Understanding urban freight activity – Key issues for freight planning

Tom Cherrett[a], Julian Allen[b], Fraser McLeod[a], Sarah Maynard[a], Adrian Hickford[a], , Mike Browne[b]

[a]*Transportation Research Group, School of Civil Engineering and the Environment University of Southampton, Highfield, Southampton. SO17 1BJ, United Kingdom*
Email: T.J.Cherrett@soton.ac.uk, F.N.McLeod@soton.ac.uk, A.J.Hickford@soton.ac.uk

[b]*Transport Studies Group, School of Architecture and the Built Environment University of Westminster, 35 Marylebone Road, London. NW1 5LS, United Kingdom*
Email: allenj@westminster.ac.uk, m.browne@westminster.ac.uk

Corresponding author: Fraser McLeod, Transportation Research Group, School of Civil Engineering and the Environment, University of Southampton, Highfield, Southampton. SO17 1BJ, United Kingdom. Email: F.N.McLeod@soton.ac.uk; Tel. +44 (0) 23 8059 3316; Fax. +44 (0) 23 8059 3152

(Post review version. Published in Journal of Transport Geography, 2012. Vol.24 pp22-32. http://dx.doi.org/10.1016/j.jtrangeo.2012.05.008)

Abstract

Using information gathered from some 30 UK surveys undertaken over the last decade, this paper provides planners with an understanding of road-based urban retail freight transport activity. The findings suggest that the average High Street business could expect up to 10 core goods and 7.6 service visits per week, in non-peak trading periods.with 25% additional activity during the build up to Christmas. Vans ('light goods vehicles') were the dominant mode, responsible for 42% of delivery activity with a mean dwell time of 10 minutes. Where possible, load consolidation should be encouraged by methods such as Delivery and Servicing Plans and using out-of-town freight consolidation centres to bring in goods over the last mile in shared vehicles. Where this is not possible, loading bay monitoring and control, and preferred lorry routes can help manage the movement of vehicles in and out of dense urban areas.

Service vehicle activity is a significant contributor to urban freight movements and often requires vehicles to be parked close to the premises being served. Centrally coordinating elements of service provision (e.g. for cleaning, equipment maintenance, recyclate collection), or providing improved, more flexible parking provision for service vehicles could be as or more beneficial in reducing overall freight impacts than focusing on core goods deliveries. In the case of the latter, 'pay-as-you-leave' car park charging systems could encourage short-stay service vehicles to park off-street.

1. Introduction

Increases in population and economic growth in urban areas have resulted in a growing demand for goods and services by commercial and domestic users. Approximately 80% of European citizens now live in an urban area, and urban populations are forecast to increase in

both more and less developed regions across the world over the coming decades (European Commission, 2007; United Nations, 2006). This is resulting in increased levels of demand for urban freight transport services. Urban authorities have traditionally considered freight only as a reaction to negative environmental impacts, often arising from complaints made by residents and other road users. As a result, Urban freight logistics policies tend to fall into six categories (Stathopoulos et al., 2012): i) market based measures which aim to alter the pricing mechanisms of goods whose production/consumption generate negative external costs, (ii) regulatory measures imposed by the local authority which impact on freight operations (e.g time access/weight restrictions), (iii) land use planning measures such as zoning of commercial and residential activities to encourage initiatives such as load consolidation (iv) Infrastructural measures which aim to encourage modal shift towards more sustainable modes (v) information related measures which encourage the exchange of specific data between logistics companies agents and other parties (e.g. vehicle location/routing information to aid traffic control and loading bay management) (vi) management measures where greater collaboration in working operations between logistics providers is encouraged through initiatives such as freight quality partnerships.

As a result, coherent urban freight transport policies have not been developed to the same extent that they have for passenger transport. However many urban authorities have begun to focus far greater attention on the efficiency and sustainability of freight transport due to its economic importance over the last decade. This has led to efforts to develop freight transport strategies and plans in some cities using a combination of the measures outlined by Stathopoulos et al. (2012), as well as research projects, trials and operational schemes. These include the implementation of urban consolidation centres in French, Italian, Dutch and British cities; the establishment of Freight Quality Partnerships in many British cities; the development of quieter freight operations to facilitate out-of-hours deliveries in Dutch cities; the variable use of road space by time of day in Barcelona; the use of electrically-assisted tricycles for parcel deliveries in central urban areas in London and Paris; and the use of locker banks and collection points in German, French and Belgian cities (Allen et al, 2007; Allen et al, 2010; Dablanc, 2010; Dasburg and Schoemaker, 2008; Frosini et al, 2005; INRETS, 2010; Munuzuri et al, 2005; Stantchev and Whiteing, 2006; Transport for London, 2007). However, there is a lack of on-going public data collection about urban freight operations with the exception of vehicle traffic counts which are relatively uninformative. This typically results in urban authorities having limited insight into urban freight operating patterns when attempting to develop suitable strategies and policy measures.

This paper provides an understanding of road-based urban freight transport activities and patterns of operation through a review of some 30 one-off urban freight surveys undertaken in the UK over the last decade. These studies have been undertaken for a variety of reasons but commonly as the first stage in the development of ‘freight quality partnerships’ between local authorities and freight operators in local areas, where basic understanding of freight operations is required. The majority of the studies surveyed have been undertaken in the South of the UK and therefore raises issues as to whether any general traits exposed could be expected in Northern towns with potentially different characteristics. Given the national coverage of many high street brands, the logistics operations serving them will be largely replicated across the country, differing only in the last-mile where unique characteristics (e.g. historic street layouts) dictate certain access times or delivery modes.

The freight sector (including product deliveries to shops as well as service activity) is often seen as a major contributor to congestion and traffic problems in urban areas, but little is understood about the individual supply chain characteristics that form the life-blood of our

retail and commercial centres. An improved understanding of urban freight activity would help planners better cater for freight vehicles through improved design and use of facilities and infrastructure, and investigate the potential feasibility and benefits that could arise from various freight initiatives. The paper is intended to demonstrate the extent to which the results of relatively small-scale, one-off surveys can be utilised to obtain a better understanding of urban freight operations. Over the study period, there have been changes in urban freight operations, particularly related to the emergence of 'on-line' retail and the move to just-in-time operations, less-than-truck loads and high street stores acting as origin points for home delivery as well as a traditional shopping outlet. Despite this, a lot of the mechanisms of supply and the associated infrastructure (pallets, roll cages, dollies etc) have remained the same.

Research has identified that urban establishments receive visits from commercial vehicles for a variety of reasons. The most noticeable are to deliver and collect 'core' goods, being those that are of fundamental importance to the activity carried out at the premises (Allen et al., 2000). In the case of retail establishments, core goods are those sold to final customers, whereas in warehousing, they would be items delivered by suppliers which are to be supplied from the warehouse to other premises. In the case of manufacturing establishments, they encompass the goods used in the production process.

In addition to the goods vehicle trips delivering and collecting core goods, there are a number of other commercial vehicle trips that take place at urban establishments including:

- Service activities at establishments (including for example the servicing of computers, cash registers, vending machines, security and fire alarm systems, lifts, air conditioning, plumbing, electrical work and pest control)
- Other goods delivered to and collected from establishments (e.g. post and waste)
- Ancillary goods deliveries to establishments (e.g. display material, till rolls, payroll records, money)
- Core and ancillary goods transfers between establishments
- Home deliveries (goods despatched from establishments to their customers)

For simplification, these other commercial vehicle journeys are referred to in this paper as 'service visits'. Many service providers have to take equipment and tools to the establishment where the service is being provided and this can result in considerable on-street vehicle dwell time. Together, the deliveries of core goods and service visits comprise total freight transport activity found in urban areas.

2. Factors impacting on core goods deliveries

Across the 30 UK studies reviewed, the numbers of core goods deliveries that take place in urban centres by business type were examined.

2.1 Average delivery rates across businesses

Table 1 shows the average number of deliveries per week to establishments. The results across 27 of the surveys which were comparable suggest a mean of 9 deliveries per week to the average business (standard deviation, 5.8). Given the spread of small independent stores and larger national chains that can be found in a typical retail high street, the average number of deliveries can become inflated by small numbers of establishments receiving large numbers

of deliveries. For this reason, the median figure across these surveys of 7.6 core goods deliveries per week might be a more useful statistic when planning for goods vehicle traffic in urban centres.

Table 1. Goods vehicle delivery trips to urban establishments in recent UK studies (adapted from Allen et al., 2008)

Study	Year	No. Respondents	Mean deliveries/ establishment/ Week *(STDEV)*	Type of survey
Leeds	1996	444	9.6	Establishment
Southampton	1996	172	9.7	Establishment
Winchester	1996	115	8.3	Establishment
Norwich & London	1999	34	19.6 *(29.1)*	Establishment
Covent Garden	2001	104	5.7	Establishment
Norwich	2001	21	21.6 *(31.7)*	Establishment
Winchester	2001	137	10.6 *(11.4)*	Establishment
Park Royal	2002	101	121.0	Establishment
Bexleyheath	2003	21	16.2	Establishment
Broadmead Bristol	2003	119	6.1	Establishment
Torbay	2003	34	24.5	Establishment
Ealing	2004	130	7.6	Observation
Colchester	2005	228	8.4	Establishment
Chichester	2005	14	6.4 *(7)*	Establishment
Crawley	2005	9	5.7 *(9.4)*	Establishment
Horsham	2005	14	8.9 *(9.3)*	Establishment
Worthing	2005	14	7.3 *(8.3)*	Establishment
Wallington	2005	85	13.0	Establishment
Mitcham	2005	81	80.5	Establishment
Catford	2006	45	12.0	Establishment
Croydon & Sutton	2006	183	4.9	Establishment
Bromley	2007	98	5.4	Establishment
Clapham Junction	2007	n/a[a]	9.5	Establishment
Croydon	2007	10	1.8	Establishment
Kingston	2007	12	2.0	Establishment
Lewisham	2007	7	5.3	Establishment
Merton	2007	15	2.1	Establishment
Reading (Friar St)	2003	30	23.0	Establishment
Winchester (High St)	2008	83	5.8 *(7.7)*	Establishment
Covent Garden	2009	118	4.2	Establishment

[a] n/a – not available.

There can be considerable differences in the mean numbers of deliveries received by establishments, depending on the mix of large multiple and small independent retailers

present. A key problem with making cross-survey comparisons between urban freight surveys is the different classifications of business used (van Binsbergen and Visser, 1999) who suggest that wherever possible, the 'UK Standards Industrial Classification of Economic Activities – SIC 2007' business classification system should be used. This issue is also compounded by the different circumstances under which each survey was undertaken (time of year, business sampled, method of approach etc).

2.2 Differences in delivery rates between business types

The type of business conducted at an establishment is also a determinant of the number of goods vehicle deliveries that take place. In the 2008 Winchester study, charity shops, clothing retailers and 'other services' (including estate agents and travel agencies) received the least number of weekly core goods deliveries (less than 3 per week on average), compared to food and drink retailers and footwear retailers who received over 7 deliveries per week on average. The 2001 Winchester survey highlighted the impacts of hotels on freight traffic generation, each producing 24.5 core goods deliveries per week on average, which could include linen, food and other ancillaries, highlighting the difficulty in distinguishing between 'core goods' deliveries and 'service visits' in this sector.

Of interest is the extent to which joint procurement strategies between potentially rival businesses could bring about a reduction in delivery vehicle trips for certain common goods (e.g. stationary). The ISPRO project which is currently being carried out with small and medium sized businesses in three British towns is examining the potential for collaborative procurement to help reduce purchasing costs for these urban businesses while at the same time reducing delivery vehicle activity. The concept of 'consolidating' deliveries prior to the 'last-mile' delivery has been well practiced and a push by local authorities to help identify opportunities to encourage this (through collaborative procurement strategies as part of a Freight Quality Partnership) could reduce vehicle impacts.

2.3 Impacts of store size on delivery rates

One might assume that larger retailers are responsible for more delivery activity based on their sales area. Results from the 2008 Winchester study suggested that there did not appear to be a strong correlation between store size and the number of core goods deliveries received per week (0.13). A logical explanation would be that larger stores may tend to use larger delivery vehicles and may also consolidate loads, particularly when they are served from a distribution centre in a centralised distribution system. Smaller stores, particularly when served through decentralised distribution systems may receive more deliveries from a range of different suppliers using smaller vehicles.

When looking in more detail by business category, the results suggested that mobile phone stores and jewellers were the smallest in terms of sales area but generated considerable numbers of weekly core goods movements per $100m^2$ sales area (7.29 and 4.67 respectively, Table 2) with the average across all business categories of 2.05 core goods deliveries per week per $100m^2$. The 'food and drink' business category recorded the second highest weekly delivery rate in the Winchester survey, emphasising the contribution this retail area has on freight generation, especially given the number and total floor space of this business type in urban areas.

One interesting issue is the extent to which the width of shop frontage impacts on the number of deliveries received, delivery times and types of vehicle used. Such data were not available for any of the studies investigated but planners should be wary of the potential for increased freight activity where small independents are clustered in areas with limited shop front access such as arcades.

Table 2. Mean numbers of weekly core goods deliveries received by businesses on Winchester High Street per 100m^2 sales area

Business type	Mean floor area (m^2)	Standard deviation of floor area	Mean number of core goods deliveries/week/100m^2
Charity shop	90	17.6	2.22
Other services	220	153	1.17
Clothing retail	383	351	0.74
Jewellers	86	25.8	4.67
Mobile phones	77	39.6	7.29
Pub/restaurant	424	380	1.77
Opticians	279	151	2.27
Food and drink retail	124	85.8	5.64
Footwear	320	139	2.60
Other retail	269	254	2.26
All businesses			*2.05*

Using 12-hour vehicle delivery rates from surveys in Wallington (2005) and Ealing (2004) suggested that the average delivery rate across all shops, financial institutions and cafes/restaurants was 5.6 and 7 vehicle visits per 100m^2 per week. The Winchester data do suggest that certain types of small, specialist retailer (in terms of retail sales space) could be responsible for significant freight vehicle generation on a high street. The assumption by urban authorities can often be that large, national chain stores are associated with significant proportions of the total freight vehicle activity within a street, whether for core goods delivery or service provision. In a lot of cases, these types of business, serviced through centralised distribution systems, can be linked with a relatively small number of large heavy goods vehicle (HGV) deliveries on a scheduled basis. The surveys suggest that smaller, specialist stores can be responsible for considerable freight vehicle activity, albeit in smaller goods vehicles, often vans. In terms of town planning, one should not assume that larger retailers (over 500m^2 sales area) are the most likely generators of freight delivery traffic, and should automatically be the ones targeted for improved access/infrastructure provision. In areas with considerable numbers of independent stores operating decentralised logistics systems, there could be greater scope for the introduction of consolidation centres to group product for co-ordinated last mile delivery and hence reduce vehicle impacts.

2.4 Impacts of supply chain type on delivery rates

The method of goods supply can impact on the number of core goods deliveries made. Allen et al. (2000) identified three types of goods supply system from establishment studies in Norwich and London:

- ***Centralised goods supply systems*** (where businesses receive goods from a single point of dispatch, which could be a single main supplier or a distribution centre)
- ***Decentralised goods supply systems*** (where businesses receive goods from several points of dispatch which could include a variety of different suppliers)
- ***Hybrid goods supply system*** (where businesses can receive a significant proportion of their core goods deliveries from a centralised supply system, with others being received through decentralised networks).

The results from the 2008 Winchester study suggested that businesses using decentralised logistics systems received significantly more weekly core goods deliveries (9.1) compared to centralised stores (3.6), $T_{(39)}$=3.05, p=0.003, around three times the number. Similar results were found in the 1999 Norwich and London studies where decentralised served stores generated 14.2 weekly core goods deliveries on average (median, 10) with centralised served stores receiving 4.5 (median, 2.5). Despite the fact that stores using decentralised logistics supply systems may receive goods via many different points of dispatch (some stores recorded up to 50 different points of dispatch for core goods deliveries in the Norwich and London surveys), there is often a core logistics provider/supplier that undertakes the majority of the transport. Across the 37 stores using decentralised goods supply chains in the Winchester study, the results suggested that a single supplier/logistics provider accounted for 68% of the vehicle activity to that business. A 2 by 2 homogeneity Chi-squared test showed that there were no significant differences in the proportions of articulated/rigid HGVs and vans used by businesses served by centralised and decentralised systems (χ^2 = 0.57 and $\chi^2_{(0.05)}$ (1df) = 3.84).

2.5 Delivery scheduling

Deliveries of core goods to establishments can either be scheduled (i.e. planned in advance and regular) or ad hoc (i.e. unscheduled). Table 3 shows the degree of organisation of delivery schedules identified in three of the urban freight studies reviewed that used establishment surveys.

Table 3. Extent of scheduling identified at establishments receiving deliveries in recent UK urban freight studies (% of respondents)

Organisation of Delivery Schedule	Bromley, 2007	Croydon & Sutton, 2007	Bristol, Broadmead, 2003
Regular schedule	87%	56%	66%
Ad hoc	7%	8%	12%
Mix	6%	36%	22%

Total	100%	100%	100%
No. of respondents	98	183	119

The majority of respondents operated with regular delivery schedules, with only a small proportion receiving completely ad hoc deliveries. The majority of retailers receiving a mix typically received unpredictable deliveries from parcel carriers and couriers and/or had arrangements in place for emergency ordering of stock which was delivered when required alongside their regular planned deliveries. The respondents receiving ad hoc deliveries tended to be small retail outlets with either low stock turnover or who were selling perishable items.

2.6 Courier operations

A study of an express parcels carrier as part of the Birmingham/Basingstoke/Norwich freight study (Allen et al., 2003) reported that across 41 rounds, the average number of collections/deliveries was 44. Courier rounds involving home delivery often have very high drop rates with 120 deliveries on a round being reported by Edwards et al. (2010). The various studies show that there is considerable variability in the numbers of drops made by couriers in urban centres on a typical round. The average courier would expect to make 66% more delivery trips to businesses in Winchester during the Christmas period.

3. Characteristics of core goods deliveries to establishments

In terms of freight planning, it is important to understand the patterns of delivery found in urban centres.

3.1 Deliveries by time of day

The studies suggest that the 06:00 to 12:00 period generates the most urban delivery activity with 49% of 2178 recorded delivery times relating to a morning delivery before 12:00, often during the morning peak congestion period (Allen et al., 2008). Research undertaken by McKinnon (1999) suggested that food retailers receive the majority of their deliveries between 05:00 and 09:00 but the 2008 Winchester study found no significant differences between individual business categories in terms of the delivery time of the most common logistics provider/supplier, or between the delivery times of stores who were served through centralised and decentralised logistics systems.

Suppliers and carriers can have considerable influence on delivery times, with the receiving business often having little input into when the vehicles arrive. In the 2008 Winchester study, 26% of businesses did not have a set delivery time arranged, with goods potentially arriving at any time during the working day. The Covent Garden study (Tyler, 2001) suggested that only 40% of businesses surveyed (mainly small independent retailers) had any control over delivery times which was a feeling echoed in Colchester (31%) (Steer Davies Gleave, 2005).

3.2 Deliveries by day of the week

Friday is generally the busiest day of the week (8 out of 16 studies) and Monday the quietest, in terms of freight vehicle activity. There is however a great deal of variability, with wholesale produce markets studied in London in 2006 (Western International, New Spitalfields and Billingsgate) receiving considerable vehicle activity on Saturdays, demonstrating that the nature of the commercial activity very much dictates the supply chain patterns. This was in contrast to Winchester where Tuesdays and Wednesdays recorded the greatest delivery vehicle activity (just over 20% of the businesses in the 2008 High Street survey received deliveries on Tuesdays), with significantly less being undertaken at the weekends ($\chi^2 = 88.02$ and ($\chi^2_{(0.05)}$ (10df) = 18.3). The findings suggested that one could expect 19% of High Street businesses to have no fixed day for deliveries with arrival patterns that could vary from week to week, depending on stock levels and sales.

3.3 Deliveries by time of year

In terms of peak business periods, the retail sector typically sees the greatest increase in core goods volumes from October through to December, with some seasonal variation associated with Easter and other traditional sales periods. The results from the 2008 Winchester High Street study suggested that 87% of the businesses considered December to be their busiest trading month with February being the quietest period. Similar peak business patterns were noted in studies at Bexleyheath (2003), Colchester (2005) and in Chichester, Crawley, Horsham and Worthing (West Sussex, 2005). However, studies in towns which are traditional holiday resorts can expect to experience peak freight activity during different periods of the year. A study of 34 businesses in Torbay, 2003, suggested that July and August were the peak months for freight activity followed by June and December (Allen et al., 2008).

Of key interest in terms of freight planning is to what extent the numbers of deliveries per week increases during these peaks, and how the mean size of the delivery changes. The 2001 Winchester survey suggested that across 110 retail and service businesses, 25% more deliveries would be made to the average business during a peak trading week (an additional 2.4 deliveries per business per week). A one-way analysis of variance (ANOVA) test showed that there were significant differences between the clothing, food, 'other retail', personal services and 'other services' business categories in the ratio of additional peak period weekly deliveries to the typical non-peak number, ($F_{(4,93)} = 2.7$, $p=0.035$, MSE = 0.19), with the average clothing retailer receiving 51% more deliveries during the pre-Christmas period. This was in contrast to food retailers (not including pubs and restaurants) who only saw an 8% increase on average.

The 2008 Winchester survey found that 21% of businesses (across all business categories) received additional deliveries, whilst 57% saw increases in mean consignment size but no increases in the number of deliveries made during peak periods. Only 4 businesses (5%) claimed to experience both situations. This has highlighted that although one would expect a retailer to receive more core goods deliveries in the build up to Christmas (looking across all their supplier base), their primary goods supplier, responsible for up to 82% of their stock, may not generate additional vehicle visits during this period but may just increase the mean consignment size, which might result in a larger vehicle being used. A study of retailers in Broadmead Bristol (2003) attempted to gauge the quantity of stock delivered to businesses during their peak trading week (Allen et al., 2008). Retailers expecting at least a doubling in the quantity of goods delivered were cards and gifts shops, clothing retailers, entertainment retailers, food, home furnishings, jewellery stores and toy shops. Similar findings came out of

studies of retailers in Bromley (2007) and Croydon/Sutton (2007) where 28% and 50% increases were reported in the quantity of consignments delivered during the peak week, respectively. Increases in peak-time delivery volumes would be an important design criteria to consider when planning for an urban consolidation centre.

3.4 Types of vehicle used to make core goods deliveries

In nine out of the twelve establishment surveys involving retailers undertaken since 2001 (Allen et al., 2008), vans ('light goods vehicles') were the dominant mode, and across all the studies, were responsible for 42% of the delivery activity on average (Table 4), perhaps suggesting the influence of the major parcel carriers on store deliveries and also, issues encountered when accessing often congested urban centres with larger delivery vehicles. In the 2001 Winchester freight study (Cherrett et al., 2002), there were significantly more rigid lorries used for making core food deliveries, and vans were the mode of choice for the service industries, whereas more articulated lorries were used by warehousing and manufacturing businesses(χ^2 = 252.6, and $\chi^2_{(0.01)}$ (9df) = 21.6). 'Other services' (estate agents, travel agents, solicitors, recruitment agents etc.) received the majority of their core deliveries by van (66% on average), as did businesses selling personal services.

The seven distribution companies that were interviewed as part of the Birmingham/Basingstoke/Norwich study used vehicles ranging in gross weight from 3.5 tonnes to 38 tonnes, with each company using two or three different sizes. The 2008 Winchester study suggested that there were no significant differences in the proportions of articulated and rigid goods vehicles and vans used by businesses served by centralised and decentralised systems. The evidence suggests that weight restrictions, product characteristics and the number of drops that have to be made during the day can also influence the types of vehicle used by logistics providers in urban centres (Allen et al., 2008).

Table 4. Vehicles used for core goods deliveries across 12 urban freight surveys (2001 to 2008), Allen et al., (2008).

Study	Year of study	Articulated goods vehicle	Rigid goods vehicle	Light goods vehicle	Car	Other[a]	Total
Leeds	1996	17%	81%	2%	-	-	100%
Southampton	1996	45%	16%	38%	-	-	100%
Winchester	1996	30%	59%	11%	-	-	100%
Winchester	2001	16%	50%	33%	1%	-	100%
Reading (Market St)	2003	1%	17%	75%	6%	1%	100%
Reading (Friar St)	2003	16%	26%	51%	1%	6%	100%
Bexleyheath	2003	10%	39%	45%	6%	-	100%
Broadmead, Bristol	2003	21%	34%	45%	-	-	100%
Ealing	2004	4%	18%	60%	15%	3%	100%
Chichester	2005	42%	39%	19%	-	-	100%
Colchester	2005	10%	26%	35%	23%	7%	100%
Crawley	2005	48%	32%	20%	-	-	100%
Horsham	2005	29%	23%	48%	-	-	100%

Worthing	2005	24%	28%	48%	-	-	100%
Wallington	2005	2%	72%	25%	-	-	100%
Mitcham	2005	3%	44%	53%	-	-	100%
Catford	2006	1%	31%	68%	-	-	100%
Bromley	2007	29%	41%	27%	-	2%	100%
Clapham Junction	2007	21%	32%	35%	-	-	100%
Croydon & Sutton	2007	26%	39%	25%	-	9%	100%
Kingston	2007	0%	55%	45%	-	-	100%
Lewisham	2007	0%	42%	58%	-	-	100%
London (Lisson Grove)	2008	3%	42%	54%	1%	-	100%
London (Regent Street)	2009	1%	27%	64%	3%	5%	100%

[a] "Other" includes motorcycle, taxis and minibuses. In the case of the Bromley and Croydon & Sutton studies, “other” includes private cars.

3.5 The use of delivery vehicles for ‘back-loading’

Back-loading specifically refers to the use of delivery vehicles to take back items (customer returns, stock cascading to other stores, recyclate) to a distribution centre, depot, supplier/manufacturer or other retail outlet as part of a delivery round, with the aim of reducing empty running and improving transport efficiency.

From the 2008 Winchester study, 41% of businesses stated that they did not utilise any back-loading capability of their main supplier/logistics provider while 39% stated that they sometimes used the main supplier/logistics provider’s delivery vehicles to specifically back-load customer returns. While these were predominantly scheduled deliveries, 80% of these back-loads were ‘on demand’, indicating that the back-loading of customer returns tends to be used on an ‘as needs’ basis, rather than as a matter of course. Back-loading the main suppliers’/logistics providers’ delivery vehicles with stock for return to the supplier/distribution centre was also cited as an activity undertaken by 45% of the respondents while 42% had, at sometime, back-loaded stock for rotation to other stores. Only 15 of the respondents (18%) claimed to back-load any waste or recyclate using the main suppliers/logistics providers delivery vehicles.

The review suggested that in any retail centre, one would expect to find a small number of retailers who routinely back-load returns, primarily through centralised logistics networks. In Winchester, approximately 37 vehicles per week (16%) serving 12 retailers routinely did this. Of interest from a planning perspective is whether existing centralised returns systems can be tapped into to allow small-to-medium enterprises (SMEs) to benefit and potentially consolidate backloads to reduce this type of freight movement.

3.6 Dwell times of core goods delivery vehicles and planning implications

A detailed understanding of freight vehicle dwell times (i.e. the period of time that the vehicle remains stationary during loading and unloading operations) is important if any type of co-ordinated delivery and service plan is to be drawn up as part of a future Town Access Plan. Knowledge of how freight uses any current delivery bays and the extent of on-street deliveries, which may contravene current waiting policy, is essential in order to better plan for delivery

and service vehicle provision in the future. Systems encouraging shorter dwell times should be prioritised to help reduce traffic delays and minimise the environmental impacts of freight. Allen et al. (2000) identified that dwell times can be influenced by:

- The distance from the goods vehicle to the premises being served
- The location where the vehicle parks (off-street v on-street)
- The size of the delivery and the weight of the goods
- The type of product and whether or not the goods are unitised
- The means of getting goods off the vehicle and conveying them to the premises
- Whether the driver has to close and lock the vehicle
- The number of people performing the delivery
- Whether staff at the receiving establishment assist with loading/unloading
- Whether or not the goods have been pre-ordered by the establishment
- Whether or not goods have been sorted for delivery prior to the vehicle's dispatch from the warehouse
- The extent to which the receiver checks the goods
- Whether or not staff at the receiving establishment need to be present at the time of delivery
- Whether or not the driver requires a signature for delivery
- Whether or not other deliveries/collections are taking place at the receiving establishment at the same time (resulting in queuing)

For freight planning in urban centres, the results (Table 5) suggest that approximately 30 minutes should be allowed for the average articulated HGV delivery, 20 minutes for rigid HGVs, 10 minutes for vans and cars. The 2001 and 2008 Winchester surveys suggested that logistics providers and couriers recorded the shortest mean van dwell times of 9 minutes and 8 minutes respectively. Where vehicles were owned by the business concerned, the dwell times were considerably longer (over 20 minutes) suggesting that deliveries might involve multiple consignments or be more complex owing to the nature of the goods or the activity being undertaken at the establishments (perhaps involving the driver checking off individual items with the proprietor). Across all the business categories, there did not appear to be a strong correlation between store size and the mean dwell time of core goods delivery vehicles (0.12). One might expect larger stores to receive greater volumes of goods in a typical delivery and therefore have a greater mean dwell time but this was not found to be the case. One might also expect vehicles in centralised systems to be more involved in material take-back to the distribution centre (either product returns, stock returns, recyclate return, or a combination) and would therefore record a longer mean dwell time compared to vehicles operating through a decentralised system which may operate on multi-drop rounds, however, the results suggested that the mean dwell times of vehicles in decentralised distribution systems were not significantly shorter (14.5 minutes) compared to those from centralised systems (16.9 minutes),$T_{(71)}$=0.76, p=0.45.

Table 5. Mean dwell times for loading/unloading in recent UK studies by vehicle type (minutes). From Allen et al., (2008)

Study	Year	Type[b]	Artic HGV	Rigid HGV	Van	Car
Bar End[a]	2001	Est	50	20	8	7
Winnall[a]	2001	Est	21	13	7	7

City[a]	2001	Est	31	21	9	9
High St[a]	2001	Est	41	20	12	7
Reading	2002	Est	11	11	9	6
Bexleyheath	2003	Obs	22	22	7	6
Ealing	2004	Obs	16	14	19	8
Chichester	2005	Est	42	33	11	-
Crawley	2005	Est	48	14	7	-
Horsham	2005	Est	33	18	7	-
Worthing	2005	Est	38	33	7	-
Wallington	2005	Obs	21	7	7	-
All studies			***31***	***19***	***10***	***8***

[a] Surveys undertaken in Winchester by Cherrett et al. (2002)
[b] Type of survey undertaken (Est - Establishment survey; Obs - Observation survey)

Given that rigid vehicles and vans record mean dwell times under 20 minutes, there is scope for looking at more innovative ways of managing short-stay freight activity in urban centres. Changing car parks to 'pay-as-you-leave' with a zero tariff if the vehicle has a total dwell time of under 15 minutes would be one way of encouraging more responsible delivery. The use of remote monitoring technology for loading bay control has also been trialled (e.g. sensing delivery vehicles in loading bays as part of the EMEL trial (part of the Straightsol project, www.straightsol.eu) in Lisbon. Other potential policy initiatives to aid delivery relate to the management of the local infrastructure and particularly, whether shared use zones (e.g. bus stop/delivery zone) could be created to maximise the use of scare space in urban centres.

Results from the 2001 and 2008 Winchester surveys suggested that the longest dwell times were associated with charity shops (26.3 minutes), food and drink retail (22.5 minutes) and 'other retail' (20.5 minutes). Jewellers, mobile phone retailers and opticians recorded the shortest dwell times with delivery vehicles from the main supplier/logistics provider all taking under 10 minutes on average. This perhaps highlights the impact of smaller consignment sizes and the influence of the couriers in these particular supply chains. Across the 120 businesses on Winchester High Street, it was estimated that approximately 173 hours of unloading activity typically take place each week (1 hour 27 minutes per business per week), of which 40% involves vans. Taking a 5-day week, this equates to 17 minutes of delivery vehicle dwell time per business each week day, of which 73% (13 minutes) could occur on-street.

3.7 Unloading locations and characteristics

The availability of off-street loading/unloading locations in urban areas varies depending on the type of location served. Table 6 shows the proportion of loading/unloading that takes place on-street and off-street in the recent UK studies reviewed. Even when off-street loading facilities exist, this does not necessarily mean that they are always used. In the 2002 Park Royal study, while 14% of respondents said that their establishment had off-street facilities for goods vehicles, 22% of them said that deliveries were made from vehicles parked on-street. From the 2008 Winchester High Street study, 73% of respondents (n=70) stated that unloading took place on-street.

Four of the studies examined whether or not on-street loading/unloading was carried out legally by drivers. The 2002/03 Reading 'Market Place' study suggested that 86% of on-street

freight activity contravened loading regulations, compared to 69% in Ealing (2004) and only 20% in Wallington (2005) and Regent Street (2009). In the Wallington study, the most common contravention was stopping in a location in which no loading was permitted (75% of all contraventions), followed by stopping on a yellow line for more than 20 minutes (11%), stopping on a bus stop (9%), and double parking (4%).

The type of goods being delivered also dictates the delivery requirements and as a result, some types of goods might require specialist vehicles or specialist in-vehicle equipment to enable loading and unloading to take place, which may necessitate the vehicle being close to the premises. Surveys of 531 deliveries to businesses in Bromley and to 183 establishments in Croydon and Sutton (Allen et al., 2008) suggested that 'loose boxes' made up 68% and 56% of the delivery activity to retailers respectively. Similar findings were made in the 2008 Winchester survey of High Street business managers where 58% of the respondents (n=71) stated that the typical delivery from their main supplier/logistics provider was made up of loose boxes. Across these three studies, 20% (Bromley), 25% (Croydon and Sutton) and 32% (Winchester) of deliveries involved a mix of two or more items (boxes, crates, totes, dollies, roll cages, hanging rails, pallets). Little use of roll cages was reported across the three studies (4%, 1% and 1% respectively), implying that these may be used by the larger multiples operating single-drop deliveries served through centralised distribution systems.

Table 6. Proportion of loading/unloading that takes place on-street and off-street in recent UK studies reviewed

Study	Year	On-street	Off-street	Comments
Norwich	2003	95%	5%	Retail street
Reading (Market Place)	2003	90%	10%	Town centre street
Wallington	2005	90%	10%	High street
London (Lisson Grove)	2008	89%	11%	High street
Clapham Junction	2007	85%	15%	Retail street
Winchester	2001	82%	18%	High street
Worthing	2005	71%	29%	Major retail chains in town centre
Colchester	2005	70%	30%	Town centre streets
Chichester	2005	69%	31%	Major retail chains in town centre
Norwich and London	1999	64%	36%	Wide range of establishments across urban areas
Horsham	2005	61%	39%	Major retail chains in town centre
Torbay	2003	59%	41%	Retailers plus hotels, supermarkets, manufacturers, and hospital
Park Royal	2002	22%	78%	Industrial estate

Broadmead, Bristol	2003	13%	87%	High proportion of respondents in shopping centre
Crawley	2005	13%	87%	Most respondents in shopping centre
Sutton and Croydon	2007	13%	87%	High proportion of respondents in shopping centre
Bromley	2007	10%	90%	High proportion of respondents in shopping centre
London (Regent St)	2009	92%	8%	Major retail and commercial street

4. Characteristics of service visits to establishments

Freight vehicle activity in a retail area is often construed as being 'core goods' related, where vehicles are supplying product to retailers for customer purchase. In order to get a complete picture of commercial vehicle movements and to fully understand their influence, it is important to quantify the impacts of service vehicles which support the business activity on a daily basis.

4.1 Type and frequency of service visits

Studies have shown that the most common service visits are typically for mail delivery (3.3 visits per business per week, on average) and waste collection (2.4 visits per business per week, from the Winchester 2008 study). Other service visits which typically occur on a weekly basis are for cleaning (the inside of the premises), window cleaning, delivery of ancillary products (for the essential operation of the business) and catering. Results from the 2001 Winchester study involving 137 businesses across the city centre (33%) suggested that mail deliveries generated 457 weekly visits, window cleaning (122), cleaning (209), ancillary product delivery (145), dedicated mail collections (141) and specific waste collections (140) (Figure 1). During a typical week, one would expect 12 (9%) of the 137 businesses to receive engineer visits for the maintenance of computer equipment, 10 for photocopier maintenance (7.3%), 11 for security equipment (8%), 2 for lift/escalator overhaul (1%) and 4 visits for pest control (3%). Interestingly, the survey suggested that 39 visits were made per week for floral care whereas maintenance visits for the utilities (gas, water and electricity) only generated 29 visits per week. The West Sussex surveys (2005) suggested that during a typical, non-peak trading week, one would expect 9% of businesses to receive engineer visits for the maintenance of computer equipment, 21% for security equipment, 6% for lift/escalator overhaul and 4% visits for pest control.

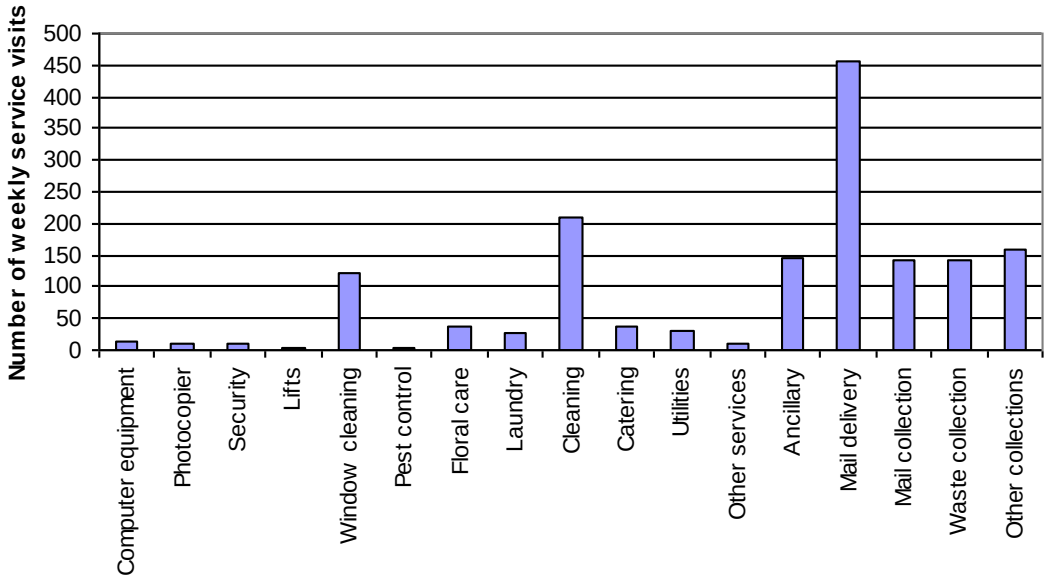

Figure 1. The mean number of weekly service visits to businesses in Winchester by type of service (2001 Winchester survey)

Of particular interest are the number of service providers competing for customers within the same sector and the potential implications for transport. From the 2008 Winchester High Street surveys, some 19 separate waste contractors collected residual waste and/or recyclate from 74 businesses despite the fact that 67% of the average businesses outgoings consisted of the same materials (paper and card). On average, each business in the sample received 2.4 waste collections per week with significant differences noted in the mean numbers of collections between business categories. Mean weekly collections ranged from 1.2 for the 'other services' category to 6.3 collections per week for charity shops. The latter receive deliveries of potential stock from a variety of sources, the saleability of which cannot be gauged until the items are inspected by staff.

Several of the recent UK urban freight studies have examined the total number of service trips made to urban establishments (Table 7) and emphasise the importance of this activity category as a trip generator.

Table 7. A comparison of weekly service and core goods vehicle activity to urban establishments (adapted from Allen et al., 2008)

Study	Mean no. service visits/business/week	Mean no. core goods deliveries/business/week	Service trips as % of total delivery & service activity
Norwich (2001)	2.7	21.6	11%
Winchester (2001)[a]	8.6	8.3	51%
Bexleyheath (2003)	5.7	16.2	26%
Chichester (2005)	7.9	6.4	55%
Crawley (2005)	7.1	5.7	55%
Horsham (2005)	8.7	8.9	49%

Worthing (2005)	12.6	7.3	63%
Winchester (2008)[b]	9.8	5.8	63%
All studies	***7.6***	***10***	***47%***

[a] From 137 respondents from across Winchester
[b] From 107 respondents on Winchester High Street

Service trips as a proportion of all commercial trips (service trips plus goods delivery trips) range from 11% in the Norwich study to 63% in the Worthing study. However, it is important to bear in mind that not all service trips take place in motorised vehicles, some being provided by bicycle or on foot.

To control the amount of service provider activity, many dedicated shopping centres require the resident retailers to buy-in to a centralised service operation run by the centre landlord for activities such as waste collection and recyclate management. In the UK a travel plan is required by planning authorities for major developments or extensions that incorporate employment, retail and leisure uses, and has to be submitted with the planning application. The travel plan is intended to put in place sustainable transport arrangements for the site. The planning authority can agree suitable sustainable transport obligations and conditions, including freight transport, as part of the planning approval process (Department for Communities and Local Government, 2012). In London, for instance, travel plans for major new developments should put in place strategies to consolidate or eliminate delivery and service trips, provide safe and legal loading facilities (preferably off street), make use of off-peak delivery and service activity, and ensure operators demonstrate best practice (Transport for London, 2012).

4.2 Vehicle types used for service visits and dwell times

The Winchester and West Sussex studies were the only ones providing a breakdown of service visits by vehicle type (Table 8). The results suggested that vans play a major part in servicing urban businesses. The two surveys show a similar pattern, although there were slightly more cars and slightly fewer articulated lorries used in West Sussex compared to Winchester. In the Regent Street (2009) survey, vans were used for approximately three-quarters of all service visits. The results suggested that approximately 70% of service visits may be made by motorised transport, of which approximately 50% would be vans.

Table 8. Comparison of service vehicle types

Service vehicle type	Winchester	West Sussex towns
Articulated goods vehicle	8%	3%
Rigid goods vehicle	8%	8%
Van	53%	50%
Car	14%	22%
Motorcycle	0%	0%
Bicycle	2%	1%
On foot	15%	16%
Total	100%	100%

Mean dwell time across all service types can be in the region of 35 minutes (2001 Winchester study), but some activities such as lift/escalator maintenance, cleaning and computer maintenance can take over 40 minutes on average (Figure 2). Service vehicle activity is clearly a significant contributor to urban freight movements and due to its nature, often requires vehicles to be parked close to the premises being served. A survey of 13 service providers servicing 438 clients in Winchester (Cherrett and Smyth, 2003) suggested that 38% of the vehicle activity involved parking on a public road near the premises with 31% off-street at the clients' premises. The Colchester study, using a sample of 244 town centre establishments, suggested that 76% of service providers' vehicles were parked on a public road whilst the service was carried out (Allen et al., 2008). Given their frequency, relatively long vehicle dwell times and their high use of on-street parking, service visits can be responsible for the consumption of a substantial quantity of kerbside parking in urban areas.

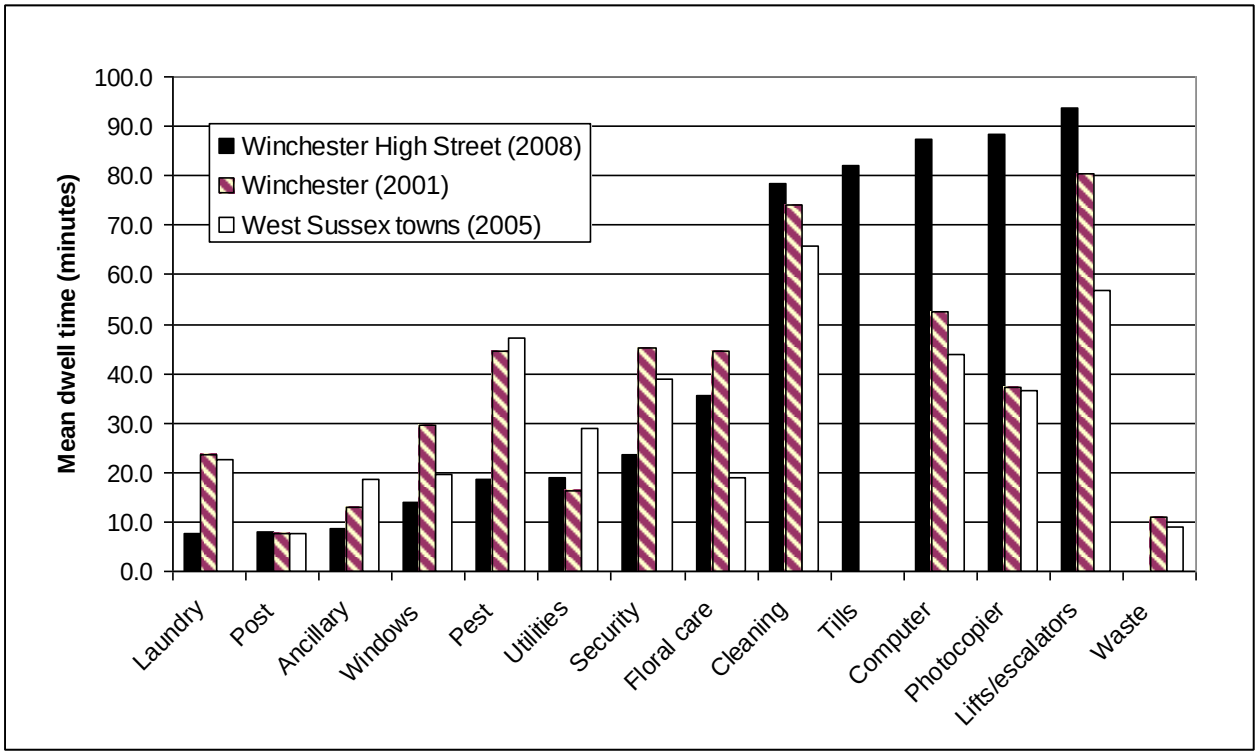

Figure 2. Mean dwell time (minutes) by type of service visit in the Winchester (2001, 2008) and West Sussex Town's surveys (Chichester, Crawley, Horsham, Worthing), 2005

Discussion of issues for freight planning and conclusions

The findings from the review suggest that the average High Street business could expect up to 10 core goods and 7.6 service visits per week, in non-peak trading periods. Given the predominantly on-street, kerbside nature of these activities, there is considerable dwell time taken up by freight vehicles on a daily basis, with the associated impacts on other road users. It is often assumed that large national chain stores can be associated with significant proportions of the observed freight vehicle activity, whether it be for core goods delivery or service provision. However, these types of business are often served through centralised

distribution systems, and often make use of large rigid or articulated HGV deliveries on a scheduled basis. These factors help to limit the number of deliveries required, and hence the vehicle kilometres travelled and the associated fossil fuel use, greenhouse gas emissions and impacts on local air quality. By contrast, the review suggests that smaller, specialist stores can be responsible for considerable freight vehicle activity, albeit in smaller vans, and in terms of town planning, one should not assume that larger retailers (over 500m^2 sales area) are the generators of the greatest quantity of freight traffic. This has implications for the quantity and location of infrastructure provision for loading and unloading.

Transport for London has developed 'Delivery and Servicing Plans' (DSPs) in order to assist retailers and other companies to consider the steps they can take to reduce the freight activity associated with the deliveries and collections they receive, which may also have beneficial effects in terms of the reliability and cost of these operations (Transport for London, 2009). This can involve measures such as reducing the number of suppliers used, encouraging freight operators to consolidate goods flows destined for companies in close proximity to one another, reducing the frequency of deliveries and collections, and making greater use of off-street stopping locations where available. The inclusion of delivery and servicing activities in travel plan requirements for major new developments can also be used to help make urban freight transport operations more sustainable.

Other measures available to policymakers to help reduce the environmental impacts of urban freight transport include the encouragement of the use of electric and hybrid goods vehicles (with hybrid vehicles switching to a non-polluting power source in the vicinity of sensitive locations such as near schools, hospitals and densely populated areas), and the introduction of specified lorry routes to keep heavy goods vehicles away from more sensitive locations as they access the central urban area (such as in Berlin – Menge, 2010). This latter approach can potentially be used in conjunction with technologies such as routeing and scheduling systems and satellite navigation systems.

The findings show indicate that a single logistics provider/supplier can be responsible for the majority of delivery vehicle activity to businesses even in decentralised supply systems. The supply chain characteristics of these 'premier' providers warrant further investigation in an urban setting to determine any synergies that could be exploited in order to reduce freight vehicle activity levels (joint working, co-ordinated delivery times, consolidated take-back opportunities). In terms of peak delivery activity in the build up to Christmas, the review suggested that these 'premier' logistics providers may not generate additional vehicle visits during this period but may just increase the mean consignment size. Retailers expecting at least a doubling in the quantity of goods delivered included cards and gifts shops, clothing retailers, entertainment retailers, food, home furnishings and jewellery stores and toy shops.

In nine out of the twelve establishment surveys involving retailers undertaken since 2001, vans ('light goods vehicles') were the dominant mode, and across all the studies, were responsible for 42% of the delivery activity on average. The major use of vans reflects the difficulties of accessing often congested urban centres with larger, heavier delivery vehicles. However, the use of vans rather than larger vehicles can further exacerbate urban traffic levels. The average vehicle dwell time while deliveries are being made was 31 minutes for articulated HGVs, 19 minutes for rigid HGVs, 10 minutes for vans, and 8 minutes for cars.

Consolidation centres offer a tried and tested route for optimising and consolidating the movement of core goods into urban centres across different supply chains (Browne et al., 2005). Their long-term survival however depends on the viability of the underlying business

model, as a consolidation centre serving a high street can be a cost-adding activity, requiring local authority subsidy.

Service vehicle activity is clearly a significant contributor to urban freight movements and due to its very nature, often requires vehicles to be parked close to the premises being served. In terms of business processes that could be targeted to reduce overall freight vehicle impacts, centrally coordinating elements of service provision (e.g. for cleaning, equipment maintenance, recyclate collection), or providing improved, more flexible parking provision for service vehicles could be as or more beneficial in reducing overall urban freight impacts than focusing on core goods deliveries. Attempts to bring about 'green logistics' in a retail setting through urban freight planning should incorporate measures aimed at both the delivery and collection of goods as well as service provision that results in vehicle activity. Providing improved, more flexible parking provision for service vehicles especially in off-street locations could lead to traffic and environmental benefits. For instance 'pay-as-you-leave' car park charging systems could encourage short-stay service vehicles to park off-street. Meanwhile, dual use 'drop zones' incorporating bus stop and delivery facilities in one area could be introduced to make use of vacant periods in the public transport timetable.

Given the fact that the average business on Winchester High Street received 2.4 waste collections per week and that across a sample of 74 retailers, over 19 separate waste contractors were involved in recyclate removal alone, material 'take-back' could be another service activity that could be optimised. Back-loading is the obvious answer to this in which any spare capacity available on the core goods delivery vehicles is utilised to take back recyclate, stock and customer returns. This practice suits certain types of operations where individual suppliers in decentralised systems might use their own fleets to take back material to their manufacturing point, but more commonly in centralised systems, where logistics providers remove recyclate, stock and returns back to a distribution centre for sortation and onward movement.

Local authorities would have to be the key drivers of such 'green logistics' strategies. This is likely to involve encouraging or possibly stipulating that in certain areas, freight management (be it for core goods delivery or for service activity) is undertaken in a particular way, perhaps using certain recognised processes/contractors for the benefit of all businesses in that area. Such collaborative procurement also has the potential to lead to cost reductions for urban businesses working jointly. In that sense, the local authority would act as the management 'landlord', similar to those running large multi-retailer shopping centres. Freight 'Service Plans', similar to the DSPs developed by Transport for London (Transport for London, 2009) would be a move in this direction.

Acknowledgements

The research reported in this paper was funded by the Engineering and Physical Science Research Council as part of the University of Southampton's and University of Westminster's contribution to the Green Logistics project. Further details of the Green Logistics project can be found at: http://www.greenlogistics.org

References

Allen, J., Browne, M., Piotrowska, M. and Woodburn, A., 2010. Freight Quality Partnerships in the UK – an analysis of their work and achievements, Green Logistics project report, London: University of Westminster. Available from: http://www.greenlogistics.org/themesandoutputs/wm9/downloads/FQP%20report%20Westminster%20Uni%20June%202010.pdf [Accessed 21 May 2011]

Allen, J., Browne, M., Cherrett, T., McLeod, F., 2008. Review of UK Urban Freight Studies, Green Logistics Project, Universities of Westminster and Southampton. Available from: http://www.greenlogistics.org/SiteResources/42d40831-89de-41d0-847f-8ed946ee00e8_Review%20of%20UK%20freight%20study%20results%20_final_%20November%202008.pdf [Accessed: 5 July 2011]

Allen, J., Browne, M. and Thorne, G., 2007. Good Practice Guide on Urban Freight Transport, BESTUFS project. Available from: http://www.bestufs.net/download/BESTUFS_II/good_practice/English_BESTUFS_Guide.pdf [Accessed 21 May 2011]

Allen, J., Tanner, G., Browne, M., Anderson, S., Christodoulou, G. and Jones, P., 2003. Modelling policy measures and company initiatives for sustainable urban distribution – Final Technical Report. Project carried out as part of the EPSRC/DfT Future Integrated Transport Programme (London: University of Westminster).

Allen, J., Tanner, G., Browne, M., Jones, P., 2000. A framework for considering policies to encourage sustainable urban freight traffic and goods/service flows - Summary Report, London: University of Westminster. Available from: http://home.wmin.ac.uk/transport/projects/u-d-summ.htm [Accessed: 5 July 2011]

Menge, J., 2010. Transport, Berlin's strategy for an integrated urban freight transport system - planning approaches and lessons learned, presentation at the Annual POLIS Conference, 27 November, Dresden. Available from: http://www.polisnetwork.eu/uploads/ModuleXtender/PublicEvents/66/Berlin-s_integrated_urban_freight_transport_system-strategy_and_lessons_learned.pdf [Accessed: 24 May 2012].

Van Binsbergen, A.J. and Visser, J., 1999. Innovation Steps Towards Efficient Goods Distribution Systems for Urban Areas, TRAIL Thesis Series nr. T2001/5 (Delft: TRAIL Research School.)

Brown, M., Sweet, M., Woodburn, A., Allen, J., 2005., Urban Freight Consolidation Centres, Final Report, Transport Studies Group, University of Westminster, Available online at http://freightbestpractices.org.uk/urban-freight-consolidation-centre-report [Accessed: 5 July 2011]

Cherrett, T. and Smyth, K., 2003. Freight Vehicle Movements in Winchester: Issues affecting supplier, courier and service providers, Final Report, Southampton: University of Southampton.

Cherrett, T., McLay, G. and McDonald, M., 2002, Effects of Freight Movements in Winchester, Final Report, Southampton: University of Southampton.

Dablanc, L., 2010. Freight transport, a key element of the urban economy: Guidelines for practitioners. Paper presented at the Transportation Research Board 89th Annual Meeting, January 2010, Washington, D.C.

Dasburg, N and Schoemaker, J., 2008. Quantification of urban freight transport effects II, Deliverable D5.2, BESTUFS project. Available from: http://www.bestufs.net/download/BESTUFS_II/key_issuesII/BESTUFS_Quantification_of_Urban_Feight_Transport_Effects_II.pdf [Accessed 23 May 2011]

Department for Communities and Local Government, 2012. National Planning Policy Framework, London: Department for Communities and Local Government.

Edwards, J., McKinnon, A., Cherrett, T., McLeod, F., Song, L., 2010. The CO2 benefits of using collection / delivery points for failed home deliveries. Accepted for publication in the Transportation Research Record.

European Commission, 2007. Preparation of the Green Paper on urban transport: Background paper, January 2007, Brussels: European Commission. Available from: http://ec.europa.eu/transport/clean/green_paper_urban_transport/doc/2007_01_31_urban_transport_background_paper_en.pdf [Accessed 21 May 2011]

Frosini, P., Huntingford, J. and Ambrosino, G., 2005. Urban mobility and freight distribution service: best practices and lessons learnt in the MEROPE Interreg III B project, *European Transport \ Transporti Europei* 28, 44-56.

INRETS, 2010. Good Practices Analysis, Deliverable 3.3, SUGAR project.

McKinnon, A., 1999. Vehicle utilization and energy efficiency in the food supply chain. Full Report of the Key Performance Indicator Survey. Edinburgh: Heriot-Watt University. Available from: http://www.sml.hw.ac.uk/downloads/logisticsresearchcentre/kpi98.pdf [Accessed: 24 May 2011]

Munuzuri, J., Larraneta, J., Onieva, L. and Cortes, P., 2005. Solutions applicable by local administrations for urban logistics improvement, *Cities*, 22(1), 15–28.

Stantchev, D and Whiteing, T., 2006. Urban freight transport and logistics: An overview of the European research and policy, EXTR@Web Project, Brussels: DG Energy and Transport. Available from: http://www.transport-research.info/Upload/Documents/200608/20060831_105348_30339_Urban_freight .pdf [Accessed 24 May 2011]

Stathopoulos, A., Valeri, E., Marcucci, E (2012) Stakeholder reactions to urban freight policy innovation. Journal of Transport Geography, 22. pp34–45

Steer Davies Gleave, 2005. Freight in Colchester Town Centre: Outputs of Town Centre Business Survey, London. Available from: http://www.colchester.gov.uk/servedoc.asp?filename=Low_Res_FINAL_Business_Survey_Technical_Note.pdf [Accessed: 23 May 2011]

Transport for London, 2007. London Freight Plan, London: Transport for London. Available from:

http://www.tfl.gov.uk/microsites/freight/documents/London-Freight-Plan.pdf [Accessed 21 May 2011]

Transport for London, 2009. Managing freight effectively: Delivery and Servicing Plans, London: Transport for London. Available from: http://www.londonsfqps.co.uk/LinkClick.aspx?fileticket=pHtduQYPiSk%3D&tabid=157&mid=600 [Accessed: 21 May 2011]

Transport for London, 2012. Travel planning for new development in London - Incorporating deliveries and servicing, London: Transport for London. Available from: http://www.lscp.org.uk/newwaytoplan/resources/file/Travel%20planning%20for%20new%20development%20in%20London.pdf [Accessed 24 May 2012]

Tyler, A., 2001. Sustainable Goods Distribution: The Possibilities for Clear Zones. Unpublished MSc dissertation, London: University of Westminster.

United Nations, 2006. World Urbanization Prospects: The 2005 Revision, Department of Economic and Social Affairs: Population Division, New York: United Nations. Available from: http://www.un.org/esa/population/publications/WUP2005/2005WUPHighlights_Final_Report.pdf [Accessed 24 May 2011]