refuse would cost a business £509 per annum. The London Borough of Southwark provides a trade waste recycling collection service for materials including glass, cans, paper via a range of receptacles. The council charges for receptacles on a per lift basis, with an additional weekly charge for rental of each container type. Weekly charges for renting a 660L Euro bin for residual waste are £1.55 with a per lift additional charge of £4.70. If the business uses the bin for recycling paper or cardboard, the weekly collection charge is £1.48 and per lift charge £2.70 providing an incentive to separate out materials.

6.2 Reuse and Refurbishment Markets

Of key importance to reverse logistics networks handling recyclables is the end market for the recyclate. The lack of available markets for recyclables has long been identified as a barrier, restricting recycling performance. The Waste and Resources Action Plan (WRAP) was established in 2001 to create stable and efficient markets for recyclables

with specific focus on aggregates, glass, organics, paper, plastics and wood (WRAP, 2006).

Material markets are found on a local, national and global level (RRF, 2004). Individual commodity pricing structures are complex and depend on a range of factors including the supply of, and demand for the recyclate, transportation and handling costs, market competition and overheads (RRF, 2004). If a particular recyclate market becomes saturated, with supply exceeding demand, the commodity value decreases, affecting the viability of the collection systems. This market behaviour was experienced in Germany when the German Packaging Ordinance referred to as the "Topfer Decree" was introduced in 1992. This covered all types of packaging waste and obliged manufacturers and distributors to take back packaging for reuse or recycling outside the public waste disposal system. The over-supply of recovered paper resulted in a crash in prices which led to an increase in paper dumped across Europe. The UK recyclate market is influenced by its foreign counterpart (through which exports and imports of materials are exchanged), the virgin commodity market and the PERN market (packaging waste recovery notes as part of the packaging and Packaging Waste Regulations).

There are many mature markets available for components of WEEE, especially plastic and cathode ray tubes, ferrous and precious metals (Enviros, 2002). European Metal Recycling (EMR) have an established network of facilities throughout the UK to process WEEE, metal packaging, plastics and rubber (Enviros, 2002). The markets for WEEE are influenced by the age of the material and also the techniques used by the reprocessor to reclaim components with value.

Community and charity groups also generate a market for recovered material for reuse (Enviros, 2002). Organisations such as Furniture Reuse Network (FRN formerly known as Furniture Recycling Network), Community Recycling Network, CREATE UK Ltd, CRISP, ECT Recycling, Realise-It, the SOFA project play an integral role in local and national sustainable waste management. Through local community schemes and social enterprises, materials such as EEE (computers, TV's etc), can be refurbished and reused within the community. There are also established charity markets which export materials to developing countries (e.g. Recommit that collect and export computers).

6.3 Transport and Waste Management

Waste management policies aimed at increasing recycling and recovery tonnages will pressurise the transport sector (RRF, 2004). The separation of the municipal, commercial and industrial wastes streams make it inevitable that waste and reusable/recyclable products will be transported over different routes with potentially long distances to disposal, storage, or reprocessing (Figure 5).

Road transport is currently a significant part of the process in the waste recovery and recycling supply chain, both in terms of its functional importance and in its contribution to total cost. It is also a key issue in sustainable development, significantly affecting the environment.

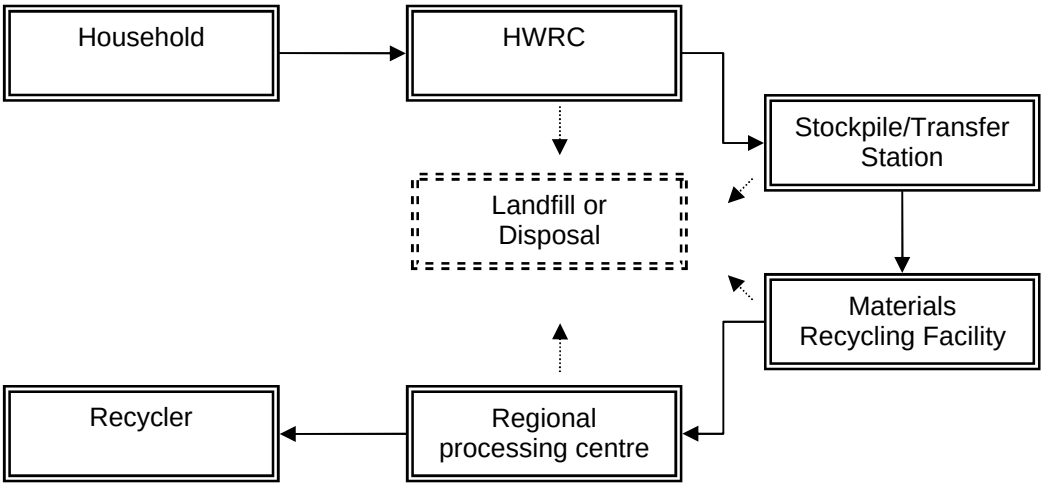

Figure 5: Waste management supply transport chain (adapted from RRF, 2004)

Future use of alternative modes of transport – predominantly rail and water – may have significant environmental and economic advantages (STRAW, 2006), and may be best taken forward in an intermodal (or multimodal) transport system, incorporating a unit or container that can be easily moved from one mode of transport to another – road to rail or to water-borne. Two basic principles emerge from the STRAW report:

- A proactive and collaborative approach is needed which brings together land use planning with transport planning, waste planning and economic development strategy
- A forward looking approach is required which promotes integrated resource management and re-use, centred away from material disposal.

RRF (2004) report on the development of a model which aims to estimate the increase in financial, environmental and social transport costs associated with diverting increasing quantities of waste from landfill to alternative recycling and recovery facilities. The model assesses the total cost of waste management from initial household collection, through materials reprocessing facility to re-processor (glass, paper, plastics, aluminum, steel and mixed metal) and finally through to incineration, composting and landfill. It presumed that transport costs would increase as shorter journeys to landfill would be replaced by longer journeys from source to re-processor (i.e. HWRC, kerbside collection, bring-sites). Of particular note was the likely impact of the Road Transport Directive (RTD, 2002/15/EC) on waste logistics which came into force on 23rd March 2005, affecting the working time of 'mobile workers'.

Based on a theoretical fleet of 100 collection vehicles operating across a typical English county, the implementation of the RTD would result in 159 driving hours lost per week, a 4% reduction on current productivity levels. For the notional 100-vehicle fleet, reassigning these hours across the drivers effectively would require four additional vehicles at 48 hours per week.

The modelling results suggested that the potential impacts on transfer vehicle fleets, more likely to be involved in the movement of recyclate and items for re-use, would be much more severe due to the longer distances involved between transfer stations and final disposal/recycling points. Across a notional fleet of 100 vehicles, the results suggested that 598 driving hours would be lost per week representing some 13% of the original output level. Rescheduling the vehicles to keep within the RTD would require an additional 12 vehicles and drivers if they could all be scheduled for an average of 48 hours per week (RRF, 2004).

The issue of increased journey length has been heightened by changes brought about through the Landfill Regulations 2002 (Landfill Directive 99/31/EC). These have meant that hazardous and non-hazardous wastes can no longer be 'co-disposed' in landfill sites and as a result, the number of available sites licensed to take hazardous waste has dropped from around 240 nationally to fewer than 15 which are not evenly distributed. The average length of haul is predicted to rise significantly given that nearly 42% of hazardous waste is currently transported across regional boundaries (Envirowise, 2005) and there will be no licensed sites in London or Wales. The

Environment Agency estimates that as a result, the cost of collecting and disposing of hazardous waste will increase significantly from £150 million per annum up to approximately £500 million.

The wider transport impacts of WEEE take-back schemes are less certain. The operation of a National Clearing House (NCH) for WEEE would coordinate collections and deliveries nationwide (Figure 6). This would be achieved by allocating each collection to an individual producer (or more likely groups of producers working together) who would have an obligation to collect within a set time frame (48 hours). The Government envisages that this allocation could be based on the results of a routing and scheduling algorithm, operated by the clearing house.

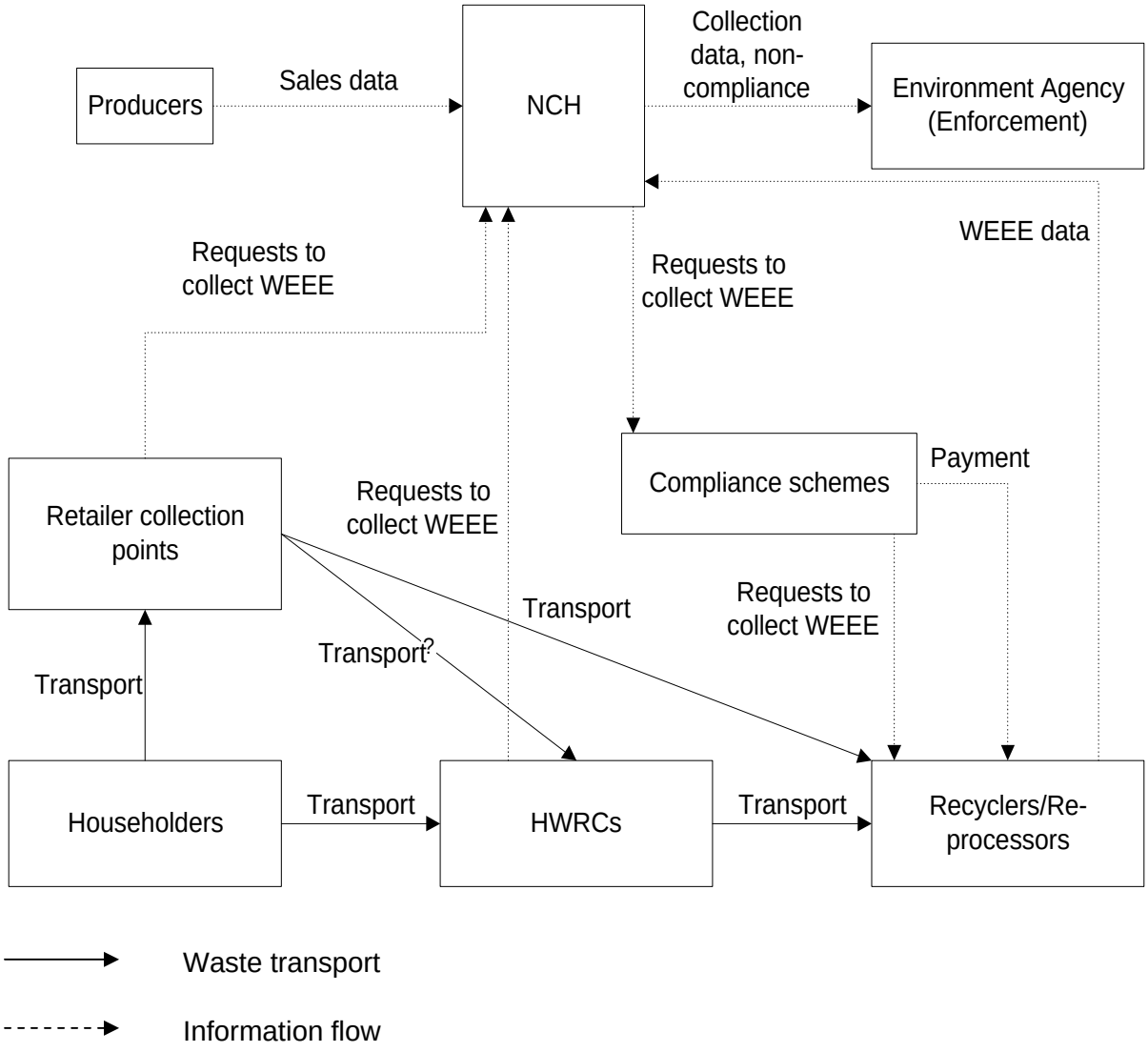

Figure 6: Potential role of a National Clearing House in co-ordinating transport movements of WEEE. (Source: Adapted from a presentation given by Mark Dempsey, Parliamentary Sustainable Waste Group)

The NCH could also operate a complete UK collection service itself funded as part of the producer's registration fee. In the Government's second consultation on the WEEE Directive, 48% of respondents thought that the NCH should pass on the responsibility of collection to producers or their agents while 35% thought that it should manage the collection service.

Whichever system is agreed, the actual collection and carriage of WEEE would be sub-contracted, with the NCH acting as national transport co-ordinator from local collection through to treatment and processing. It is still undecided whether a series of national 'bulking-up' consolidation centres for WEEE might be needed but the directive will generate additional transport trips through the need to separate out and treat different categories of WEEE.

Commercial vehicle activities at Household Waste Recycling Centres (HWRCs) could intensify as the Government intends to continue using those existing HWRCs which collect WEEE separately. The Government is mindful of the extra transport burden this could cause local authorities and is encouraging them to consider upgrading sites where possible with the aid of a specific modernisation fund that would be set up. All UK local authorities would have access to the proposed new NCH service, which would remove WEEE within 48-hours free of charge.

The recycling of WEEE is significantly different to other household waste as it is compositionally complex which may include hazardous or precious materials, both of which will require separate handling and reprocessing (Nagurney and Toyasaki, 2005), increasing overall transport arisings.

Two consumer in-store take back trials conducted by PC World in Southampton (DTI, 2004b) recovered obsolete PCs which were transported approximately 20 miles to the Intex facility in Portsmouth. Of the 62 participants, 40% discussed how they usually would have disposed of WEEE via a HWRC. The distance travelled to the store was on average 8.5km in which 94% of participants had specifically travelled to the retailer to dispose of their WEEE. The trial highlights that despite the benefits of WEEE recovery, retailer take back schemes could increase the number of specific dedicated journeys to dispose of one particular waste stream.

Wincanton, the supply chain solutions provider has teamed up with Remploy, the UK's leading provider of employment opportunities to disabled people, and several high street retailers including Comet and Brighthouse Stores to offer a WEEE take-back service in the Midlands. White goods are returned by the retailer compliance schemes to Wincanton's facility at Darlaston for sortation and processing. Remploy work alongside Wincanton on-site to identify items that can be refurbished for re-use in the community. The remaining items are then recycled via established channels, such as Wincanton's fridge processing plant in Billingham (Wincanton, 2004).

The implementation of the Restriction of Hazardous Substances (RoHS) and specifically the WEEE Directive, look set to have an impact on both commercial and private waste journeys. Increased material collection and transportation to licensed facilities to be treated and reprocessed before disposal will increase the number of journeys and distances travelled by commercial vehicles.

If retailers or distributors choose to take-back themselves, then there will be a requirement to register for a storage license, or an exemption license, with an enforcing body such as the Environmental Agency, for the areas where the WEEE is kept. There will also be a requirement for those who transport WEEE to hold a waste carrier's license and for the drivers to have special training in the transportation of hazardous waste. These measures will all increase transport costs.

7. Uncertainty in Reverse Logistics

Guide *et al.,* (2000) highlight seven characteristics which increase uncertainty and introduce complexity within supply chain activities:

(1) the uncertain timing and quantity of returns,
(2) the need to balance demands with returns,
(3) the need to disassemble the returned products,
(4) the uncertainty in materials recovered from returned items,
(5) the requirement for a reverse logistics network,
(6) the complication of material matching restrictions, and
(7) the problems of randomly determined routings for returned products and highly variable processing times.

In order to minimise the impact on the effectiveness of operations, managers must take actions to reduce uncertainty in the timing and quantity of returns, balance return rates with demand rates, and make material recovery more predictable. Another issue to address is the effect that customer non-compliance in returning distribution equipment can have on the effectiveness of reverse logistics operations (Breen, 2006).

In the retail context, future planning and forecasting for reverse logistics are made difficult because individual customers ultimately initiate reverse logistics activities, and different products have very different return rates (Tibben-Lembke *et al.*, 2002). There appears to be significant potential for information to reduce the inherent uncertainties for a firm operating in an environment with product returns (Ketzenberg *et al.*, 2004).

As firms from different industries and process types start using recoverable-manufacturing systems, more information will become available on the implementation of such systems and on handling the associated uncertainty. The use of information systems with new production-planning and control techniques should make management of these activities more predictable.

8. Impact of E-Commerce and Information and Communication Technologies on Reverse Logistics

E-Commerce enables retailers to sell products and services directly to consumers without the need to establish a physical point of sale. Some products, such as airline tickets and music CDs, can be delivered digitally to the end consumer, but most products purchased online must be physically transported to the end-user. A reliable, efficient delivery system is an essential element for gaining customer loyalty online, and subsequent profitability. Home delivery is increasingly a key element in e-commerce.

The growth of e-commerce has led to a new dimension in retailing. Generally, the consequences of e-commerce on Green Logistics and reverse logistics are little understood, but some trends can be identified. Physical distribution systems are changing as a result of e-commerce becoming more accepted and used. Retailing

distribution is disaggregated, and the trend towards consolidation has reversed (Rodrigue *et al.*, 2001).

Since products are more likely to be returned in an environment of greater e-commerce, there is a direct impact on the amount of products moving up the supply chain. Traditionally, shoppers have borne the costs of moving goods from the retailer to home, but with e-commerce, this aspect of the supply chain is integrated in the freight distribution process. The result potentially involves more packaging and more tons-km of freight transported, particularly in urban areas.

There are several problems associated with faulty or damaged goods that are delivered to customers' homes, including: who is responsible and will pay for the damage, the additional transport requirements and costs involved to remove the goods and then deliver replacement goods, and the inconvenience caused to the customer in achieving a resolution to any dispute and the delay in receiving the goods purchased. The market for managing the return of goods is growing as the pace of e-commerce retail sales accelerates. While the historical rate for returning merchandise is about 5%, some estimates suggest that online-driven products realize return rates in excess of 30% (Park *et al.*, 2004).

One of the major tasks in the planning of reverse logistics activities is to be able to manage the uncertainty inherent in systems involved in product recovery and reuse, where used products are a far less homogeneous and standardised input resource than traditional raw materials and new parts. Modern information technology can play an important role in dealing with this uncertainty (Fleischmann *et al.*, 1997; Lee *et al.*, 2001; Kokkinaki *et al.*, 2002, De Brito *et al.*, 2002, Jun *et al.*, 2006).

The general aspects of e-commerce for reverse logistics are summarised in Table 6 (Kokkinaki *et al.*, 2000).

E-Commerce Applications	Reserve Logistics Tasks
Marketing	Advertisement of available used products, parts or material
	Notification of used products, parts or material, currently sought
Purchasing	Search for suppliers/customers
	Making purchasing commitments
	Receive information of expected delivery
	Respond to request for sought used products, parts or materials
Sales	Price setting (i.e. fixed, negotiations, auction)
	Order processing
	Tracking and tracing orders
	Customer invoicing, collection and payment
Post Sales/Service	Product tracking
	Customer support
	Customer/product monitoring

Table 6: E-Commerce relation to reverse logistics (Kokkinaki *et al.*, 2000)

The tasks identified in Table 6 are not all equally represented. Kokkinaki *et al.,* (2000) identified three prominent e-commerce models for the support of reverse logistics activities. The most popular model was 'Electronic Marketplaces', which are used for both new and used products. Then, there were sites that use the Web to offer used parts or remanufactured equipment. Finally, there was a Web-based concept which incorporated collection, selection, reuse and redistribution.

E-business has been a powerful and compelling enabler of supply chain integration across a wide range of industries (Lee *et al.*, 2001). The Internet has allowed companies to come up with highly innovative solutions that accelerated the widespread adoption of these core supply chain principles such as information sharing, multi-party collaboration, outsourcing and partnerships, and extended or joint performance measures.

Kokkinaki *et al.,* (2002) suggest that Web technology and e-commerce contribute to more efficient returns handling in four major directions:

Proactive minimisation of returns – increased efficiency of forward logistics using on-line tracking and tracing; selecting an appropriate product mix for the target market using web-accessible databases; 'gatekeepers' for on-line purchases which aim to minimize returns due to misunderstanding of product functionality, and 'no fault found' returns;

Minimisation of returns' uncertainty – when customers declare a return, they are directed to a Web interface that collects data on the condition of the product, the intended collection method, the time and the place of the return;

Returns and third party logistics operators – 3PL are often employed to provide end-to-end process management for returns as they can make more money out of it than businesses themselves. Increasingly 3PL offer Web-enabled applications with real-time access to data across their customers' reverse supply chain;

Consolidating returns channels – exploiting the Web, Original Equipment Manufacturers (OEMs) consolidate their channels of returns into a central stream. In a sense, these sites operate as electronic outlets that are owned by the OEM and aim to redirect their returns back to the market swiftly.

Ferguson *et al.,* (2001), in their study of end-of-life vehicles illustrating the specific information flow between the key players within the automotive industry, give an example of how a Web-based system to aid in the recovery of end-of-life vehicles might work by allowing a much greater level of communication both within the reverse distribution channel and between the dismantler and the forward distribution channel.

'Clearing houses' are organisations which aim to match back-loads with available vehicles. Originally, clearing houses used the telephone to match spare capacity with loads in return for a commission. In recent years, the growth in e-business has made this service more effective and widespread, using online freight exchanges to allow carriers to communicate with fellow operators (DfT, 2005).

In a study of six case studies in different industries, Mortensen *et al.,* (2005) found that use of information technologies had little impact on the integration and coordination of the flow of information and the reverse flow of products between companies. De Brito *et al.,* (2002), however, offer several specific examples of Information and Communication Technology (ICT) impacting on reverse logistics activities, observing that ICT is used to support reverse logistics during different stages of a life-path of a

product. The authors emphasise that it is the quality of data and information that is the critical factor in the success of using such systems, rather than the technology.

The eDRUL project (eCommerce Enabled Demand Responsive Urban Logistics) looked specifically at how to improve the management of freight forwarding for urban areas where vehicular access is restricted (eDRUL, 2006). The partners developed a "Web agency" to provide portal access for booking deliveries and load exchange in such areas.

9. Modelling Approach to Reverse Logistics

While a review of mathematical modelling techniques used to assess the factors involved in reverse logistics is beyond the scope of this review, it may be useful to highlight a number of documents in which such information is available. Fleischmann *et al.*, (1997) offer a review of mathematical models pertaining to distribution planning, inventory control, and production planning, and note that the forward and reverse flows cannot be treated independently but have to be considered simultaneously to achieve adequate planning. They also note that there is an increasing level of uncertainty in systems involved in reuse.

A quantitative model assessment is also given by Dowlatshahi (2000), who goes on to note that "the conceptual, quantitative, and application-case-based articles do not provide an extensive treatment of reverse logistics topics."

De Brito *et al.*, (2002) review 60 case studies and articles describing how organizations deal with reverse logistics, and compare their findings with the models that have been developed to support decision making in the area of reverse logistics.

An overview of reverse logistics frameworks, and issues relating to processes and information systems is given by the DfT (2004), together with an overview of models supporting supply and transportation decisions, inventory management techniques and the important role that Information Communication Technology plays in reverse logistics operations. Kokkinaki *et al.,* (2002) review a selection of e-business models for reverse logistics.

10. Summary

This literature review provides an overview of the literature pertaining to reverse logistics, particularly relating to retailing and sustainable urban distribution, green logistics, packaging and waste management.

Originally perceived as simply the management of returns, the modern objective of any ‘green’ reverse logistics process is to provide an environmentally-friendly method of recovering and re-using materials at the end of the life-cycle of a product.

There are three driving forces for the growth in environmentally-friendly manufacturing and distribution operations: 1) environmental laws and regulations, 2) the positive economic impact of recycling, remanufacturing, and processing of used products, materials, and packaging representing an additional revenue stream, and 3) other non-economic factors relating to social responsibility lead organisations to address the environmental issues surrounding sustainable distribution.

Issues of reverse logistics that affect retailers can be different from those which affect manufacturers or distributors; for instance, retailers may have to deal with obsolete, damaged or unsold stock, and to have facilities in place to manage products returned by customers for a variety of reasons, as well as for the proper disposition of packaging and other waste products. Some retailers will manage returns in-house, while others prefer outsourcing these responsibilities as a means of controlling the management of returns in a cost-effective and efficient manner.

The implementation of a simple hierarchy of disposition could help to minimise the impact of returns; reduce, reuse, recycle. These aims, together with the management approaches of integration, collaboration and evaluation will help the reverse logistics providers work towards the objectives of economic performance and sustainable development.

The environmental impact of logistical activities is most severe in urban centres, but research into sustainable urban distribution (‘City Logistics’) has largely focused on the forward supply chain. Little research has been undertaken to understand the logistics which support the running of retail establishments in urban areas, the return

of damaged, unsold or returned consumer products to manufacturers, and the consolidation, handling and disposal of packaging and other waste products generated by the retail and other trade processes.

Future use of Information and Communication Technologies will help to alleviate some aspects of uncertainty inherent in systems involved in product recovery and reuse with potential for ‘electronic marketplaces’ and other Web-enabled systems to enhance supply chain integration.

REFERENCES

Aberdeen Group (2006). *Revisiting Reverse Logistics in the Customer-Centric Service Chain.* Aberdeen Group Benchmark Report

Beamon, B.M. (1999). Designing the Green Supply Chain. *Logistics Information Management.* 12(4), 332-342

BESTUFS (2003). *Consolidated Best Practice Handbook.* Best Urban Freight Solutions Project Report.

BESTUFS (2006). Best Urban Freight Solutions. Project website (at http://bestufs.net, accessed 04/12/06)

Bettac, E., Maas, K., Beullens, P., Bopp, R. (1999). RELOOP: Reverse logistics chain optimisation in a multi-user trading environment. *Proceedings of the 1999 IEEE International Symposium on Electronics and the Environment*

Breen, L. (2006) Give me back my empties or else! A preliminary analysis of customer compliance in reverse logistics practices (UK). *Management Research News.* 29(9), 532-551

Bridgwater, E., Anderson, A. (2003). *CA Site WEEE Capacity in the UK*. Report prepared for Defra by *Network Recycling*

Buellens, P. (2004). Reverse Logistics in Effective Recovery of Products from Waste Materials. *Reviews in Environmental Science and Bio/Technology.* 3: 283-306

Carter, C.R., Ellram, L.M. (1998). Reverse Logistics: A Review of the Literature and Framework for Future Investigation. *Journal of Business Logistics.* 19(1), 85-102

Cherrett, T.J., Hickford, A.J., Maynard, S. (2006) The Potential for Local Bring-Sites to Reduce Householder Recycling Mileage. *Proceedings of the Transportation Research Board Annual Meeting, 2007*

Council of Supply Chain Management Professionals (2006). Online Glossary (at http://www.cscmp.org/Downloads/Resources/glossary03.pdf, accessed 22/11/06)

De Brito, M.P., Dekker, R. (2003). A *Framework for Reverse Logistics.* Erasmus Research Institute of Management Report Series *Research In Management*

De Brito, M.P., Flapper, S.D.P., Dekker, R. (2002). Reverse Logistics: A Review of Case Studies. *Econometric Institute Report EI 2002-21*

Defra (1990). *Waste Management, The Duty of Care: A Code of Practice*. Environmental Protection Act 1990, Section 34

Defra (2005). *Landfill Allowance Trading Scheme (LATS). A Practical Guide*.

Defra (2006a). The website of UK Department of Environment, Food and Rural Affairs (at http://www.defra.gov.uk/environment/waste/topics/producer-responsibility.htm, accessed 22/11/06)

Defra (2006b). *The Producer Responsibility Obligations (Packaging Waste) Regulations 2005.* UK Department of Environment, Food and Rural Affairs

Defra (2006c) Review of England's Waste Strategy: A Consultation Document (at http://www.defra.gov.uk/corporate/consult/wastestratreview/index.htm, accessed 15/01/07)

DETR (1999). *Sustainable Distribution: A Strategy.* Department for the Environment, Transport and the Regions, *Integrated Transport White Paper daughter document*

DfT (2004). *The Efficiency of Reverse Logistics.* Report prepared for the Department for Transport by Cranfield University School of Management, Sheffield Hallam University, and The Chartered Institute of Logistics and Transport (UK)

DfT (2005). *Make Back-Loading Work for You*. Department for Transport Freight Best Practice Programme

Dowlatshahi, S. (2000). Developing a Theory of Reverse Logistics. *Interfaces.* 30(3), 143-155

DTI (2004a). Assessment of Responses to the Third Consultation Document: WEEE and RoHS Directives. UK Department of Trade and Industry (at http://www.dti.gov.uk/files/file30558.pdf, accessed 16/01/07)

DTI. (2004b) EC Directive on Waste Electrical and Electronic Equipment (WEEE) and EC Directive on the Restriction of the Use of Certain Hazardous Substances in Electric and Electronic Equipment (RoHS). Consultation. (at http://www.dti.gov.uk/sustainability/weee/index.htm, accessed 01/05/05).

eDRUL (2006). eCommerce Enabled Demand Responsive Urban Logistics. Project website (at http://www.edrul.com, accessed 14/12/06)

EA (2005) Commercial and Industrial Waste Survey 2002/3 (at http://www.environment-agency.gov.uk/subjects/waste/1031954/315439/923299/1071046/?version=1&lang=_e, accessed 15/01/07)

Enviros Consulting (2002). Potential markets for electronic and electrical equipment. Project funded by the Environment Agency (at http://www.londonremade.com/download_files/weee.doc, accessed 25/11/06)

Enviros Consulting (2005). *Best Practice Guidance: Trade Waste Recycling.* Report for the Waste Strategy Support Unit, Greater London Authority

Europa (2006). Waste Electronic and Electrical Equipment, on the Portal site of the European Union (at http://ec.europa.eu/environment/waste/weee_index.htm, accessed 22/11/06)

European Commission (2006). *Urban Freight Transport and Logistics: An Overview of the European Research and Policy.* DG Energy and Transport Brochure.

Envirowise (2005) 'Hazardous Waste Managament. Essential information for businesses', Available at: http://www.envirowise.co.uk/envirowisev3.nsf/key/hazwaste (Accessed 4/7/2005).

Farrow, P.H., Johnson, R.R., Larson, A.L. (2000). Entrepreneurship, Innovation and Sustainability Strategies at Walden Paddlers, Inc. *Interfaces*, 30(3), 215–225

Ferguson, N., Browne, J. (2001). Issues in End-of-Life Product Recovery and Reverse Logistics. *Production Planning & Control*, 12(5), 534-547

Fernie, J., Hart, C. (2001). UK Packaging Waste Legislation; Implications for Food Retailers. *British Food Journal.* 108(3), 187-197

Fernie, J., McKinnon, A.C. (2003). The Grocery Supply Chain in the UK: Improving Efficiency in the Logistics Network. *The International Review of Retail, Distribution and Consumer Research.* 13(2), 161-174

Fleischmann, M. (2001). *Reverse Logistics Network Structures and Design*. Erasmus Research Institute of Management Report Series *Research In Management ERS-2001-52-LIS, 2001*

Fleischmann, M., Bloemhof-Ruwaard, J.M., Dekker, R., Van der Laan, E., Van Nunen, J.A.E.E., Van Wassenhove, L.N. (1997). Quantitative Models for Reverse Logistics: A Review. *European Journal of Operational Research.* 103, pp1-17

Fleischmann, M., Krikke, H.R., Dekker, R., Flapper, S.D.P. (2000). A Characterisation of Logistics Networks for Product Recovery. *Omega, the International Journal of Management Science.* 28, 653-666

Geroliminis, N., Daganzo, C.F. (2005). A Review of Green Logistics Schemes Used in Cities Around the World. *UC Berkeley Center for Future Urban Transport, Working Paper*

Golding, A.(1999). *Reuse of Primary Packaging – Final Report.* Prepared for European Commission

Guide, V.D.R., Jr., Jayaraman, V., Srivastava, R., Benton, W.C. (2000). Supply-Chain Management for Recoverable Manufacturing Systems. *Interfaces.* 30(3) 125-142

Guide, V.D.R., Jr., Pentico, D.W. (2003). A Hierarchical Decision Model for Re-manufacturing and Re-use. *International Journal of Logistics: Research and Applications.* 6(1-2), 29-35

Jun, H.-B., Kim, J.-G. (2006) State of the Art: Research Issues and Framework for Enhancing the Productivity of Reverse Logistics. *Proceedings of the Asia-Pacific Productivity Conference, 2006*

Ketzenberg, M.E., Van der Laan, E., Teunter, R.H. (2004). *The Value of Information in Reverse Logistics*. Erasmus Research Institute of Management Report Series *Research In Management ERS-2004-053-LIS, 2004*

Kokkinaki, A.I., Dekker, R., Van Nunen, J., Pappis, C. (2000). An Exploratory Study on Electronic Commerce for Reverse Logistics. *Supply Chain Forum, 2000*

Kokkinaki, A.I., Dekker, R., De Koster, M.B.M., Pappis, C., Verbeke, W. (2002). E-Business Models for Reverse Logistics: Contributions and Challenges. *Proceedings of the International Conference on Information Technology, Coding and Computing, 2002*

Kroon, L., Vrijens, G. (1995). Returnable Containers: An Example of Reverse Logistics. *International Journal of Physical Distribution and Logistics Management.* 25(2), 56-68

Lave, L.B., Hendrickson, C.T., Conway-Schempf, N.M., McMichael, F.C. (1999). Municipal Solid Waste Recycling Issues. *Journal of Environmental Engineering.* 125(10), 944-949

Lee, H.L., Whang, S. (2001). E-Business and Supply Chain Integration. *Stanford Global Supply Chain Management Forum, November 2001*

Lourenço, H.R., Soto, J.P. (2002). *A Recoverable Production Planning Model.* Working Paper, Grup de Recerca en Logistica Empresarial, Barcelona.

Lummus, R.R., Krumwiede, D.W., Vokurka, R.J. (2001). The Relationship of Logistics to Supply Chain Management: Developing a Common Industry Definition. *Industrial Management & Data Systems.* 101/8, 426-431

Marien, E.J. (1998). Reverse Logistics as a Competitive Strategy. *The Supply Chain Management Review.* 2(1), 43-52

MIRACLES (2006). *Final Deliverable D4.2: Report on Evaluation Results*. Transportation Research Group, University of Southampton, March 2006

Mortensen, O., Lemoine, W. (2005). Information Technologies and Supply Chain Integration. A Study Among Manufacturers and Transport and Logistics Service Providers. *Paper presented at the Workshop Supply Chain Management and Communication Technology.* University of Groningen, November 2005.

Mukhopadhyay, S.K., Setaputra, R. (2006). The Role of 4PL as the Reverse Logistics Integrator. *International Journal of Physical Distribution & Logistics Management.* 36(9), 716-729

Nagurney, A., Toyasaki, F. (2005). Reverse Supply Chain Management and Electronic Waste Recycling. *Transportation Research E: Transportation and Logistics*, 41, 1-28.

NetRegs (2006). The website of NetRegs (at http://www.netregs.gov.uk, accessed 04/12/06)

Park, M., Regan, A. (2004). *Issues in Emerging Home Delivery Operations*. Research Paper. University of California Transportation Center: Los Angeles, CA

Parvenov, A. (2005). Reverse Logistics: Best Practices in Warehouse Returns. *SupplyChainDigest, 2005*

RRF (2004). *The Impact of Increasing Road Transport Costs on Waste Recovery and Recycling*. A report for the Resource Recovery Forum by Ceres Logistics

Richey, G.R., Daugherty, P.J., Genchev, S.E., Autry, C.W. (2004). Reverse Logistics: The Impact of Timing and Resources. *Journal of Business Logistics.* 25(2), 229-250

Richey, G.R., Genchev, S.E., Daugherty, P.J. (2005). The Role of Resource Commitment and Innovation in Reverse Logistics Performance. *International Journal of Physical Distribution & Logistics Management. 3*5(4), 233-257

Rodrigue, J.-P., Slack, B., Comtois, C. (2001). Green Logistics (The Paradoxes of). *Published in Brewer, A.M., Button, K.J., Hensher, D.A. (eds), The Handbook of Logistics and Supply-Chain Management*

Rogers, D.S., Tibben-Lembke, R.S. (1999). *Going Backwards: Reverse Logistics Trends and Practices.* Reverse Logistics Executive Council, Pittsburg, PA.

Rogers, D.S., Tibben-Lembke, R.S. (2001). An Examination of Reverse Logistics Practices. *Journal of Business Logistics.* 22(2), 129-148

Shakantu, W., Tookey, J.E., Bowen, P.A. (2002). Defining the role of reverse logistics in attaining sustainable integration of materials delivery with construction and demolition waste management. *In Proceedings of Creating a Sustainable Construction Industry*

Shih, L. (2001). Reverse Logistics System Planning for Recycling Electrical Appliances and Computers in Taiwan. *Resources, Conservation and Recycling.* Vol. 32, pp55-72

START (2006). Short-Term Actions to Reorganize Transport of goods. Project website (at http://www.stat-project.org, accessed 04/12/06)

STRAW (2006). *Sustainable Transport Resources and Waste*. Report by Envirocentre, as part of the Biffaward Programme on Sustainable Resource Use.

Taniguchi, E., Thompson, R., Yamada, T. (2003). Visions for City Logistics. *Proceedings of the 3rd International Conference on City Logistics*, Madeira, Portugal, June 2003, pp1-16. Cited in Geroliminis, N., Daganzo, C.F. (2005). A Review of Green Logistics Schemes used in Cities around the World. *UC Berkeley Center for Future Urban Transport, Working Paper*

Tibben-Lembke, R.S., Rogers, D.S. (2002). Differences Between Forward and Reverse Logistics in a Retail Environment. *Supply Chain Management.* 7(5), 271-282

Wincanton (2004) 'Wincanton to deliver WEEE pilot scheme for three retailers'. (at http://www.wincanton.co.uk/4mediacentre/pressreleases/press040824.htm, accessed 01/05/05)

Wu, H.-J., Dunn, S.C. (1994). Environmentally Responsible Logistics Systems. *International Journal of Physical Distribution & Logistics Management.* 25(2), 20-38

WRAP (2006). The Waste Resources Action Programme (at: http://www.wrap.org.uk/, accessed 20/11/06)

APPENDIX A

Uncertainty/Variance

In reverse logistics, particularly for retailers, uncertainty prevails. It is difficult to predict which products are likely to be returned, where they will originate or where they will need to be sent. In order to minimise the impact on the effectiveness of operations, managers must take actions to reduce uncertainty in the timing and quantity of returns, balance return rates with demand rates, and make material recovery more predictable.

In the retail context, future planning and forecasting for reverse logistics are made difficult because individual customers ultimately initiate reverse logistics activities, and different products have very different return rates.

As firms from different industries and process types start using recoverable-manufacturing systems, more information will become available on the implementation of such systems and on handling the associated uncertainty. The use of information systems with new production-planning and control techniques should make management of these activities more predictable.

Trends

The impact of legislation regarding disposal of certain waste streams and packaging will affect reverse logistics activities, as will trends affecting general freight flows, such as urban growth and road traffic congestion.

The growth of e-commerce has led to a new dimension in retailing. Generally, the consequences of e-commerce on Green Logistics and reverse logistics are little understood, but some trends can be identified. Physical distribution systems are changing as a result of e-commerce becoming more accepted and used. Retailing distribution is disaggregated, and the trend towards consolidation has reversed.

Future use of Information and Communication Technologies will help to alleviate some aspects of uncertainty inherent in systems involved in product recovery and reuse with potential for ‘electronic marketplaces’ and other Web-enabled systems to enhance supply chain integration.

Measures

Much of the literature reviewed was qualitative in nature, but measures such as retail return rates, quantities and types of waste generated by businesses and retailers, targets for recovery and recycling of WEEE, packaging and municipal waste were among those identified in the review.

In proposing an extended supply chain which includes mechanisms for product recovery, Beamon (1999) suggests the following list of potential measures to describe supply chain performance:

Performance Measure Classification	**Performance Measure** (Measured over Product and Process Life Cycle, except where indicated)
Resource Use	• Total energy consumed • Total material consumed (e.g., water, timber, steel, etc.)
Product Recovery **Remanufacturing** **Reuse** **Recycling**	• Time required for product recovery • % recyclable/reusable materials (volume or weight) available at end of product life • % product volume or weight recovered and reused • Purity of recyclable materials recovered • % recycled materials (weight or volume) used as input to manufacturing • % product disposed or incinerated • Fraction of packaging or containers recycled • Material Recovery rate (MRR) • Core Return Rate (CRR) • Ratio of virgin to recycled resources • Ratio of materials recycled to materials potentially recyclable • Materials Productivity: economic output per unit of material input
Product Characteristics	• Useful product operating life • Total mass of products produced
Waste Emissions and Exposure Hazard	• Total toxic or hazardous materials used • Total toxic or hazardous waste generated • Solid waste emissions • % product (weight or volume) disposed in landfills • Concentrations of hazardous materials in products and by-products • Estimated annual risk of adverse effects in humans and biota • Waste ratio: the ratio of wastes to all outputs.
Economic	• Average life-cycle cost incurred by the manufacturer • Purchase and operating cost incurred by the consumer • Average total life-cycle cost savings associated with design improvements
Economic/ Emissions	• Eco-efficiency: adding the most value with the least use of resources and the least pollution. Generally, the ability to simultaneously meet cost, quality, and performance goals, reduce environmental impacts, and conserve valuable resources

Methods/Techniques/Tools

The following research techniques have been identified during the review:

- Literature reviews
- In-depth case studies of reverse logistics activities
- Interviews and focus groups with representatives from various aspect of the supply chain, including reverse logistics activities
- Questionnaire surveys
- Cost-benefit analyses
- Quantitative and framework modelling

Sectors
The review focuses on reverse logistics activities primarily within the retail sector, as well as to waste management operations, although consideration is also given to a more general range of sectors.

Geography
The focus of the review has largely been on reverse logistics and waste management operations in the UK, although more general aspects of these topics in the European Union and the United States are also considered.

APPENDIX B:

LITERATURE REVIEW
DOCUMENT OUTLINE

WM10 Literature Review – Document Outline

No:	1
Title:	The Efficiency of Reverse Logistics
Author(s):	Department for Transport (prepared by Cranfield School of Management, Sheffield Hallam University and The Chartered Institute of Logistics and Transport)
Year:	2004
Location:	UK
Keywords:	reverse logistics product returns sustainability
Abstract:	[From Executive Summary]: There is increasing concern regarding sustainable development in terms of achieving economic growth whilst maintaining environmental protection and social progress. The government sees business playing a key role in delivering sustainable development through the use of effective transport and logistics systems. However, most research in this area has focused on the delivery of the product to the market place. Little research has been undertaken to examine the impact of unsold consumer goods returned from the retail market and the impact on sustainability. This report sets out to address this gap in knowledge by evaluating reverse logistics practices within UK retailing and the findings are based on a literature review, three detailed case studies, a preliminary postal survey and results from industrial focus group meetings.
Type of document:	Report for DfT Project

WM10 Literature Review – Document Outline

No:	2
Title:	Defining the Role of Reverse Logistics in Attaining Sustainable Integration of Materials Delivery with Construction and Demolitian Waste Management
Author(s):	Shakantu, W., Tookey, J.E., Bowen, P.A.
Year:	2002
Location:	UK, South Africa
Keywords:	reverse logistics materials recovery C&D waste management sustainable integration vehicle movements pollution sustainable construction
Abstract:	Logistics management is a complex task within both the modern manufacturing and construction industries. Effective logistics management implies a mastery of various key processes, including planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from the point of origin to the point of consumption in order to fulfil customer requirements. A truly effective logistics system involves the integration of information, transportation, inventory, warehousing, materials handling and packaging. Until recently, investment in logistics has focussed mainly on the flows from companies to markets. This was simply satisfying demand via a distribution system without appreciating the effort, cost and resources required to operate that system. Growing concerns for the environment and conserving resources has created new logistical approaches to more effectively manage the distribution function, and make better use of the resources available to an organisation. One such approach is the concept of reverse logistics. Reverse logistics uses various methods to give scope for a 'back-load' of finished products, components, waste, reusable packing, etc. from consumer to manufacturer. Back-loads – 'logistics against the flow' - allow manufacturers to reduce costs by using the distribution vehicle's return journey to create income or added value. Often this is very simple – a distribution vehicle picks up pallets previously deposited at the warehouse where it makes its deliveries. The return trip adds value to the process by returning those pallets back to usable condition (i.e. back at their point of origin). This basic concept is now being developed to create novel solutions to the problems of reducing pollution, costs and vehicle movements, whilst maintaining high customer service levels. This paper develops the concept of 'reverse logistics' in a construction context in order to improve materials availability whilst simultaneously improving construction and demolition (C&D) waste management and reducing vehicle movements. The paper also provides an overview of the need for, and methods of, implementation of advanced logistical approaches pioneered in the Fast Moving Consumer Goods (FMCG) industries. The paper finishes by outlining an ongoing UK/South African research project seeking to integrate materials delivery and C&D waste removal operations so as to reduce costs and vehicle movements.
Type of document:	Paper in In Proceedings of Creating a Sustainable Construction Industry

WM10 Literature Review – Document Outline

No:	3
Title:	Designing the Green Supply Chain
Author(s):	Beamon, B.M.
Year:	1999
Location:	US
Keywords:	supply chain logistics environment environmental management
Abstract:	The supply chain has been traditionally defined as a one-way, integrated manufacturing process wherein raw materials are converted into final products, then delivered to customers. Under this definition, the supply chain includes only those activities associated with manufacturing, from raw material acquisition to final product delivery. However, due to recent changing environmental requirements affecting manufacturing operations, increasing attention is given to developing environmental management (EM) strategies for the supply chain. This research: (1) investigates the environmental factors leading to the development of an extended environmental supply chain, (2) describes the elemental differences between the extended supply chain and the traditional supply chain, (3) describes the additional challenges presented by the extension, (4) presents performance measures appropriate for the extended supply chain, and (5) develops a general procedure towards achieving and maintaining the green supply chain.
Type of document:	Paper in Logistics Information Management (1999) Vol. 12, No. 4, pp. 332-342

WM10 Literature Review – Document Outline

No:	4
Title:	Developing a Theory of Reverse Logistics
Author(s):	Dowlatshahi, S.
Year:	2000
Location:	US, EU
Keywords:	environment transportation freight/materials handling
Abstract:	Reverse logistics, a fairly new concept in logistics, has gained increasing importance as a profitable and sustainable business strategy. I describe a holistic view of reverse logistics and distil 11 insights for successful implementation of reverse logistics from the existing literature and published case studies. The strategic factors consist of strategic costs, overall quality, customer service, environmental concerns, and legislative concerns. The operational factors consist of cost-benefit analysis, transportation, warehousing, supply management, remanufacturing and recycling, and packaging. Insights about these factors together form the state-of-the-art knowledge about the keys to successful design and use of reverse-logistics systems.
Type of document:	Paper in INTERFACES 30: 3 May–June 2000 (pp. 143–155)

WM10 Literature Review – Document Outline

No:	5
Title:	E-Business Models for Reverse Logistics: Contributions and Challenges
Author(s):	Kokkinaki, A.I., Dekker, R., de Koster, M.B.M., Pappis, C., Verbeke, W.
Year:	2002
Location:	EU, US
Keywords:	reverse logistics e-business
Abstract:	Reverse logistics, that is, all operations related to the extension of useful lifecycle for used products, commercial returns, excess inventory and packaging materials, gains increasing attention globally for its promising financial potentials, its sustainable growth alternative and the environmental positive impact it could have. In this paper, we include a brief discussion of the major reverse logistics issues and we present the new e-business models in this field. We identify key factors for their competitive advantage and we discuss conceptual and current opportunities for these e-business models to thrive and advance. Finally, we outline some possible future developments of e-commerce tools for reverse logistics.
Type of document:	Paper in Proceedings of the International Conference on Information Technology, Coding and Computing, 2002

WM10 Literature Review – Document Outline

No:	6
Title:	A Framework for Reverse Logistics
Author(s):	De Brito, M.P., Dekker, R.
Year:	2003
Location:	EU, US
Keywords:	reverse logistics framework content analysis theory supply chain management
Abstract:	Reverse Logistics has been stretching out worldwide, involving all the layers of supply chains in various industry sectors. While some actors in the chain have been forced to take products back, others have pro-actively done so, attracted by the value in used products One way or the other, Reverse Logistics has become a key competence in modern supply chains. In this paper, we present a content analysis of reverse logistics issues. To do so, we propose a content framework focusing on the following questions with respect to reverse logistics: why? what? how?; and, who?, i.e. driving forces and return reasons, what type of products are streaming back, how are they being recovered, and who is executing and managing the various operations. These four basic characteristics are interrelated and their combination determines to a large extent the type of issues arising from the resulting reverse logistics system.
Type of document:	Report for Erasmus Research Institute of Management Report Series "Research In Management"

WM10 Literature Review – Document Outline

No:	7
Title:	Going Backwards: Reverse Logistics Trends and Practices
Author(s):	Rogers, D.S., Tibben-Lembke, R.S
Year:	1999
Location:	US, EU
Keywords:	reverse logistics managing returns secondary market environment
Abstract:	[From Preface] The purpose of this book is twofold: to present an overview and introduction to reverse logistics, and to provide insights on how to manage reverse logistics well. Reverse logistics is a new and emerging area, and as such, only a limited amount of information has been published to date. When possible, we have tried to present additional sources of information for the interested reader. However, in some chapters, such as Chapter 3 on Secondary Markets, no written information exists. When documentation was unavailable, information was gained through interviews, many of which were conducted on the condition of anonymity.
Type of document:	Book

WM10 Literature Review – Document Outline

No:	8
Title:	A Hierarchical Decision Model for Re-manufacturing and Re-use
Author(s):	Guide, V.D.R., Jr., Pentico, D.W
Year:	2003
Location:	US
Keywords:	hierarchical model reverse logistics
Abstract:	This paper presents a model to facilitate managerial decision-making for re-manufacturing and re-use. A system designed for product re-use relies on product returns. Reverse logistics models assume that the product returns process is exogenous and outside the control of the firm. The proposed approach is unique because it allows financial incentives to control product returns. That way timing, quantity and product quality as well as associated logistics functions are more predictable. The model consists of three stages and is intended for decision support in product acquisition, operational planning and control, as well as demand management and product pricing.
Type of document:	Paper in International Journal of Logistics: Research and Applications. 6(1-2), 29-35

WM10 Literature Review – Document Outline

No:	9
Title:	Issues in End-of-Life Product Recovery and Reverse Logistics
Author(s):	Ferguson, N., Browne, J.
Year:	2001
Location:	EU
Keywords:	reverse logistics extended enterprise end-of-life products automotive recycling information systems
Abstract:	There is a fundamental shift in waste management responsibility from the private waste management industry and local governments towards manufacturers, distributors, and retailers. In recent years the responsibility of manufacturers has been extended to cover the entire life of certain products. This also includes responsibility for the products safe disposal. As the enforcement of environmental legislation becomes more stringent and an increasing number of customers are demanding take-back of their old products, companies are beginning to focus on possible distribution channels for the return of their products i.e. reverse logistics. The aim of this paper is to examine the emerging issues in reverse logistics, in particular the information requirements for reverse logistics within the Extended Enterprise. A study of end-of-life vehicles (ELVs) will illustrate the specific information flow between the key players within the automotive industry. This paper addresses the initial development of possible distribution channels, their key operational decisions and supporting information systems for the recycling of end of life products.
Type of document:	Paper in Production Planning & Control, 12(5), 534-547

WM10 Literature Review – Document Outline

No:	10
Title:	Municipal Solid Waste Recycling Issues
Author(s):	Lave, L.B., Hendrickson, C.T., Conway-Schempf, N.M., McMichael, F.C.
Year:	1999
Location:	US
Keywords:	urban waste waste management recycling upgrading cost benefit analysis environment impact
Abstract:	Municipal solid waste (MSW) recycling targets have been set nationally and in many states. Unfortunately, the definitions of recycling, rates of recycling, and the appropriate components of MSW vary. MSW recycling has been found to be costly for most municipalities compared to landfill disposal. MSW recycling policy should be determined by the cost to the community and to society more generally. In particular, recycling is a good policy only if environmental impacts and the resources used to collect, sort, and recycle a material are less than the environmental impacts and resources needed to provide equivalent virgin material plus the resources needed to dispose of the postconsumer material safely. From a review of the existing economic experience with recycling and an analysis of the environmental benefits (including estimation of external social costs), we find that, for most communities, curbside recycling is only justifiable for some postconsumer waste, such as aluminum and other metals. We argue that alternatives to curbside recycling collection should be explored, including product takeback for products with a toxic content (such as batteries) or product redesign to permit more effective product remanufacture.
Type of document:	Paper in Journal of Environmental Engineering. 125(10), 944-949

WM10 Literature Review – Document Outline

No:	11
Title:	Quantitative Models for Reverse Logistics: A Review
Author(s):	Fleischmann, M., Bloemhof-Ruwaard, J.M., Dekker, R., Van der Laan, E., Van Nunen, J.A.E.E., Van Wassenhove, L.N.
Year:	1997
Location:	EU, US
Keywords:	survey modelling product recovery logistics
Abstract:	This article surveys the recently emerged field of reverse logistics. The management of return flows induced by the various forms of reuse of products and materials in industrial production processes has received growing attention throughout this decade. Many authors have proposed quantitative models taking those changes in the logistics environment into account. However, no general framework has been suggested yet. Therefore the time seems right for a systematic overview of the issues arising in the context of reverse logistics. In this paper we subdivide the field into three main areas, namely distribution planning, inventory control, and production planning. For each of these we discuss the implications of the emerging reuse efforts, review the mathematical models proposed in the literature, and point out the areas in need of further research. Special attention is paid to differences and/or similarities with classical 'forward' logistics methods.
Type of document:	Paper in European Journal of Operational Research. 103, pp1-17

WM10 Literature Review – Document Outline

No:	12
Title:	RELOOP: Reverse logistics chain optimisation in a multi-user trading environment
Author(s):	Bettac, E., Maas, K., Beullens, P., Bopp, R.
Year:	1999
Location:	EU
Keywords:	internet electronics industry geographic information systems legislation recycling engineering computing
Abstract:	RELOOP is a project running since January 1998 and sponsored by the European Commission within the ESPRIT programme. RELOOP focuses on the electrical and electronics sector where particular need for action exists since take-back laws have been introduced or anticipated in various countries. The objective of RELOOP is the development of models and methods which supports the management of take-back logistics (TBL) and recycling chains and networks. The models and methods will be implemented in an Internet-based and Geographical Information System (GIS) based software tool providing a multi-user and multi-site trading and optimisation environment. The RELOOP software will allow a multi-criteria optimisation of TBL regarding cost, environmental impact, legislation and product design concerning recycling strategy
Type of document:	Paper in Proceedings of the 1999 IEEE International Symposium on Electronics and the Environment

WM10 Literature Review – Document Outline

No:	13
Title:	Returnable Containers: An Example of Reverse Logistics
Author(s):	Kroon, L., Vrijens, G.
Year:	1995
Location:	EU, US
Keywords:	packaging reverse logistics
Abstract:	Considers the application of returnable containers as an example of reverse logistics. A returnable container is a type of secondary packaging that can be used several times in the same form, in contrast with traditional cardboard boxes. For this equipment to be used, a system for the return logistics of the containers should be available: this system should guarantee that the containers are transported from the recipients to the next senders, and that they are cleaned and maintained, if necessary. Outlines several ways in which the return of these containers can be organized. Also includes a case study involving the design of such a return logistic system in The Netherlands. Also describes a quantitative model that can be used to support the related planning process.
Type of document:	Paper in International Journal of Physical Distribution and Logistics Management. 25(2), 56-68

WM10 Literature Review – Document Outline

No:	14
Title:	Consolidated Best Practice Handbook
Author(s):	BESTUFS
Year:	2003
Location:	EU
Keywords:	
Abstract:	
Type of document:	Report for Best Urban Freight Solutions Project

WM10 Literature Review – Document Outline

No:	15
Title:	Reverse Logistics: A Review of Case Studies
Author(s):	De Brito, M.P., Flapper, S.D.P., Dekker, R.
Year:	2002
Location:	EU, US
Keywords:	reverse logistics case studies supply chain overview
Abstract:	This paper gives an overview of scientific literature that describes and discusses cases of reverse logistics activities in practice. Over sixty case studies are considered. Based on these studies we are able to indicate critical factors for the practice of reverse logistics. In addition we compare practice with theoretical models and point out research opportunities in the field.
Type of document:	Report for Econometric Institute EI 2002-21

WM10 Literature Review – Document Outline

No:	16
Title:	Reverse Logistics as a Competitive Strategy
Author(s):	Marien, E.J.
Year:	1998
Location:	US
Keywords:	reverse logistics competitive strategy
Abstract:	More and more industries are discovering that it pays to be proactive on environmental issues—as opposed to passively waiting to be regulated into action. They've found that it makes good business sense (to say nothing of the positive societal implications) to recycle and reuse their products after the consumer is done with them. This article examines the power and potential of "reverse logistics" in a competitive context. It spotlights the efforts of the paint industry, which while facing difficult challenges has recorded some early successes.
Type of document:	Paper in The Supply Chain Management Review. 2(1), 43-52

WM10 Literature Review – Document Outline

No:	17
Title:	Reverse Logistics in Effective Recovery of Products from Waste Materials
Author(s):	Buellens, P.
Year:	2004
Location:	US, EU
Keywords:	reverse logistics economics of recovery management of remanufacturing management of recycling collection system design
Abstract:	Technical solutions for the recovery of products from waste materials become more and more available. To have these new technologies implemented in a real world, a feasibility study is indispensable. For this purpose, it is often imperative to adopt the viewpoint of an individual firm and ask whether it would be wise to engage in product recovery activities or not. Aspects of economics and logistics are of prime importance here. Some important frameworks, models, and insights that have been developed in recent years are described in this paper.
Type of document:	Paper in Reviews in Environmental Science and Bio/Technology. 3: 283-306

WM10 Literature Review – Document Outline

No:	18
Title:	Reverse Logistics Network Structures and Design
Author(s):	Fleischmann, M.
Year:	2001
Location:	EU, US
Keywords:	reverse logistics distribution management network design facility location supply chain management
Abstract:	Logistics network design is commonly recognized as a strategic supply chain issue of prime importance. The location of production facilities, storage concepts, and transportation strategies are major determinants of supply chain performance. This chapter considers logistics network design for the particular case of closed-loop supply chains. We highlight key issues that companies are facing when deciding upon the logistics implementation of a product recovery initiative. In particular, we point out differences and analogies with logistics network design for traditional 'forward' supply chains. Moreover, we discuss the strategic fit between specific supply chain contexts and logistics network structures. Conclusions are supported by a quantitative analysis.
Type of document:	Report for Erasmus Research Institute of Management Report Series Research In Management ERS-2001-52-LIS, 2001

WM10 Literature Review – Document Outline

No:	19
Title:	Reverse Logistics System Planning for Recycling Electrical Appliances and Computers in Taiwan
Author(s):	Shih, L.
Year:	2001
Location:	Taiwan
Keywords:	electrical appliances recycling reverse logistics
Abstract:	Since the disposition of end-of-life home appliances has caused tremendous attention, Taiwan recently promulgated a Scrap Home Appliances and Computers Recycling Regulation that mandates manufacturers and importers to take back their products. Reverse logistics system planning shall become vital as the take-back rate increases and the service area expands in the future. This study utilizes a mixed integer programming model to optimize the infrastructure design and the reverse network flow. The proposed model attempts to minimize the total cost, which consists of transportation cost, operating cost, fixed cost for new facilities, final disposal cost and landfill cost, as well as the sale revenue of reclaimed materials. Results for various scenarios that consider various take-back rates and operating conditions are presented.
Type of document:	Paper in Resources, Conservation and Recycling. Vol. 32, pp55-72

WM10 Literature Review – Document Outline

No:	20
Title:	Supply-Chain Management for Recoverable Manufacturing Systems
Author(s):	Guide, V.D.R., Jr., Jayaraman, V., Srivastava, R., Benton, W.C.
Year:	2000
Location:	US, EU
Keywords:	environment manufacturing performance productivity
Abstract:	Recoverable manufacturing systems minimize the environmental impact of industry by reusing materials, reducing energy use, and reducing the need to landfill industrial products. These systems are widespread in the United States and are profitable, in addition to contributing to sustainable development. However, the management of supply-chain activities can differ greatly from management activities in traditional manufacturing supply chains. Seven complicating characteristics increase uncertainty. Managers must take actions to reduce uncertainty in the timing and quantity of returns, balance return rates with demand rates, and make material recovery more predictable. Managers must also plan for the collection of products from end-users. The use of information systems with new production-planning and control techniques makes management of these activities more predictable.
Type of document:	Paper in Interfaces. 30(3) 125-142

WM10 Literature Review – Document Outline

No:	21
Title:	Sustainable Distribution: A Strategy
Author(s):	Department of the Environment, Transport and the Regions (DETR)
Year:	1999
Location:	UK
Keywords:	
Abstract:	[From Summary] * This document fulfils the Government's commitment in the White Paper "A New Deal for Transport" to set out a comprehensive, integrated strategy for the sustainable distribution of goods and services in the UK. * A sustainable distribution strategy should consider more than just the transport of goods from A to B. This paper encompasses supply chain management or "logistics" as well as all modes of transport. * The aim of a sustainable distribution strategy must be to ensure that the future development of the distribution industry does not compromise the future needs of our society, economy and environment.
Type of document:	UK Government White Paper

WM10 Literature Review – Document Outline

No:	22
Title:	A Characterisation of Logistics Networks for Product Recovery
Author(s):	Fleischmann, M., Krikke, H.R., Dekker, R., Flapper, S.D.P.
Year:	2000
Location:	EU, US
Keywords:	reverse logistics distribution location case studies
Abstract:	Recovery of used products is receiving much attention recently due to growing environmental concern. Efficient implementation requires appropriate logistics structures to be set up for the arising goods flow from users to producers. We investigate the design of such logistics networks. As a basis for our analysis we review recent case studies on logistics network design for product recovery in different industries. We identify general characteristics of product recovery networks and compare them with traditional logistics structures. Moreover, we derive a classification scheme for different types of recovery networks.
Type of document:	Paper in Omega, the International Journal of Management Science. 28, 653-666

WM10 Literature Review – Document Outline

No:	23
Title:	Make Back-Loading Work for You
Author(s):	Department for Transport (DfT)
Year:	2005
Location:	UK
Keywords:	
Abstract:	[From Foreword] The aim of this guide is to: introduce back-loading and how it works highlight the potential benefits of back-loading to your business outline ways of obtaining back-loads It also provides a checklist of questions you need to ask when considering back-loading as an option for your business and details of organisations that can provide you with further information.
Type of document:	Best Practice Guide as part of a series of publications produced for the Department for Transport under the TransportEnergy BestPractice programme.

WM10 Literature Review – Document Outline

No:	24
Title:	Green Logistics (The Paradoxes of)
Author(s):	Rodrigue, J.-P., Slack, B., Comtois, C.
Year:	2001
Location:	EU, US
Keywords:	green logistics reverse distribution sustainability
Abstract:	Logistics are an important function of modern transport systems. Contemporary technological and spatial developments have improved the cost, efficiency and reliability of freight and passenger transport systems. At the same time, the negative environmental impacts of transportation have gained wide recognition and are at the core of issues of sustainability, especially in urban areas. Since the applications of logistics are generally positive for the efficiency of transport systems, it has been suggested that logistics are environmentally friendly, thus the concept of “green logistics”. It is argued that although logistics may be linked to less environmentally damaging transportation systems, they have created a set of paradoxes that may prove to be the contrary to what is believed. This paper will thus investigate the issue of green logistics and the environmental paradoxes it creates in terms of transportation modes, terminals and activities.
Type of document:	Chapter published in Brewer, A.M., Button, K.J., Hensher, D.A. (eds), The Handbook of Logistics and Supply-Chain Management

WM10 Literature Review – Document Outline

No:	25
Title:	Recoverable Production Planning Model
Author(s):	Lourenço, H.R., Soto, J.P.
Year:	2002
Location:	Spain
Keywords:	reverse logistics production planning remanufacturing returns supply chain management simulation optimisation
Abstract:	Aware of the importance of developing new alternatives to improve the performance of the companies, our purpose in this paper is to develop a medium term production planning model that deals with the concepts of Partnerships and Reverse Logistics. Our model takes advantage of the synergies of integration, developing a model for global production planning that generates the optimal production and purchasing schedule for all the companies integrating a logistic chain. In a second part of the paper we incorporate products returns to the first model proposed, and analyze the implications they have over this model. We use some examples with different configurations of supply chains varying the number of production plants, distribution centers and recovery plants. To solve the model we have combined optimization and simulation procedures.
Type of document:	Working Paper, Grup de Recerca en Logistica Empresarial, Barcelona.

WM10 Literature Review – Document Outline

No:	26
Title:	Reverse Logistics: The Impact of Timing and Resources
Author(s):	Richey, G.R., Daugherty, P.J., Genchev, S.E., Autry, C.W.
Year:	2004
Location:	US
Keywords:	
Abstract:	[From Discussion] This research explored the issue of timing of introduction of a formal reverse logistics program. Previous research results regarding new programs or product introductions are mixed. In some instances, being the first is believed to give a firm a competitive edge; beating the competition can place a firm in an advantageous situation. Alternately, some researchers say it's better to enter late and "catch up" fast perhaps by exploiting or copying what others have done. The current research didn't support either of these perspectives.
Type of document:	

WM10 Literature Review – Document Outline

No:	27
Title:	A Review of Green Logistics Schemes Used in Cities Around the World
Author(s):	Geroliminis, N., Daganzo, C.F.
Year:	2005
Location:	EU, Japan, US
Keywords:	green logistics sustainable transportion city logistics
Abstract:	Freight carriers strive to provide higher levels of transportation service with lower costs. However, the economic and environmental viability of cities are negatively affected by the present organization of urban goods distribution. Can these two competitive goals be harmonised to create efficient and environmentally friendly urban logistics systems? This paper presents several examples of “green logistics” schemes tried in a number of forward-looking cities around the world. The review highlights the basic qualitative ideas of these schemes and the results of field tests. Most of the ideas can be applied to other cities, but analysis is needed to figure out which combination of schemes is best for a particular location. This should be an item of some research priority.
Type of document:	Working Paper, UC Berkeley Center for Future Urban Transport

WM10 Literature Review – Document Outline

No:	28
Title:	Reverse Logistics: Best Practices in Warehouse Returns
Author(s):	Parvenov, A.
Year:	2005
Location:	US
Keywords:	reverse logistics best practice warehouse returns
Abstract:	Have you ever wondered what your local store does with the items that you take back as damaged or unusable? Most industries today have liberal returns policies that can quickly tax distribution networks when large quantities of items go through the reverse logistics process. Often the distributing warehouse bears the brunt of these costs and efforts associated with returns. Thankfully, this area is also where a properly organized process, supported by latest hardware and software technologies, can produce a competitive advantage, attract new suppliers and control the returns process. In this article we will review common problems that plague returns operations in the warehouse and suggest remedies drawn from best practices.
Type of document:	Article in SupplyChainDigest, 2005

WM10 Literature Review – Document Outline

No:	29
Title:	Revisiting Reverse Logistics in the Customer-Centric Service Chain
Author(s):	Aberdeen Group
Year:	2006
Location:	US
Keywords:	reverse logistics service chain
Abstract:	[From Executive Summary] Reverse logistics – defined as the return, exchange, repair/refurbishment, remarketing, and disposition of products – is rapidly emerging as a core driver of competitive advantage and financial performance among leading manufacturers. Conservative estimates put overall reverse logistics costs at $100 billion annually in the U.S. alone. But containing costs is only part of the opportunity. Optimizing reverse logistics operations can yield increases in customer loyalty and retention, boost revenue, and improve product uptime and quality.
Type of document:	Benchmark Report

WM10 Literature Review – Document Outline

No:	30
Title:	The Relationship of Logistics to Supply Chain Management: Developing a Common Industry Definition
Author(s):	Lummus, R.R., Krumwiede, D.W., Vokurka, R.J.
Year:	2001
Location:	US
Keywords:	supply chain management logistics transportation method distribution
Abstract:	Over the past few years there has been confusion and disagreement among general business practitioners and operations professionals concerning the terms "logistics" and "supply chain management". Various formal definitions have been offered for both terms. In addition, the common usage of each term in industry varies. Business terms are often defined over time, by the common use or application of the term. Examines the historical definitions of both terms, looks at current practitioner views of the terms, and proposes a hierarchy for the relationship between logistics and supply chain management.
Type of document:	Paper in Industrial Management & Data Systems. 101/8, 426-431

WM10 Literature Review – Document Outline

No:	31
Title:	E-Business and Supply Chain Integration
Author(s):	Lee, H.L., Whang, S.
Year:	2001
Location:	US, Japan
Keywords:	supply chain management
Abstract:	E-business— the use of Internet-based computing and communications to execute both front-end and back-end business processes — has emerged as a key enabler to drive supply chain integration. Businesses can use the Internet to gain global visibility across their extended network of trading partners and help them respond quickly to a range of variables, from customer demand to resource shortages. This paper examines the impact of e-business on supply chain integration on four critical dimensions: information integration, synchronized planning, coordinated workflow, and new business models. By adopting e-business approaches businesses can reap the benefits of supply chain integration — reduced costs, increased flexibility, faster response times — more rapidly and effectively.
Type of document:	Paper in Stanford Global Supply Chain Management Forum, November 2001

WM10 Literature Review – Document Outline

No:	32
Title:	Environmentally Responsible Logistics Systems
Author(s):	Wu, H.-J., Dunn, S.C.
Year:	1994
Location:	US
Keywords:	environment logistics transport
Abstract:	Logistics can be an indispensable part of integrated environmental management programmes because of its cross-functional nature. Provides an overview of environmentally responsible logistics activities and their implications for corporate management. Also examines logistics functions in the context of the corporate value chain and identifies various environmental decision points. With environmental impact considered, many traditional trade-off decisions need to be re-evaluated. Provides examples in which innovative and environmentally-friendly logistics ideas are used. Also discusses two system-wide logistics elements, transportation and reverse logistics, that can have a profound impact on a firmprimes environmental protection programme. Concludes that logistics managers can make environmentally responsible decisions that are coherent with corporate goals and objectives.
Type of document:	Paper in International Journal of Physical Distribution & Logistics Management. 25(2), 20-38

WM10 Literature Review – Document Outline

No:	33
Title:	Information Technologies and Supply Chain Integration. A Study Among Manufacturers and Transport and Logistics Service Providers
Author(s):	Mortensen, O., Lemoine, W.
Year:	2005
Location:	EU
Keywords:	supply chain management business process integration information technologies standardization manufacturers transport and logistics service providers
Abstract:	The goal of the Supply Chain Management process is to create value for customers, stakeholders and all supply chain members, through the integration of different processes like manufacturing flow management, customer service and order fulfillment. However, many firms fail in the path of achieving integration. This study illustrates, from an empirical point of view, the problems associ-ated to SC integration among European firms operating in global/international markets. The focus is on the relationship between two echelons in the supply chain: manufacturers and their transport and logistics service providers (TLSPs). The paper examines (1) the characteristics of the collabo-rative partnerships established between manufacturers and TLSPs; (2) the IT used to support the SC cooperation and integration; (3) the key SC processes integrated; (4) the future demands for services, and the expected process integration. Our results show that the current business integra-tion practices between manufacturers and TLSPs are primarily restricted to some sub-processes in three key SC processes: Customer Service Management, order fulfillment and backwards logistics. The use of IT tools to support the integration has been quite limited. Some managerial considera-tions and upcoming challenges about the standardization of business processes are discussed.
Type of document:	Paper presented at the Workshop Supply Chain Management and Communication Technology. University of Groningen, November 2005.

WM10 Literature Review – Document Outline

No:	34
Title:	UK Packaging Waste Legislation; Implications for Food Retailers
Author(s):	Fernie, J., Hart, C.
Year:	2001
Location:	UK
Keywords:	packaging waste united kingdom retailing logistics
Abstract:	The Producer Responsibility Regulations incorporated the EU Packaging Waste Directive into UK law in March 1997. The UK legislation adopted the concept of the “polluter pays" by sharing the responsibility for waste packaging recovery across the whole supply chain. However, the retailer as the last member of the supply chain assumed the greater share of 47 per cent of waste recovery targets. The operational and resource implications for individual company obligations were compounded by the introduction of a complex waste collection scheme involving third-party waste recovery operators trading packaging recovery notes (PRNs). The UK approach has been criticised as “bureaucratic, ill-conceived and confusing", requiring companies to provide data on all primary, secondary and transit packaging they have generated, recovered and recycled over the previous year. While many retailers were unprepared for the complexities it created, others view the legislation as an opportunity to reduce waste, optimise their packaging supply chain and reduce costs. This paper will examine and compare the impact of the new regulations on various food retailers. Findings are discussed from a series of in-depth interviews with a number of senior managers involved in implementing the legislation. In particular it discusses the initiatives carried out to comply with the regulations, the impact on existing logistics networks and the investment required to implement the regulations.
Type of document:	Paper in British Food Journal. 108(3), 187-197

WM10 Literature Review – Document Outline

No:	35
Title:	The Role of Resource Commitment and Innovation in Reverse Logistics Performance
Author(s):	Richey, G.R., Genchev, S.E., Daugherty, P.J.
Year:	2005
Location:	US
Keywords:	supply chain management innovation resource management
Abstract:	Purpose – Aims to provide empirical evidence of the relationships between and among reverse logistics, resource commitment, and innovation. Design/methodology/approach – Mail surveys were sent to members of the Automobile Aftermarket Industry Association, a large trade association. Factor level results followed by between-item results, as typically reported in general linear modeling and mediated regression, are developed using a split sample methodology. Ultimately, Resource-Advantage Theory provided the framework for examining the impact of developing innovative reverse logistics-related dynamic capabilities. Findings – Resource commitment makes reverse logistics programs more efficient and more effective. However, the resources must be used in such a manner as to develop innovative capabilities/approaches to handling returns. Resource commitment was not found to be significantly related to innovation in reverse logistics at smaller firms. This is likely to be related to the level of resources available. Larger firms can commit greater resources and, thus, enjoy superior performance compared with smaller firms in the survey group. Research limitations/implications – The focus is somewhat narrow. New research should extend beyond the one industry examined. Future research should also expand to include more members of the supply chain and employ methods that allow examination of network relationships. Practical implications – Reverse logistics deserves special attention in terms of resource commitment. Resources related to labor, i.e. allocating sufficient personnel to reverse logistics programs, are especially critical. Innovation in reverse logistics programs was found to be related to operational service quality at both small and large firms. Originality/value – The research provides empirical evidence of the relationships between resource commitment and innovation – and how reverse logistics program performance is influenced. This has important implications with respect to customer relations. It can also be used to provide rationale for securing adequate resource commitment for reverse logistics programs.
Type of document:	Paper in International Journal of Physical Distribution & Logistics Management. 35(4), 233-257

WM10 Literature Review – Document Outline

No:	36
Title:	An Exploratory Study on Electronic Commerce for Reverse Logistics
Author(s):	Kokkinaki, A.I., Dekker, R., Van Nunen, J., Pappis, C.
Year:	2000
Location:	US, EU
Keywords:	e-commerce reverse logistics
Abstract:	In this paper we consider the role Electronic Commerce plays and can play for Reverse Logistics. After short introductions to electronic commerce and reverse logistics, we give an overview of existing internet sites for reverse logistics. These sites can be classified as electronic markets, supply of used parts and complete reverse logistic solutions. Finally we draw some lines to the future.
Type of document:	Paper in Supply Chain Forum, 2000

WM10 Literature Review – Document Outline

No:	37
Title:	The Role of 4PL as the Reverse Logistics Integrator
Author(s):	Mukhopadhyay, S.K., Setaputra, R.
Year:	2006
Location:	US
Keywords:	marketing strategy returns strategic alliances
Abstract:	Purpose – An effective return policy is used as an important competitive weapon in the marketplace to substantially influence product sales. However, return policy is also seen as a problem for all parties in the supply chain due to the headache in processing returned merchandise. While retailers are efficient in selling, they do not usually have the expertise in handling the reverse flow. The purpose of this paper is to propose the use of a fourth party logistics (4PL) as a return service provider, and develops optimal decision policies for both the seller and the 4PL. Design/methodology/approach – A profit-maximization model is presented to jointly obtain optimal policies for the seller and the 4PL through the use of Stackelberg like game theory, where the seller acts as the leader and the 4PL acts as the follower. Findings – Optimal values for the seller's and the 4PL's decisions are presented. Conditions under which profits for the seller and 4PL both increase are shown. Practical implications – This paper offers a number of managerial guidelines for using marketing and operational strategy variables to influence the market reaction parameters so as to obtain the maximum benefit from the market. Originality/value – This paper offers insights to seller and 4PL on how return policy may affect their strategic alliance. Treating return policy as a continuous variable is an original contribution of this paper as is the joint optimization of the seller and the 4PL.
Type of document:	Paper in International Journal of Physical Distribution & Logistics Management. 36(9), 716-729

WM10 Literature Review – Document Outline

No:	38
Title:	Differences Between Forward and Reverse Logistics in a Retail Environment
Author(s):	Tibben-Lembke, R.S., Rogers, D.S.
Year:	2002
Location:	US
Keywords:	reverse logistics supply chain management retailing
Abstract:	This paper compares and contrasts forward and reverse logistics in a retail environment, with the focus on the reverse flow of product. Many differences between forward and reverse flows of logistics systems are presented. The impact of these factors depends to some extent on the supply chain position of a firm. Unlike much reverse logistics research, which is written from the perspective of the firm which will remanufacture or refurbish the product in the reverse flow, we consider the issues from the perspective of the firm generating the reverse flow.
Type of document:	Paper in Supply Chain Management. 7(5), 271-282

WM10 Literature Review – Document Outline

No:	39
Title:	Entrepreneurship, Innovation and Sustainability Strategies at Walden Paddlers, Inc
Author(s):	Farrow, P.H., Johnson, R.R., Larson, A.L.
Year:	2000
Location:	US
Keywords:	environment industries recreation-sport manufacturing strategy
Abstract:	Walden Paddlers, a market leader in popularly priced recreational kayaks, used a simple, inexpensive guide to evaluate decisions against a parameter of environmental responsibility. This guide was applied across Walden's virtual corporation structure to yield quick innovations and economic, strategic, and environmental advantages. The guide enabled Walden and its network of partners to produce light, strong, inexpensive kayaks with superior performance characteristics made from 100-percent-recycled plastic, the only such kayaks on the market. Walden also employed the guide to create a nearly waste-free product-packaging-and-shipping system. Walden's decision guide succeeded within a network of collaborative alliances because it was applied comprehensively, it helped to clarify common goals, it created benefits for all participants, and it was implemented by a skilled entrepreneur-leader who coordinated decision making in the network.
Type of document:	Paper in Interfaces, 30(3), 215–225

WM10 Literature Review – Document Outline

No:	40
Title:	Urban Freight Transport and Logistics: An Overview of the European Research and Policy
Author(s):	European Commission
Year:	2006
Location:	EU
Keywords:	
Abstract:	[From Foreword] This document provides an overview of research results from the EC's Fourth and Fifth Framework programmes and a series of national research projects in the area of urban freight transport and logistics. It also discusses policy implications and requirements for future research. The adoption of best practice methods offers the most promising opportunities for urban logistics operations to become both more efficient and more environmentally sustainable. Such best practice methods include: • the use of more environmentally-friendly alternatives to current urban freight transport practices through improved fuel effi ciency and the use of alternative fuel vehicles; • the use of information and communication technologies (such as RFID and vehicle routing software); • the possibility to improve deliveries to urban areas through the use of urban distribution networks and consolidation depots. Full benefits are unlikely to be achieved, however, when such proposals are put into practice in isolation, and it may well be more sensible to consider them as a wider package of measures. This topic has therefore been explored in the light of the need for integrated solutions, which pull the above-mentioned policy measures together and help eliminate the obstacles to achieving more effective and sustainable urban freight transport and logistics practices. Roles and responsibilities of the various actors and stakeholders have also been considered as an additional element of analysis.
Type of document:	Brochure produced by the EXTR@Web consortium on behalf of DG Energy and Transport.

WM10 Literature Review – Document Outline

No:	41
Title:	Issues in Emerging Home Delivery Operations
Author(s):	Park, M., Regan, A.
Year:	2004
Location:	US
Keywords:	urban freight transportation trucking operations travel behaviour
Abstract:	Despite the recent economic downturn, electronic commerce (e-commerce) continues to show strong growth. According to the U.S. Census Bureau, e-commerce retail sales for 2002 reached at $45.6 billion, an increase of 26.9% from 2001, while total retail sales increased 3.1% during the same period. Although e-commerce sales account for only 1.4% of total sales, the digital economy continues to grow, albeit at a slower pace than earlier predicted. The logistical requirements of e-commerce goods may stimulate greater complexity in supply chain management and potentially cause higher costs in carrier fleet operations. It is important to encourage the development of a freight transportation system that will support the steady growth of e-commerce, while avoiding the possible negative effects from the changes in freight transportation. Advances in home delivery have the potential to promote e-commerce as well as to create sustainable urban freight transportation systems. The logistical challenges of home delivery are discussed and potential solution strategies for the issues that will lead to more efficient and reliable home delivery systems are presented in this paper.
Type of document:	Paper for University of California Transportation Center: Los Angeles, CA

WM10 Literature Review – Document Outline

No:	42
Title:	Reverse Logistics: A Review of the Literature and Framework for Future Investigation
Author(s):	Carter, C.R., Ellram, L.M.
Year:	1998
Location:	US, EU
Keywords:	
Abstract:	Reverse logistics is a process whereby companies can become more environmentally efficient through recycling, reusing, and reducing the amount of materials used.1 Viewed narrowly, it can be thought of as the reverse distribution of materials among channel members. A more holistic view of reverse logistics includes the reduction of materials in the forward system in such a way that fewer materials flow back, reuse of materials is possible, and recycling is facilitated.2 This article reviews the literature, develops a broadened view of the role of logistics personnel in reverse logistics, and identifies gaps where future research is needed. In addition, it presents a theoretically grounded yet pragmatically oriented framework to help guide further work.
Type of document:	Paper in Journal of Business Logistics. 19(1), 85-102

WM10 Literature Review – Document Outline

No:	43
Title:	Best Practice Guidance: Trade Waste Recycling
Author(s):	Enviros Consulting
Year:	2005
Location:	London
Keywords:	trade waste recycling
Abstract:	[From Introduction] The Mayor's Municipal Waste Management Strategy1 includes policies and proposals regarding the identification and dissemination of best practice on waste management issues to improve performance of waste collection, recycling and diversion from landfill. The GLA's Best Practice Scoping report2 identified that there is a need for further guidance in a number of key waste management areas, and that trade waste recycling is a priority. This document aims to develop the opportunity that trade waste recycling presents through establishing best practice guidance, which is based on researched case studies and builds on the lessons learnt by authorities who are operating successful trade waste recycling schemes. The guidance aims to identify the key considerations which need to be taken into account when implementing a trade waste recycling scheme and develops the considerations into a practical, action-oriented plan.
Type of document:	Report for the Waste Strategy Support Unit, Greater London Authority

WM10 Literature Review – Document Outline

No:	44
Title:	The Grocery Supply Chain in the UK: Improving Efficiency in the Logistics Network
Author(s):	Fernie, J., McKinnon, A.C.
Year:	2003
Location:	UK
Keywords:	grocery logistics supply chain transport efficiency UK
Abstract:	The UK grocery supply chain has experienced considerable change in the last 30 years and is now considered to be one of the most efficient in the world. It is, nevertheless, acknowledged that further improvements in supply-chain efficiency can be achieved. Using the results of a pioneering survey of transport operations in the food sector, this paper assesses the potential for further cost savings. The results of a second survey of senior managers indicates that efforts to improve vehicle utilization in this sector will be subject to the conflicting pressures of quick response replenishment and traffic congestion.
Type of document:	Paper in The International Review of Retail, Distribution and Consumer Research. 13(2), 161-174

WM10 Literature Review – Document Outline

No:	45
Title:	Reuse of Primary Packaging – Final Report
Author(s):	Golding, A.
Year:	1999
Location:	EU
Keywords:	
Abstract:	This study examines the reuse of post-consumer packaging in several European Union member states, focusing especially on the refilling of beverage containers. It discusses the amounts and types of reusable packaging on the market; systems for reuse; the costs, constraints, and obstacles to further reuse; and ways to promote the reuse of packaging. The main report also provides much useful background information about refilling, especially the logistics.
Type of document:	Report for European Commission

WM10 Literature Review – Document Outline

No:	46
Title:	The Value of Information in Reverse Logistics
Author(s):	Ketzenberg, M.E., Van der Laan, E., Teunter, R.H.
Year:	2004
Location:	EU
Keywords:	value of information newsvendor problem remanufacturing inventory control
Abstract:	We explore the value of information in the context of a remanufacturer that faces uncertainty with respect to demand, product return, and product recovery (yield loss). We assume a single period model in which the operational decision of interest is the quantity of new product to order. Our objective is to evaluate the absolute and relative value of the different types of information that such a firm may choose to invest in order to reduce the uncertainty it experiences in matching supply with demand. The different types of information include demand, return, and yield loss. Our results are extensive and reveal that the value for any specific type of information depends both on the overall level of uncertainty and the level of uncertainty that is attributed to the information for which it explains. We develop and test a theoretical model that is predictive of 1) the value of each type of information, 2) the conditions that give rise to the value for each type of information, and 3) the relative value for each type of information.
Type of document:	Report for Erasmus Research Institute of Management Report Series Research In Management ERS-2004-053-LIS, 2004

WM10 Literature Review – Document Outline

No:	47
Title:	An Examination of Reverse Logistics Practices
Author(s):	Rogers, D.S., Tibben-Lembke, R.S.
Year:	2001
Location:	US
Keywords:	
Abstract:	[From Conclusions] In this paper, we have discussed the definition of reverse logistics and presented an overview of the current state and estimated the size of reverse logistics activities. While much of the world does not yet care about the reverse flow of product, many firms have begun to realize that reverse logistics is an important and often strategic part of their business mission. This research found many examples of large bottom-line impact. For example, some large retailers have realized savings of as much as $6 million per $1 billion in retail sales (Jedd 2000). Good reverse logistics management not only results in reduced costs, but it can also increase revenues. A lot of money is being made and saved by bright managers who are focused on improving the reverse logistics processes of their company. It is clear that, while sometimes derisively referred to as junk, much value can be obtained from managing the reverse flow cost-effectively. While the efficient handling and disposition of returned product is unlikely to be the primary basis upon which a firm competes, it can make a competitive difference.
Type of document:	Paper in Journal of Business Logistics. 22(2), 129-148

WM10 Literature Review – Document Outline

No:	48
Title:	State of the Art: Research Issues and Framework for Enhancing the Productivity of Reverse Logistics
Author(s):	Jun, H.-B., Kim, J.-G.
Year:	2006
Location:	
Keywords:	reverse logistics RFID research issues productivity
Abstract:	In general, reverse logistics is the process of planning and controlling the recovery flow of end of life (EOL) products that have lost their usage values. The reverse logistics becomes important because of not only stringent environmental legislations but also economic reasons. Hence, industry is increasingly being confronted with the need to solve several issues related to reverse logistics. So far, it is not easy to implement the optimization of reverse logistics because of the invisibility of product information over the lifecycle. However, thanks to emerging product identifying technologies such as radio frequency identification (RFID) and wireless telecommunication, it is possible to know the details of EOL product status information. Using the information, we can enhance the productivity of reverse logistics by reducing unnecessary cost throughout efficient operations of EOL products collection, recovery, and re-distribution. However, it requires a comprehensive and systematic approach for the research of reverse logistics under new environment. In this regard, in this study, we look into the details of new environment for reverse logistics from technological viewpoints and introduce new research issues of reverse logistics with the survey of previous literature.
Type of document:	Paper presented at the Asia-Pacific Productivity Conference, 2006

WM10 Literature Review – Document Outline

No:	49
Title:	Give me back my empties or else! A preliminary analysis of customer compliance in reverse logistics practices (UK)
Author(s):	Breen, L.
Year:	2006
Location:	UK
Keywords:	distribution management distribution operations recycling waste minimisation
Abstract:	Abstract: Purpose – This research aims to conduct an exploratory analysis into current industrial reverse logistics practice in business-to-business (B2B) and business-to-customer relationships (B2C), and determine the financial and operational impact of customer non-compliance in returning distribution equipment back to their source. Design/methodology/approach – The analysis was conducted over multiple industry sectors using qualitative research techniques. The research sample included seven industry sectors, providing a response rate of 72 per cent (53 sources approached). The focus was on both B2B and B2C relationships to determine similarities and differences in financial and operational repercussions. Findings – The research findings indicate that the efficacy of the reverse logistics system can be undermined by lack of customer compliance, with losses of up to £140 million (B2B). Research limitations/implications – In both B2B and B2C relationships, there is evidence of suppliers suffering financial loss due to customer non-compliance. Due to the small scale of the analysis and the breadth of the industry sectors investigated, these results are not generalisable, but do indicate that this is an area, which could undermine supply chain effectiveness. Practical implications – Non-compliance of this nature carries a direct and highly applicable cost for manufacturers and distributors in the practitioner arena. Suppliers within industry need to acknowledge this issue and manage their reverse logistics more effectively. Originality/value – This paper adopts an innovative focus on an understated feature of the reverse logistics cycle, i.e. the recycling of distribution equipment used to transport outbound and returned products. The paper identifies a range of options, which practitioners can use as guidance when managing the returns system.
Type of document:	Paper in Management Research News, 29(9), pp 532-551