Freight Consolidation Centre Study

Main Report

Prepared for

Department for Transport

by

Transport & Travel Research Ltd

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TRL

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Common terms and assumptions used within this report

Consolidation	Consolidation, in the context of freight transport, refers to the reduction in the number of vehicles operating with only part loads. This is achieved by combining loads bound for the same or similar location for at least part of the journey.
Electricity Generation Mix	For electricity generation the emissions are based on the UK electricity generation mix of 2008-9 as published by the Dept of Energy and Climate Change. Future variation in generating mix would be expected to have an impact on CO_2 emissions, as would a decision to purchase 100% renewable electricity, which is of course possible on the open market.
Final mile	The ‘final mile’ is a freight industry term used to describe the urban leg of a journey from the point the vehicle has left the trunk road network.
Mandatory Participation	Mandatory participation, by whatever means, results in scenarios where all deliveries to the target location pass through the consolidation centre. This results in levels of throughput and FCC vehicles that have not been seen to date in relation to FCCs in the UK.
Pallet Equivalent	This report uses the phrase ‘pallet equivalent’ as a unit measure of freight space for both trucks and warehousing. The specific measurement being used is a Standard Pallet which equals 120cm x100cm in size. Retail freight is typically transferred in units such as cages, rails (clothes) and boxes. The study translates these units into pallet equivalents for ease of reference. Construction freight is considerably more varied with larger prefabricated items being delivered as well as smaller boxes, pallets and tools.
Study Boundary	Modelled values for mileage and emissions are assumed to be within the urban area in question, with the exception of CO_2 emissions which are considered in a life-cycle perspective, irrespective of location.
Vehicle Emission Standards	If diesel vehicles are operated from the freight consolidation centre it has been assumed that these are to the latest available emission standard – currently Euro V. The baseline scenarios assume a range of emissions standards as found in the overall vehicle fleet – primarily Euro III and Euro IV, with some Euro V that are working their way into the fleet and some Euro II that have not quite yet been displaced.
Vehicle Loading	The vehicle loading in the FCC model is assumed to be single stack.

1 INTRODUCTION

1.1 Context

Local Authorities, retail outlets, property developers, construction companies and the freight transport industries face a number of shared challenges. Increases in both fuel prices and land value plus a need to reduce the time lost in road congestion requires the logistics and distribution industry which has already significantly progressed efficiency measures in many areas to actively explore further methods of attaining savings.

Freight Consolidation Centres are distribution centres, situated close to a town centre, shopping centre or construction sites, at which part loads are consolidated and from which a lower number of consolidated loads are delivered to the target area.

Freight Consolidation Centres (FCCs) are increasingly promoted in local authority strategic plans and industry trade publications as a tool to help achieve improvements in local air quality and greater efficiency through optimisation of land use, faster deliveries and in the case of the construction industry reduced material and time wastage.

The FCC concept has been introduced in the UK through a small number of high profile sites over the previous decade – Heathrow, Bristol Broadmead, Sheffield Meadowhall and the London Construction Consolidation Centre. This study seeks to provide a balanced and objective view on the appropriate uses of these Centres and considerations which should be taken on board by parties wishing to implement such a scheme.

FCC's are of interest to local authorities to reduce:

- Emissions affecting air quality (PM and NOx)
- CO_2 emission
- Traffic congestion
- Conflict between road users

To wider business FCC's are of interest for the following reasons:

- Maximising retail space and store staff
- Reducing the delivery cost of 'the final mile'
- Increasing the delivery window generating opportunity for efficiencies in the distribution chain
- Meeting corporate social responsibility targets
- For construction, the need to manage site congestion

This study looks to quantify some of the financial operating costs and potential social benefits which can be gained from an FCC operation. This is needed to identify how accurate anecdotally quoted benefits are, verify the relevance of results of existing case studies and to contribute to filling the independent evidence gap that exists within the industry for these schemes.

When a delivery vehicle is caught up in congestion, its engine is not able to operate within its optimum range and valuable/costly labour time is wasted. This also results in additional emissions compared to the situation where the same vehicle operates on the same route in free-flowing traffic. The contribution to congestion by the delivery vehicles themselves can also be quantified as a social benefit as a reduction in traffic allows other transport to arrive at its destination quicker.

Local authority air quality concerns are based on modelling the contribution of emissions from traffic flow data to overall levels of local atmospheric pollution. These models generally flag the levels of particulates (PM) and oxides of nitrogen (NOx) as in excess of EC legal limits[1].

Diesel vehicles are a major contributor to both PM and NOx levels and, given that the emissions per mile of the bigger engines in heavy duty vehicles (HDVs) are significantly greater than those from diesel cars, blame is often apportioned to these HDVs. However, the traffic flow data doesn't provide information on the reason why the vehicle is travelling where it is and what it is carrying. It is this type of information that needs to be included as part of an initial feasibility study to really understand the cause of the problem. For example if it is unnecessary through traffic or rat running then an FCC may not be part of the answer.

HGVs and vans combined contribute 35% of the UK transport sector's domestic Greenhouse Gas (GHG) emissions. HGVs are estimated to produce 4-5% of the UK's total emissions[2]. A reduction in vehicle mileage of non consolidated deliveries would bring carbon saving benefits. These savings can be improved through the use of different low carbon vehicle types within the FCC delivery fleet.

The focus of the study is on the use of FCCs within the retail and construction sectors which is where existing industry experience and operational data lies. The concept could however also be applied to other sectors such as non-retail commercial premises (e.g. business parks) and light industry (industrial estates).

1.2 What are Freight Consolidation Centres?

Freight consolidation is a term that is commonly used to describe a number of different types of activity in the distribution chain. In this study, the term "freight consolidation" is defined as:

> *"Freight consolidation involves grouping individual consignments or part-loads that are destined for the same locality at a consolidation centre so that a smaller number of full loads are transported to their destination."*

[1] Council Directive on ambient air quality and cleaner air for Europe (2008/50/EC)
[2] National Atmospheric Emissions Inventory 2008

By using exactly this principle, individual companies, for example larger retail groups and parcel or pallet networks, have, for many years, been successful in reducing distribution costs by consolidating consignments through regional or national distribution centres. Such distribution centres or hubs accept goods from suppliers and split the inbound consignments to form full loads that are moved from the distribution centre to the various destinations it serves. However, this consolidation has tended to focus primarily on minimising the long distance 'trunking' mileage within an individual supply chain. Depending on the volume of goods destined for any one location, the content of a single full load that leaves the distribution centre may still be destined for a range of locations in neighbouring towns.

Recent industry developments have seen some suppliers with a shared customer base working together to combine their capacity with each other within their supply networks. Such relationships are typically brokered by the same distribution company with savings generated being shared amongst all the parties.

In parallel with the vertically integrated, consolidated supply chains that exist for some businesses (e.g. supermarkets, department stores), there are many other distribution journeys, made directly from the supplier or manufacturer to the receiver or by using commercial courier and parcel services. The result is that there are many different freight vehicles and operating regimes, as indicated in
Figure 1.

The general concept of freight consolidation can be taken one step further by adding an additional stage into the supply chain between the various existing dispatch points (which could be either a retailer's distribution centre or a supplier's factory or warehouse) and a specific group of end recipients such as a town centre, shopping centre or airport. A formal definition might be:

> *"A distribution centre, situated close to a town centre or other retail centre, at which part loads are consolidated and from which a lower number of consolidated loads are delivered to the target area."*

A range of other value added logistics and retail services can also be provided.

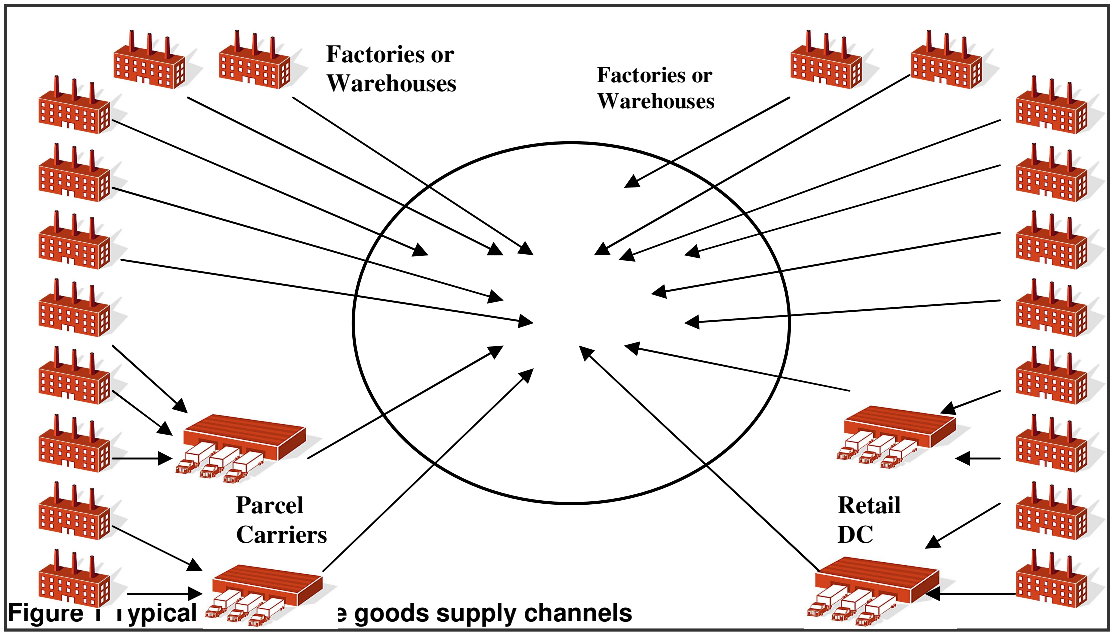

Figure 1 Typical [illegible] goods supply channels

As goods from the distribution centre are delivered and consolidated into full vehicle deliveries for onward delivery into the urban area, the result is fewer vehicle trips within the urban area, as shown in

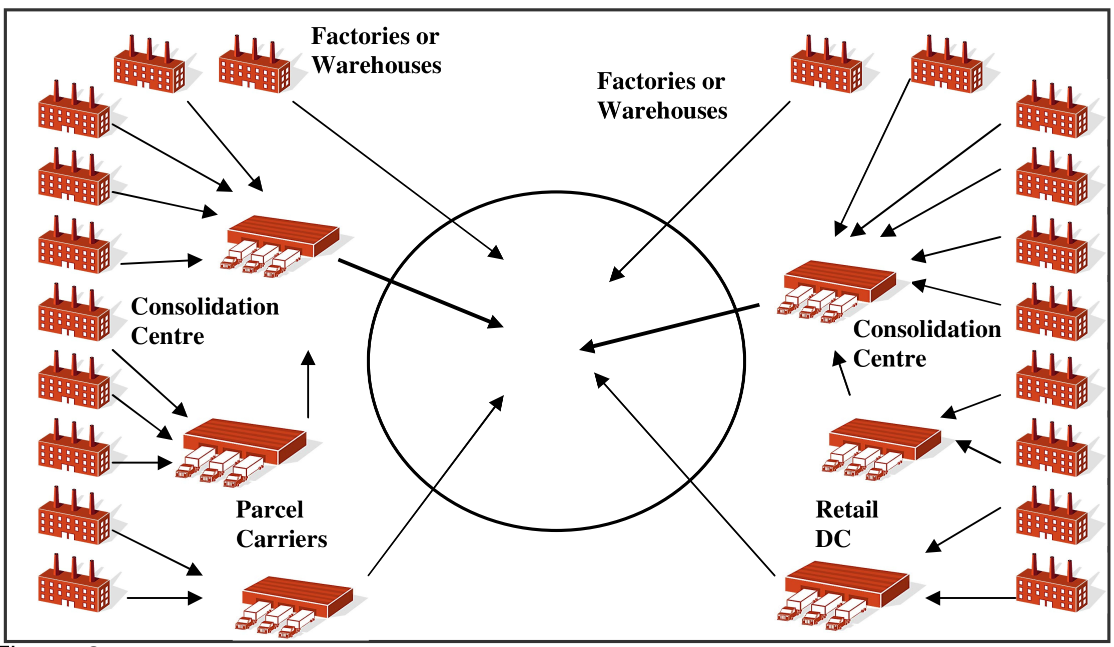

Figure 2.

Figure 2 Consolidated Delivery Approach to Supply Channels

The previous example is primarily focused on retail / general deliveries to an urban area, but the principle can be applied broadly or to a specific sector, with the current focus being particularly for retail or construction.

The term freight consolidation is sometimes misused, to refer to distribution centres where all goods destined for a particular location or area are intercepted and transferred to another vehicle for transport to their final destination, irrespective of whether they are already fully loaded for that particular location/area. From a theoretical perspective, terms such as “Urban Distribution Centre” or “Freight Transhipment Centre” are more appropriate for this type of facility, because the purpose is not only consolidating part loads with a view to reducing the number of vehicle trips required, but also controlling the type and / or number of freight vehicles used for urban deliveries.

Between the pure definition of FCCs and the UDC approach there is also a common interpretation of Freight Consolidation Centres which effectively focuses less on combining loads and reducing vehicles to site and more on smoothing out flows of freight to the final destination. The objective is to reduce the need for stock holding on site, be it retail or construction, and reducing the number of vehicles arriving at the same time for deliveries. For this type of operation the resulting reduction in total number of vehicle movements is not necessarily the primary driver, although it is a welcome outcome and the associated increase in vehicle utilisation often helps contribute to the business case of such facilities. Given this is an interpretation in widespread use, this type of facility has been included in the scope of this study.

The construction industry is often viewed as being less developed in the use of modern logistics techniques than other sectors such as retail and the automotive industry. For example, a project manager on a typical construction project may not have sight of where building materials are in the supply chain at any given time. Given this starting point a range of opportunities exist to provide improvements across the construction supply chain, of which consolidation is one of a number of complementary approaches which can be taken.

One approach by logistics purists, analogous to that taken in the retail sector, might be to take a view along the full supply chain and look to instigate a form of upstream consolidation with different suppliers to the same site, so forming an integrated supply chain. However, because construction sites have a finite life, this may not prove economic on a one off basis. In such circumstances consolidation centres and other logistics techniques such as web-based vehicle booking systems or better control of onsite storage and ordering, can offer significant potential benefits as a package of measures. Recent high profile examples have used freight consolidation, particularly in the construction fit-out stage, but there is evidence that such an approach could also be useful for certain other deliveries at earlier stages of construction projects.

There are two main drivers for construction consolidation. Developers and their contractors are primarily interested in improving efficiency within the site itself, as this is where substantial time and construction progress can be lost. For local authorities the reduction of traffic congestion, the associated emissions and the wider social benefits remain key which depends on a consideration of the wider supply chain.

1.2.1 Suitable Locations

Freight consolidation centres are not suitable for every town and city, they are typically better suited to specific environments. These are typically busy historic city centres where access can be difficult (e.g. medieval road layouts) causing congestion, air quality issues, conflict in shared road space and difficulty in provision of adequate loading space. This study does not, in itself, look at the optimum location within the network for a FCC to be located as this is specific to each case. The study is instead focussed on the types of operation best suited to an FCC.

Consolidation Centres need to have a large enough number of outlets being served to ensure a level of throughput which is economically viable. Therefore some locations which would not necessarily fit into this 'historic centre' category become suitable when viewed as an implementation covering multiple towns\cities which are in fairly close proximity to each other. This then provides the greater levels of throughput and efficiency needed. Examples of clusters of towns that fall into this category could be Bristol\Bath, Derby\Nottingham\Leicester, Perth\Dundee and Cardiff\Newport. The combined potential throughput and the potential to cover several of the deliveries in an existing supply chain could make the centre more viable commercially. Note that the scenarios modelled within this study do not include this regional multi-area approach.

1.3 Outline of objectives

This study was commissioned as a piece of pure research. The operation and evaluation of freight consolidation centres in the UK to date has been largely conducted on a basis that has been partially restricted by a number of factors including:

- The commercially confidential nature of the small number of operations
- The experimental nature of some of the original implementations, which made participants reluctant to make them available for transferability studies
- The rather specific nature of some of the schemes
- The complex nature of the interactions in any single supply chain, let alone the main supply chains that operate in a broader urban logistics environment.

Nonetheless, the results that have been produced and publicised by the small number of existing FCCs in the UK have suggested that there is potential for significant overall benefits to retailer and construction distribution networks based on the impact on the supply chains of those businesses that have participated and the likely extent of associated environmental and societal impacts on the wider community.

In discussions with industry to identify potential solutions to address the future challenges to the Logistics industry, urban freight consolidation centres have been identified as a potential means of improving collaboration across the logistics sector, reducing urban congestion and reducing other negative impacts of freight activity. If such benefits can be realised, they could provide an opportunity for local authorities to help consider how to support the local, regional and national economy whilst minimising the environmental impacts of freight

Given the significant potential but relatively limited evidence base, even allowing for previous academic reviews, this study aims to make progress towards a broader picture of how the potential benefits might be realised, with a view developing a detailed understanding of how, when and why they can be used successfully, leading to the following objective:

In order to achieve this, the study has modelled a selection of Freight Consolidation Centre (FCC) scenarios to produce cost benefit analyses and improve the understanding of how, when and why FCC's can be used successfully. The purpose of the scenarios used has been to investigate the way in which FCCs can contribute according to the market conditions that apply in each circumstance and the impact that this has on the overall balance of operating costs and benefits (particularly how costs are incurred, who incurs the costs, what drivers determine costs and how the distribution of costs and benefits is determined) in each case.

The modelling exercise has been based around three main base scenarios which are the most common uses of FCCs:

1. An in-town shopping centre complex FCC offering a service to all the shops in a single shopping centre facility (which could be a model also applicable to an FCC serving an airport or other identifiable, aggregated shopping area).
2. A retail high street or town centre FCC servicing all the commercial facilities in an area of a town or city.
3. A construction FCC servicing a single large construction project.

For each of the three base scenarios, combinations of other operational and participation states were required to be considered, leading to the following scenarios:

- Baseline – direct deliveries
- Deliveries via FCC, compulsory participation, dedicated facility
- Deliveries via FCC, voluntary participation, dedicated facility
- Deliveries via FCC, voluntary participation, shared-use facility
- Deliveries via FCC, compulsory participation, shared-use facility

For each of these scenarios the model has had to cater for the appropriate input, working and output variables needed to define the scenario and present the variables needed to meet the study objectives.

1.3.1 Inputs

The inputs needed to be able to provide for:

- the definition of the urban target area and operating scenario
- urban policy interventions such as charging, access restriction or low emission zones
- definition of supply chain variables and distribution of cost allocations between supply chain elements

- the nature of the commercial agreement between FCC initiator and operator in terms of financial incentives
- the potential of added value services
- environmental and social externality values that could be varied to match DfT or other such modelling scenarios, to ensure compatibility

1.3.2 Calculation Modules

The information used in the model calculations, for both direct deliveries and the FCC scenarios, was based on real operating cost information wherever possible.

Costs for warehouse space and staff are based on national averages. Regional variances are significant though which should be borne in mind. As an example, the 'FTA Manager's Guide to Distribution Costs' (2009) suggests a range of annual cost of warehouse space covering £4.75 to £13.25 per square foot. To avoid creating a large number of alternative scenarios testing the sensitivity of each input a breakdown of the ratio of different costs has been included for some of the scenarios produced. This can be used to identify the impact of cheaper or more expensive property rates on the overall costs.

1.3.3 Outputs

A broad range of outputs was required for each scenario, covering:

- Total FCC operational costs (exclusive of FCC operator profit margin)
- Throughput
- Financial contribution of added value services to the FCC operational cost model
- Rate to retailer charged per delivery
- Distribution of cost across all interested parties (fully disaggregated)
- Residual cost to FCC initiator
- Change in delivery vehicle mileage and duration (fully disaggregated to allow capture and allocation of direct costs and allocation within the supply chain)
- Impact on number and type of delivery vehicles in the urban area
- Quantified impact on local pollutant and CO_2 emissions
- Monetary valuation of external societal benefits and allocation to beneficiary where possible
- Assessment of impact on operations in terms of operational structures, organisation, convenience and control
- Break even calculations

This report documents the analysis undertaken and provides advice on how, where and why each FCC can be used successfully, including a set of identified minimum requirements or scenarios for each FCC to be a viable option.

The study flags up where changes at a local level could help to make a Consolidation Centre successful. E.g. Access restriction options (restricted delivery hours, possibly based on vehicle type, pedestrianised areas, quiet deliveries for consolidation centre vehicles, congestion charging, and possibly low emission zones). It also identifies what the retail and logistics industries would need to know in order to initiate discussions with other interested parties to consider setting up an FCC.

It should be noted that this study does not include exploring the use of networked consolidation centres (e.g. of the type needed to serve the whole of Greater London in a co-ordinated manner) or centres serving more than one area (e.g. two city centres).

1.4 Summary of UK Freight Consolidation Centres to date

1.4.1 Retail / General Deliveries

Leaving the numerous national and regional distribution centres (including pallet and parcel networks parcel hubs) aside, at present there appear to be eight operational retail freight consolidation centres in the UK, though this is not intended to be a comprehensive list. Three of these serve airports: Manchester Airport is served by a consolidation centre which is located in Bury, East Midlands Airport is served by a consolidation centre at a local warehousing facility, and Heathrow Airport in London is served by a consolidation centre in Stockley Park. The other five are located in Brimsdown in Enfield (serving Regent Street), Bristol (serving Broadmead / Cabot Circus Shopping Centre and in the near future Bath city centre), Greenhithe (serving Bluewater Shopping Centre in Kent), Sheffield (serving Meadowhall Shopping Centre) and Snetterton in Norfolk (serving Norwich City centre). All of these are located within 30km (19 miles) of their respective target servicing areas, and all have opened since 2000.

In spite of differences in terms of the area served, they are all operationally similar from a logistics point of view (e.g. proximity to trunk road network, dedicated or shared use facility etc), with differences merely in the proximity of the consolidation centre relative to the target area that it serves and the extent of added value services that are offered. One significant difference that sets the consolidation centre at Heathrow apart from other centres is that the airport's owner, BAA, has been able to drive the process and to specify use of the consolidation centre as mandatory as a condition of retailers' leases as they have come up for renewal.

In addition to these established UK consolidation centres, several other freight consolidation studies and, research initiatives and plans for implementations have been pursued since 2007, including Newcastle, Southampton, Westminster, Birmingham, Covent Garden, White City Shopping Centre, the Olympic Park, Strathclyde, Perth & Dundee, Edinburgh and Aberdeen. The extent of this list shows the ongoing interest across the UK in the concept and the potential it may offer to impact on the urban environment.

1.4.2 Construction

The London Construction Consolidation Centre (LCCC), modelled on the BAA centre at Heathrow, is widely accepted as one of the best demonstrations of how lessons learned from other industries can improve the performance of the construction industry. The main purpose of the LCCC was to promote the efficient flow of construction materials through the supply chain to the actual point of use on projects. The Centre aimed to enhance construction sites' performance and reduce the impact on environmental issues, such as congestion, pollution and noise.

Construction goods, excluding steel frames, aggregates and major plant, were delivered to the LCCC in relative bulk. From there, materials were called off by the various trade contractors and formed into work packs for their immediate use on site, following a just-in-time approach. Goods were checked on arrival at the Centre for quality and condition, ensuring any problems were highlighted at an early stage. The Centre did not store goods in the conventional sense, with an aim of a turnaround time of 7-10 days and deliveries to site were made using LPG fuelled goods vehicles.

With its mission to deliver materials to site in the safest and most efficient manner and an active partnership with the Trade Contractors and Project Managers, the LCCC significantly benefited the various projects it serviced and greatly contributed to the achievement of the programme certainty demanded by the clients.[3]

Equally importantly, Materials Consolidation has a positive impact on good neighbour relations with the greatly reduced flow of vehicle movements and associated emissions in any given location and time. Partners during the set up and trial period of the LCCC included Wilson James, Bovis Lendlease, Stanhope, Transport for London, Metropolitan Police, Skanska and Structuretone.

Construction consolidation has also been used successfully as part of the construction of Heathrow Terminal 5 and is being implemented in the construction of the Olympic Park and Crossrail projects by DHL.

At least two privately-operated commercial construction consolidation facilities (Wilson James and CSB Logistics), using different operating models, are now operational in London, where the density of development is sufficient to allow such commercial operation, even at a low proportion of take-up from the full potential market. Outside of London, Wincanton operate a number of construction consolidation facilities on a fully commercial basis.

1.4.3 Transferability to other sectors

The detailed evaluations of the Heathrow and Bristol retail consolidation centre implementations revealed delivery vehicle mileage reductions of 50-75%, depending on the stage of development of the scheme, time of year etc.

Similarly the LCCC resulted in 15% reduction of materials waste, leading to recovery of re-usable materials on one partner project of approximate value £200,000, increased productivity of the site labour force of up to 30 minutes per day, 68% reduction of the number of construction vehicles delivering to the sites being served by the LCCC and 75% reduction of CO_2 emissions.

[3] 'London Construction Consolidation Centre – Interim Report', Transport for London, May 2007

Despite these headline results, uncertainty remains among those who would be responsible for the initiation of, or be required to change logistics arrangements by, further freight consolidation centres about the true scale of the benefits and the costs, how the benefits would be distributed amongst interested parties and whether the cost of implementing the centre can be recouped.

An example of the uncertainty over the real degree of delivery mileage savings can be seen from a study conducted by Efficient Consumer Response UK (ECR-UK)[4]. This study investigated the potential impact of consolidating the actual urban distribution operations of three well known retail groups, Boots the Chemist, Sainsbury's and Musgraves-Budgens-Londis, using the (then) existing Boots distribution centre in Greenwich as the prospective consolidation centre. The scenario that was modelled covered their operations in central London because this was judged to be the most problematic area to conduct delivery operations due to congestion and a range of delivery restrictions. The result of this exercise was a reduction in trips of just 2% and in delivery mileage of 2.5%.

Although very different results to that were obtained from the consolidation operations in Bristol and at Heathrow, this should not be particularly surprising because the nature of Boots / Sainsbury's / Musgraves-Budgens-Londis distribution operations is quite different to the majority of the small consignments passing through the Bristol and Heathrow centres. (The three supply chains involved in this exercise are all well managed and if not already fully consolidated for individual stores will have a drop density which is relatively tightly defined, due to the strong presence of these retailers throughout the study area, hence providing little opportunity for significant reduction in delivery vehicle mileage.)

From this it would appear that the potential for delivery vehicle mileage reduction depends heavily upon the nature of the delivery traffic passing through the consolidation centre, and reinforces the difference in impact between an FCC that focuses on consolidating part loads and an urban distribution centre that aims to control all deliveries.

The origins of uncertainty over the way in which cost savings would be realised within the supply chain come from a range of sources such as:

- the way in which logistics services are contracted (either directly or indirectly as part of a broader contract)
- the way that costs are allocated to separate accounting cost centres within the same business, for example to a store or the delivery operation
- the fact that the organisation responsible for setting up, and hence paying for, the FCC would not necessarily be responsible for organising the logistics, and hence would not receive a direct financial benefit

[4] 'ECR UK Collaborative Green Distribution', Institute of Grocery Distribution, February 2007

- potential resistance from supply chain members to paying to use FCCs if they are set up purely for environmental reasons, as this is seen as a wider societal benefit that can be a burden on private sector interested parties.

1.5 Wider context of industry's freight strategy

1.5.1 Overview of the Broader Toolkit of Possible Measures

'Freight strategy' is an industry term used to describe the approach to managing efficient, safe and sustainable freight transport. This strategic approach comprises of an understanding of what currently happens in an area and then defining what should happen through the setting of targets and objectives. The following tools are relevant as alternative or complementary measures to the introduction of Freight Consolidation Centres to help meet those targets and objectives. A more detailed explanation of the tools available within the construction industry appears in section 5.4 below.

1.5.1.1 Delivery and Servicing Plans (DSPs)

Delivery and Servicing Plans (DSPs) are designed specifically for a single or small number of buildings to reduce the number of overall deliveries, improve reliability and minimise impact on the surrounding environment. DSPs typically benefit companies through cost savings from reduced delivery charges and reduced disruption.

DSPs are relevant because businesses without their own integrated supply chain can often have little knowledge about where the goods come from or how they get to them. Even when such a supply chain does exist it is often managed in isolation, without considering the wider opportunities of sharing other resources.

1.5.1.2 Construction Logistics Plans (CLPs)

Construction Logistics Plans (CLPs) are effectively DSPs for the duration of a construction project and are typically developed a part of a transport assessment. The benefits are similar though added savings through reduced risk of theft and improved security are also important.

The situation regarding CLPs for major developments is equally if not more important. A recent development has been the idea of collaborative CLPs where several construction sites exist in a similar location. CLPs would typically consider a range of options which may include:

- Just in time delivery
- Reverse logistics
- Demand smoothing
- Web based delivery booking and tracking systems
- Consolidation through onsite marketplace
- Offsite fabrication
- Better control of materials ordering
- Modal shift within the wider supply chain

In these circumstances a shared consolidation centre approach is more likely to be cost effective as part of a well-managed overall logistics solution and lead to better efficiencies than a number of separate approaches, even if, individually, they are each well managed. CLPs themselves have helped considerably in reducing a proliferation of unmanaged approaches to construction deliveries which had previously been accepted as the industry norm, but potentially at significant cost.

1.5.1.3 Out of Hours Deliveries

Out-of-hours deliveries to retail premises, comprising quiet deliveries at night-time and also during the 'shoulders' of the day (i.e. prior to opening, after closing), away from peak periods, potentially offer significant benefits to retailers and transport operators.

The operational and commercial benefits to be derived from deliveries undertaken outside of peak periods can include:

- Reduced round trip journey times
- Reduced vehicle turnaround times at stores
- Reduced fuel consumption from less time spent stationary, idling in congestion
- Improved shift productivity from drivers and vehicles
- Increased product availability within store
- Less conflict between deliveries and customers on the shop floor

Moving delivery activity out of peak periods removes HGVs from congested locations and can also contribute to wider environmental and social benefits, including reduced vehicle emissions and improvements in both local air quality and local road safety. Doing so, in turn, lessens daytime disturbance and allows quiet deliveries to become the norm.

From a logistics and retailing perspective, out-of-hours deliveries make sound operational sense. However, out-of-hours deliveries may also have an impact on local residents and local communities. Noise from vehicle manoeuvring and loading/unloading activity can impact on local residents, particularly at times of day when ambient noise levels are low. HGV movements in urban areas are therefore often constrained during night-time and/or weekend periods by local curfew regulations put in place to avoid noise impacts. These include delivery curfew restrictions imposed by planning conditions, noise abatement notices or local agreements between retailers and the local authority/local residents.

1.5.1.4 Supplier collaboration

For suppliers who currently carry some spare capacity within their distribution chains it is possible to collaborate with other suppliers with the same or similar customer base and carry out consolidation of loads. An example of this is the consolidation of deliveries for Kelloggs and Kimberley-Clark to the same small retail customers from

2006 onwards, which resulted in a reported 7% saving of transport costs[5]. This process of collaboration was made easier because the two companies are not direct competitors and already shared the same logistics provider as well as compatible products for transport.

1.5.1.5 Micro-consolidation

Micro-consolidation is a recently introduced concept to reduce delivery vehicles in the urban environment which would have been making small deliveries only. Instead they deliver to a more accessible local delivery centre and the final leg of the journey is completed by electric vehicle, scooter, bicycle or foot.

2 METHODOLOGY

2.1 Aim

The aim of the methodology used in this study was to bring in as much real world data as possible to create a realistic model for the scenarios being examined. There have been a number of previous studies of consolidation centres. Studies of Bristol and Heathrow founds that there was a significant reduction in the number of vehicle movements in the affected area and a benefit to the participating retailers in freeing up customer facing staff from delivery activity; a study by ECR-UK in contrast found that little could be gained by consolidating the urban delivery chains of three specific retailers who already operated heavily consolidated loads. A University of Westminster report acknowledged that consistent evaluation of existing and new schemes was required and recommended a further investigation into the total supply chain costs and benefits associated with the use of FCCs.

This study seeks to attempt to demonstrate the impact off a range of scenarios by working with industry and local authorities to assess the real operating costs and benefits. The result is to contribute some new ideas, approaches and decisions which need to be considered by an organisation interested in implementing a consolidation centre.

2.1.1 Alternative Approach of Study

Previous Consolidation Centre study results have been viewed in some quarters as being presented in a rather narrow manner. For example, the results quoted for both Bristol and Heathrow centres have quoted high reductions in numbers of vehicles, based solely on the impact on the supply chains of those retailers that have participated. For Heathrow this is now all retailers, and, given the size of stores at the airport is such that not many would require full vehicle loads for each outlet, it is a reasonable measure. However, for Bristol, the 60 or so retailers who participate form a small proportion of the total in the city and so the large reductions in mileage and emissions for the participants (i.e. the retailers who chose to participate and who would be expected to be those who have something to gain) would be diluted if the

[5] Article 'Transport Collaboration', Nick Hughes, publication 'The Grocer', 14th February 2009

deliveries to the whole city centre were included in the evaluation. In contrast to those examples, the ECR-UK study focused solely on trying to bring together three already fully consolidated supply chains, so excluding any supply chains that would potentially benefit.

The University of Westminster report[6] for DfT correctly acknowledged the discrepancies between these studies and estimated a range of overall emissions / mileage reductions somewhere in the middle. However they were not able to find evidence from the projects reviewed to back this up. Therefore this study seeks to be the first to attempt to demonstrate the true impact of a range of scenarios.

In compiling the scenarios used within this study, we have sought to include the full range of situations that can be modelled, to notionally include and exclude situations that may not necessarily be considered in practice, but which can be instructive to understand different effects: for example, including supermarkets, department stores or courier deliveries within the FCC envelope in order to assess the impact.

A key element of this particular study is to compare the differences between voluntary and compulsory use of consolidation centres by retailers and offices. Drawing on lessons learnt on actual participation levels from existing centres and the profile of participating stores will allow realistic expectations to be set on throughput, centre size, costs and revenue.

2.1.2 Increased complexity of the real world

As discussed earlier in the document, it is important that the model is seen for what it is – a detailed spreadsheet model of different but specific operational scenarios. Lessons can be drawn from these scenarios that also reflect on wider examples but the real world remains more complex. At the time of writing, Newcastle City Council is investigating a consolidation centre which would serve not just one but two shopping centres plus the main high street area. Bristol City Council is seeking to expand their FCC to also include Bath City Centre as well as the existing Broadmead and Cabot's Circus shopping centres within Bristol.

To serve London, or even Central London, a collaborative approach to freight consolidation would be needed, with a strategic approach and a common system architecture for a network of freight consolidation centres.

2.2 Data Model

2.2.1 Empirical Model

The project approach is based around the development of an empirical model pulling together a range of interrelationships that will provide the outputs required from the study in a form that is useful for 'industry, local authorities and other interested parties. This approach is based on detailed knowledge of the operational data that is

6 'Urban Freight Consolidation Centres', University of Westminster for DfT, 2005

already available and our understanding of the interactions within that data that could be used to deliver the required outputs.

The model was constructed using a series of linked spreadsheets, where key variables are either inputted or calculated and then passed between the spreadsheets to mimic the many interrelationships within the urban supply chain.

Each spreadsheet covers a module with a number of common variables that define the form of, for example, the supply chain, supplier mix, retail mix, urban operating environment and local policy context etc.

Subsidiary variables were required to investigate variation within each scenario, for example the retailer mix, degree of local congestion etc.

Commercial agreements form the core of FCC operations and each FCC provider operates its own specific type of agreements. The model we have developed for this study provides a standard commercial model rather than a reflection of any particular provider's scheme. These commercial agreement factors combined with an LA's tender requirements would influence the practicalities of each operation, the throughput levels and component costs. The resultant model appears to be representative of actual and expected costs based on feedback from our consultations e.g. warehouse operating costs, operational costs per pallet etc.

2.2.2 Cost Benefit Analysis (CBA)

2.2.2.1 Relevance of Cost Benefit Analysis

Freight consolidation centres generate private costs and benefits which private businesses are in the best position to analyse and understand (though there may be some role for sharing knowledge of successes). In addition potentially there are also societal benefits as well as costs; these are the impacts of consolidation centres upon society as a whole and not just the users of the facility, such as reduced road congestion, reductions in CO_2 production, noise levels and particulate emissions. Cost-benefit analysis can identify these and show how they compare to the private costs/benefits. As a result we can investigate whether the current situation may or may not be in society's best interest when taking all the costs and benefits into account.

Benefits and costs are generally expressed in monetary terms, and are adjusted for the time value of money, so that all flows of benefits and costs over time (which tend to occur at different points in time) are expressed on a common basis in terms of their "Net Present Value" (NPV). The aim is to gauge the efficiency of the intervention relative to the baseline scenario – in this case direct deliveries. The guiding principle is to identify all costs and benefits generated by an intervention and place a monetary value on them where possible.

Freight Consolidation Centres (FCCs) have the potential to bring benefits to both users and society as a whole. However there are also costs; on whom these impact and how they are addressed will determine the viability of FCC facilities.

It may have been the concerns expressed by distribution companies about the potential problems that have impeded the expansion of FCCs around the country. For example, companies are anxious that if they relinquish control over the total supply chain their operating costs could be higher – perhaps too high to outweigh the potential benefits. Adding an extra link into the supply chain may, potentially, generate risks for distribution companies since it will alter the economics of distribution significantly. The average road freight journey is about 54 miles (87km) and only 4% of road freight travels more than 187 miles (300km), when rail freight becomes a more competitive position than for shorter journeys. Additional transhipment costs from using a FCC could undermine the potential benefits. Furthermore, while improvements have been made in increasing the load factors of road freight, the average is still only a little over 50%; mainly due to the difficulty of securing return trip (backhaul) loads. FCCs must be able to provide the scale of operations that will bring benefits to the main parties: suppliers; transport operators; and customers. Essentially an FCC offers a type of co-location of supply with demand; but is it more efficient for operators than a traditional operation?

Local authorities can have a significant role to play in determining whether FCCs are required or favoured though local policy incentives. Their interest in this would be if the implementation would deliver impacts that help them meet local target indicators, many of which are linked to broader societal benefits such as reduced goods vehicle traffic, noise, visual intrusion, local air pollution and emissions contributing to climate change. These societal benefits may be difficult to identify and measure, but may actually be the main justification for encouraging FCC use. Much will depend upon the relative location of FCC facilities to markets; the distance from the supplier to the FCC and the distance from the FCC to the final destination will impact on vehicle operating costs, for example. The scope of the operations may generate economies of scale that might lead to cost reductions. Some costs and benefits may merely transfer expense between different interested parties, with no net benefit to society. Some costs and benefits, particularly to society as a whole, may be direct while others will be indirect. Others may accumulate over time.

Although benefits are being monetised within this study, there are transfer costs and gains to parties within the existing supply chains which need to be considered. For example:

- FCC retailer charges are typically charged to a local store; however the financial benefits of taking trunk network freight vehicles out of the urban area are pocketed by the logistics dept (or contractor) which will probably be a centralised business cost.
- In construction the FCC operational costs may be charged to a developer as an additional cost to the contractors overall build price. However the financial benefits of the FCC would primarily be received by the main contractor and subcontractors.

Similarly there are transfer benefits of the social costs:

- The private sector generally sees any environmental benefit as a benefit to the local authority, but can the latter actually capture the notional monetised social benefits? Some local authorities have expressed an interest in trying out FCCs in the hope that the air quality impact will be big enough that they won't have to pay fines to the EU because they will come in below threshold. However, avoiding fines would be a financial benefit to the local authority whereas savings from health benefits would be a benefit accrued by the public. There is also a reasonable amount of dispute on whether or not air quality fines can be avoided simply through the introduction of FCCs and probably require a much broader air quality strategy.

This study goes some way in identifying these transferable benefits but does not propose solutions as to how to transfer them more appropriately. Ultimately it is the willingness of the individual parties involved to come to an arrangement to transfer the benefits to those who are taking on the costs. This willingness will vary as every supply chain is different, as are personal preferences and the importance individual organisation place on direct control. To help identify where there may be greater levels of willingness this study identifies a clear distinction in costs and benefits between those retailers who already operate highly consolidated loads and those who do not.

2.2.2.2 Private Cost Benefit Analysis Methodology

Due to commercial confidentiality this study has not been able to gain sufficient quantifiable data on the private cost benefits of operating an FCC or participating in one as a retailer or construction company. Similarly it is not possible to publish specific numbers for the business case a typical retailer may have in comparing its current supply chain to the benefits and costs of using an FCC. Therefore whilst this study includes a detailed social benefit value analysis the private costs have been included only as far as operational costs for the FCC itself (including a comparison of relative costs in alternate scenarios) and the potential rates which retailers may be willing to pay based on the operational costs and professional judgement.

2.2.2.3 Social Cost Benefit Analysis Methodology

The TTR model has generated various data that has been applied in the social cost benefit analysis, notably: total mileage under different scenarios; emissions (NOx, PMs - particulate matter, CO_2) all on a per week basis.

A spreadsheet model has been developed to incorporate all the potential impacts with their valuations over different time periods. The model comprises twelve interlinked worksheets so that changes in one aspect will automatically update the results elsewhere, as appropriate. The spreadsheet model has been used to generate illustrative net present values for the social benefits, currently estimated over a 5 year period during which time the main benefits will have been delivered. As a result, it is relatively easy to change any variables and interrogate the model to generate new values.

For most of the FCC scenarios there is little variation in the data; the main differences emerge from the use of different vehicle types. Indeed the TTR model does not differentiate between mileage from a shared centre and that from a dedicated centre; the types of social impacts for all scenarios are also the same (accident reduction, reduced emissions of NOx, PMs, CO_2, noise and congestion reduction). Only for a construction FCC is there a difference – the inclusion of savings due to not sending as much waste material to land-fill and thereby reducing the charges incurred by the local authority for failing to meet targets. Furthermore the data for construction applies to the duration of the build and is not calculated over a five year period; thus the data has not been discounted to current values.

2.2.2.4 Assumptions

The expectation is that consolidation centres reduce traffic congestion, carbon production, noise levels and polluting air emissions. This section looks at the approach being taken to estimate how significant they actually are.

In undertaking this study it has been essential to make various assumptions about the impacts of FCC on a range of indicators. Throughout the analysis we have erred on the side of caution, generally underestimating the potential social benefits to local communities. Clearly the valuation of the benefits will change over time, as a result of policy measures, for example the charges levied for sending waste from construction sites to land-fill will rise in response to policy decisions, in this case from the European Commission. Other values will change over time as a result of market measures, for example estimates of the impact of noise as residents change their expectations. The basis of this study is the current costs and benefits, discounted over a 5 year period, including allowance for the increasing values of congestion, air pollution, noise etc.

For the analysis a range of different sources of information have been applied:

- **Road Traffic Accidents**
  Data on the costs of road traffic accidents from the DfT's WebTAG, in this case unit 3.4 (http://www.dft.gov.uk/webtag/documents/expert/unit3.4.php) has been applied. Although these figures are revised from time to time, for this analysis it has been assumed that the values will not change over the five year period of analysis. DfT data on the accident rates for HGVs has been used to calculate the average number of accidents saved a year as a result of reduced mileage. Calculations of the impact of the reduction in mileage resulting from the adoption of a FCC have been applied to estimate the reduction in road traffic accidents involving lorries and hence their social value. Rather than calculating the reduction in specific types of accidents with individual values for each category (e.g. fatal, seriously injured, slight), the average accident value of prevention of road accidents by severity (£ per type of accident) has been used; currently £75,610.

  Reduced lorry traffic might, in some locations, enable other vehicles to travel at higher speeds. This could cause additional accidents, and hence social costs. The model does not calculate this impact but it is likely that the accident benefits from reduced lorry mileage would outweigh these additional costs to society.

Savings from a reduction in injuries to HGV vehicle occupants involved in a road traffic accident have not been specifically included in the spreadsheet; these injuries are included in the overall accident total.

- **CO_2 (Carbon Dioxide)**
The social cost of carbon measures the full global cost today of an incremental unit of carbon dioxide (or equivalent amount of other greenhouse gases) emitted now, summing the full global cost of the damage it imposes over the whole of its time in the atmosphere.

The data used in our analysis derives from the draft WebTAG unit on Greenhouse Gases[7]. As these carbon values are in 2002 prices we have used a GDP deflator to recalculate them in 2009 prices. This inflates the carbon values further from £160-£170ptonne to the £190-£200 range.

- **Emissions NOx**
A similar approach to that for CO_2 emissions has been taken for both NOx and PMs.

Air pollution is associated with a wide range of damaging effects, including impacts on human health, personal satisfaction, economic performance and natural ecosystems. Each of these areas is clearly important in considering the total cost of air pollution and consequently need to be reflected in decisions that alter the quality of the air.

DEFRA data[8] on the social costs of air pollution in £ per tonne of pollutant have been applied using the same basis as for CO_2 emissions, increasing over time. Annual values have been applied, based on the outputs from the TTR model.

- **Emissions PM**
The impact of savings in emissions of PMs - particulate matter, has been calculated using a similar basis to that for CO_2 and NOx with the DEFRA values for Urban Big being used. This provides a sensible general value for the types of town and city who would typically use FCCs. However smaller urban centres such as York and Bath would suit a lower value and London sites would require a value of almost three times the Urban Big valuation. These alternative values are available in the DEFRA published tables.

- **Congestion**
The DfT provided data on the externality values of articulated HGVs. This has included data (in pence per mile at 2010 prices) of the estimated cost per additional lorry mile in 2010, 2015 and 2025 based on outputs from the DfT's National Transport Model. The values reflect an estimate using the best

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[7] http://www.dft.gov.uk/webtag/documents/expert/unit3.3.5d.php
[8] http://www.defra.gov.uk/environment/quality/air/airquality/panels/igcb/guidance/damagecosts.htm

available sources of the marginal externalities of the current fleet. They can be interpreted as either the cost of adding an extra lorry mile to the network or the benefit of removing one, as is projected in the case of introducing an FCC. They are applicable for relatively small changes to the level of HGV traffic, where overall travel patterns and behaviour are unlikely to be affected. They would be applicable to a change in level of HGV traffic by a few percentage points but not necessarily for a fundamental change in the location and nature of supply chains. Nevertheless it provides a useful starting point; the impact of any individual FCC, while important, is unlikely to be so significant that the whole pattern of travel behaviour in an area is likely to be affected. Estimates for smaller vehicles are, currently, unavailable. Using data for large vehicles may have overestimated the benefits from reduced congestion and therefore may have exaggerated the benefits of consolidation centres. Thus as part of our sensitivity testing a rate of half the articulated HGV congestion values was also applied. Even with a lower value of congestion costs significant positive benefits, still in the tens of thousands of pounds, were generated by the spreadsheet model from the introduction of consolidation centres.

Furthermore the congestion values are only estimates and are therefore subject to uncertainty, but nevertheless provide a useful guide to the likely level of savings from a consolidation centre.

The work to produce these values was carried out towards the end of 2008. Hence the full impacts of the recession were not reflected, which particularly affects the estimate of the values of congestion saved. This is important since most of the social benefits are due to reductions in congestion. Tests have been undertaken in the National Transport Model to assess how much the congestion value may be overestimated; these suggest that in 2010 the congestion value estimate would be 83% of the value presented by DfT, and in 2015 and 2025 the estimate would be 80% and 84% respectively. While these adjustments have not been applied in the spreadsheet model we have referred to them in the discussion. Clearly a 17% reduction in the congestion benefits could have a significant impact upon the viability of a FCC from a societal point of view. However, as the economy recovers, it seems likely that congestion will return to similar levels to those experienced previously.

This data has been applied to calculate the benefits of mileage reduction resulting from the adoption of different types of FCC. The data includes various options – London and Conurbations, other urban and rural, for motorways, A-roads and other roads. For this analysis, the data (£1.12 per lorry mile in 2010 rising to £1.46 in 2015) for “other urban, A-roads” has been applied since this represents the type of area and road that would most likely benefit from the introduction of a FCC.

- **Noise**
  DfT have provided data of the estimated cost per additional lorry mile at 2010 market prices for use in the analysis. Data for Articulated HGVs operating on A-road in “other urban areas” (i.e. not London or the conurbations) has again been used.

Lorry noise comes from two sources[9]: rolling noise (from the interaction between the vehicle's tyre and the road surface) and propulsion noise (from the engine). In addition the effect of driver behaviour (speed and acceleration) is taken into account in the formulation of the source strength of both rolling and propulsion noise. The impact of reduced lorry miles upon noise will depend upon the mix of traffic, since in heavy traffic, reductions in lorry noise will be masked by the overall noise levels, while on a rural road the removal of lorries would be noticeable. An articulated HGV is likely to be noisier than other types of lorry at high speeds because it is likely to have more tyres in contact with the road; at lower speeds it depends on the type of engine. For this analysis we have assumed that the artic would tend to be noisier.

For this analysis, the data (£0.17p per lorry mile in 2010 rising to £0.19p in 2015) has been applied, since this represents the type of area and road that would most likely benefit from the introduction of a FCC.

- **Waste**

There is a benefit to construction of reducing material waste through a secure and well handled stock control system, as provided by the FCC. This reduces not only reduces the cost of wasted extra stock, which is no longer needed as a safety net but also the cost of waste disposal itself.

Data on the level of waste generated by construction sites has been attained from the Building Research Establishment (BRE)[10]. There are several versions of BREEAM (BRE Environmental Assessment Method) for different types of building, e.g. healthcare, offices etc. Government departments are required to obtain an 'Excellent' rating for all new builds and a 'Very good' for refurbishment. The credits associated with waste vary with up to 3 credits being available for the diversion of non-hazardous waste from landfill as below and for preparing and implementing a SWMP (Strategic Waste Management Plan). One BREEAM credit can be obtained where at least 75% by weight or 65% by volume of non-hazardous construction waste generated by the project has been diverted from landfill and either:

a) Reused on site (in-situ or for new applications)
b) Reused on other sites
c) Salvaged/reclaimed for reuse
d) Returned to the supplier via a 'take-back' scheme
e) Recovered from site by an approved waste management contractor and recycled.

The amount of waste per $100m^3$ internal floor area for the mid range BREEAM assessment is 4.7 - 6.5 tonnes. This has been used as input into the spreadsheet as a base figure but has not been adapted to account for

[9] The Noise Emission Model For European Road Traffic, IMAGINE project (Improved Methods for the Assessment of the Generic Impact of Noise in the Environment, 2007
[10] http://www.breeam.org/index.jsp

buildings with a larger floor space. Thus the figures for savings will be underestimates.

The current rate of landfill tax has been used as the basis for the calculations. For non-inert waste, the tax is £48/tonne, rising at £8/year to discourage sending waste to landfill, and will continue to rise at this rate until 2014 when it will be £72/tonne. Non-inert waste includes packaging, wood, plasterboard, plastic, metal and organic material, so includes most construction waste. The rate for inert material is much lower, £2.50/tonne, but the definition of inert is relatively restricted; soil and stones, crushed rock, concrete, bricks and tiles and glass. For this analysis we have used the higher tax rate.

- **Discount factor**
  The discount factor of 3.5% has been applied in the analysis to calculate the Net Present Values of the social benefits. This is the rate recommended in The Green Book: Appraisal and Evaluation in Central Government[11]. The impact of other discount rates upon social benefits could easily be investigated. Illustrative net present values for the social benefits have been estimated over a 5 year period; using a longer time may lead to overvaluation of the benefits.

  The business costs have been assessed on an annual basis with lease costs rather than capital costs used as is industry practice. There has been no provision of figures on actual documented value gained from retailers or the construction industry though the study proposes per pallet rates which retailers may need to pay dependant on the operation of the FCC.

2.3 Consultation with interested parties

The project team identified and collated the necessary variables needed to complete building the various modules in the model. For the most part this involved identification of information already held within the partner organisations. However, where information was found to be missing or of suspect quality, an additional data collection / validation exercise was conducted through literature review and through interested party consultation in order to satisfy our data needs.

Additionally, in order to ensure appropriate input to the Cost Benefit analysis a series of meetings and telephone calls were conducted into areas identified, where the financial and social cost information needed to be augmented.

A brief summary of the interested parties consulted can be seen in the table below. A small number of those approached did not wish to participate in the study, with a further number either unable to participate or not contactable within the required project timeframes.

Consultee type	Number Approached	Number Participated	Reason for consultation

[11] The Green Book: Appraisal and Evaluation in Central Government, HM Treasury

Academia	1	1	Industry knowledge and expertise
Consolidation Centre users	5	4	Experience of usage – challenges, benefits
Construction	2	1	To gather data and perspectives on construction consolidation centres
Consultancy	1	1	Industry knowledge and expertise
Freight distribution & logistics	10	9	To gather data and perspectives on FCCs
Industry bodies	8	6	Industry knowledge and expertise and data
Local Authorities	10	8	To gather data and perspectives on drivers, policy and success criteria
Property development	2	0	To identify drivers, experience and implementation experience.
Regional Transport Bodies	2	1	To gather data and perspectives on drivers, policy and success criteria
Retailers	7	3	Experience of usage – challenges, benefits
Wholesalers	2	1	Industry perspective
Total	50	32	

Table 1 Summary of interested parties consulted

Although no property developers participated in the study there was a sufficient level of relevant information published in previous studies to compensate.

The production of the dataset needed to inform the development and population of the scenarios and the subsequent modelling involved collection and analysis of data from the above sources. It was inevitable that some of this data would be commercially sensitive and therefore is only to be used for the purposes of this study. In order to ensure co-operation of as many relevant parties as possible, an offer of data anonymity was provided to any organisation that co-operated with or contributed to the study should they wish it.

A list of interested parties who wished to be identified as having participated with this study can be found within the Acknowledgements section at the front of this report.

All participants were subsequently invited to a workshop presentation before the completion of this final report. This session was designed to present the draft findings of the study team with time for discussion and feedback on any of the points raised so that they could be considered for the final report.

2.4 Data Sources

For the study we sought a minimum of three sources for each piece of data undertaken and also undertook a collective analysis of the figures to ensure mutual agreement within the project team of reasonableness and accuracy. The following provides a generalisation of data sources used in order to provide the anonymity requested by some of the participants:

- Annual industry data tables from trade associations
- Existing published and unpublished FCC studies
- Existing operators of freight consolidation centres
- Local authorities
- Existing studies undertaken by the authors
- Broader supply chain costs from freight distribution and logistics providers

2.5 Specific Model Inputs

A few of the specific model inputs require explanation ahead of the results and analysis.

2.5.1 Delivery Units

Goods are packaged and grouped for transportation in many different ways according to what suits shippers, transporters and receivers and the nature of the product in question.

Within this report we have used 'pallet equivalent' as our common denominator for the amount of throughput. This is by no means intended to imply that pallets are the most common medium by which goods are grouped – in fact the Bristol and Heathrow consolidation centres use roll cages for a variety of reasons. However, for a study based around a common model covering both retail and construction, pallet equivalents formed the best common basis.

2.5.2 Delivery Vehicles

For each retail scenario variation, the model compares what the operation would be like if it was using a fleet comprised solely of one of four vehicle types:

- 7.5 tonne diesel rigid
- 9 tonne electric rigid
- 17 tonne diesel rigid
- Urban artic

The 7.5 tonne and the 17 tonne have both been chosen due to the high uptake levels within the distribution industry for them in consolidation work. The 17 tonne rigid has been specifically selected (rather than an 18 tonne) as it is the size used to operate the Norwich FCC.

The electric vehicle has been used in the model, as it is the most commonly used lower carbon vehicle for urban deliveries and therefore the one for which most data can be obtained. The Bristol FCC already uses this type of vehicle and some of the Local Authorities interviewed who were planning an FCC are considering electric vehicles. Amongst alternative 'green' technologies currently available on the market which could have been modelled include biomethane-fuelled and diesel-electric hybrid delivery vehicles. However these are currently uncommon within the urban delivery environment and are difficult to reliably reference in a standard form as emissions and price varies for the few available models. These other technologies should not however be excluded from consideration for an implementation.

The urban artic has been used within the model as it is the preferred vehicle for retailers with reasonably consolidated loads to use for deliveries to stores in that it gives the greatest level of logistical efficiency and in some cases more manoeuvrability than a large rigid. The vehicle weight modelled here is 26 tonnes.

Within the construction scenario the FCC delivery loads have been split between a 7.5 tonne and a 17 tonne vehicle size as different vehicle sizes will be needed for different types of load.

7.5 tonne Medium Goods Vehicle

As used in the Bristol FCC pilot phase

9 tonne electric

As trialled in the operation of the Bristol FCC

17 tonne rigid diesel

As used in the ongoing operation of the Norwich FCC

Urban artic
As used by retailers to make larger deliveries to town centre stores

Figure 3 Guide to the different vehicle types profiled in scenarios

2.6 Sensitivity of the Model

The model developed would allow for further sensitivity testing of the results by looking at a wider set of scenarios. These additional scenarios could include:

- Alternative delivery profiles of stores
- Alternative euro engine profiles of existing delivery vehicles
- Changes in the price of diesel
- Change from average UK land leasing and staff costs to regional specific costs
- Change in FCC goods out delivery window
- Reduce the FCC goods in window
- Change the distance between the FCC and area served
- Alternative delivery vehicles
- Model alternative warehousing lease costs

3 SHOPPING CENTRE

3.1 Scenario Detail

The first modelled scenario presented in this report is for a Freight Consolidation Centre serving a purpose built shopping centre. Typical features of shopping centres which distinguish them from a town centre shopping area include:

- a single landlord
- contemporary delivery facilities
- retail users are almost solely national chains
- the planning process for a new or redeveloped shopping centre site will be dealt with as a single instance

Examples of this type of shopping centre would include Meadowhall (Sheffield), Broadmead and Cabot's Circus (Bristol), Westfield Shepherds Bush (London).

3.1.1 Scenario Assumptions

For this scenario to deliver any significant, measurable benefits we have assumed it only covers shopping centres within an urban area that are no less than 6 miles from the trunk motorway network. This is based on the premise that there are insufficient benefits from the reduced vehicle mileage that comes with simple FCC implementation for shopping centres close to a motorway. (Under this assumption the existing site at Meadowhall in Sheffield would then not be covered. This apparent contradiction is worth noting because the site there provides benefits from delivery smoothing, off-site stock holding, added value services and improved security, rather than primarily focusing on consolidation.)

The following assumptions on the operation of the FCC have also been made within the model:

- The FCC would be open to receive deliveries on a 24/7 basis
- The FCC would make deliveries to stores 6 ½ days a week, 7am-7pm
- The FCC is located 6 miles by road from the shopping centre
- No operator's management charge or profit margin has been added into the FCC operating costs
- Deliveries would be made to the store as a simple drop-off at the delivery bay
- The retail mix and total number of stores used in the model is based on an average of 14 real world shopping centres.
- The voluntary participation scenario assumes a 20% take up, based on TTR studies and Bristol FCC experience, from retailers primarily focused on the medium sized stores which have previously been identified as offering the greatest consolidation potential[12].
- The dedicated FCC facility size has been rounded up to the nearest 1000 ft²

[12] 'South London Freight Consolidation Centre Feasibility Study', TTR for SLFQP, 2007

3.2 Findings of Shopping Centre Scenario

The following tables detail the results of the Shopping Centre scenarios as outputted from the study model. As well as looking at the differences which occur between mandatory/ voluntary participation and whether or not the centre is shared/dedicated we have also looked at the differences in cost and impact between four different vehicle types. All figures relate to the deliveries made by the FCC operation and not the wider supply chain.

3.2.1 Scenario size & cost comparison

		Baseline for 100% of retail stores (equiv. to mandatory)	Baseline for 20% of retail stores (equiv. to voluntary scenario)
Baseline (no FCC)	Total mileage (per week)	17,137	3,099
	Emissions NOx (g per week)	177,302	30,943
	Emissions PM (g per week)	3,656	645
	CO_2 (kg per week)	27,888	4,846

Table 2 Summary of baseline non-FCC figures in Shopping Centre scenario

Table 2 above provides weekly baseline data for the scenario of no freight consolidation centre. The factor difference of approx 6:1 between total mileage and emissions isn't the same as the voluntary participation level of 20% (defined above in scenario assumptions) because the profile of delivery loads and delivery vehicles for the stores that would participate in a voluntary scheme is different to the overall average profile of the stores.

The baseline scenario includes a vehicle delivery mix of engine age and vehicle size as per Table 3 Baseline vehicle delivery mix. The higher the Vehicle EURO value the more energy and emission efficient the vehicle is.

Vehicle Size Distributions	**Courier (local)**	**3PL**	**Direct (inc in house)**	**food wholesale**
Van (<3.5T)	40%	0%	15%	30%
Small rigid	60%	15%	40%	60%
Large Rigid	0%	35%	35%	10%
Artic	0%	50%	10%	0%
Vehicle Age Distributions	**Courier (local)**	**3PL**	**Direct (inc in house)**	**food wholesale**
EURO 2	5%	0%	15%	10%
EURO 3	35%	40%	35%	35%
EURO 4	50%	50%	45%	45%
EURO 5	10%	10%	5%	10%

Table 3 Baseline vehicle delivery mix

	Mandatory Participation		Voluntary Participation	
	Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
Facility size required (square foot)	40,362	42,000	4,834	5,000
Throughput (pallet equivalents per week)	10,090		1,209	

Table 4 Summary of FCC size requirements in the Shopping Centre scenario

Table 4 provides a useful indication of facility size, particularly the comparison between mandatory and voluntary participation by retailers, which changes the size requirement by a factor of 8:1 even though the participation levels are at 20%. The primary reason for this discrepancy is that the high throughput and heavily consolidated supermarkets and non-franchised department stores have been excluded from the voluntary participation scenario.

This study has taken a cost per pallet equivalent of approx £8 (with a small margin of flexibility) as a benchmark operator cost (excluding operator profit margin). This figure has been tested with interested parties to confirm that it is a reasonable figure to use, there was full agreement that this was reasonable although relevant participants were unable to share their own rate due to commercial considerations. Within the results below those scenarios which have produced a cost per pallet of approx £8 or less have been highlighted in green for easy identification.

		Mandatory Participation		Voluntary Participation	
		Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
7.5T Rigid	Total FCC annual cost	£ 4,128,828	£ 4,214,790	£ 609,942	£ 789,629
	Cost per pallet	£ 7.87	£ 8.03	£ 9.71	£ 12.56
	Total staff	103	105	15	21
	Total vehicles	46		6	
	Total vehicle runs per week	1262		152	
	Total mileage (per week)	15,144		1,824	
	Emissions NOx (g per week)	46,355		5,583	
	Emissions PM (g per week)	793		96	
	CO_2 (kg per week)	15,928		1,918	

Table 5 Summary of FCC using 7.5 tonne rigid delivery vehicles in Shopping Centre scenario

Table 5 shows the results of using Medium Goods Vehicles as the FCC delivery fleet. This demonstrates the difference between the operation of a mandatory system against a voluntary system. The former has much higher overall costs linked to the capacity needed to handle the increased throughput required but can also then achieve a lower cost per pallet rate. The Voluntary system costs approx 15-

18% of the mandatory scenario but the cost per pallet rate is 24-56% higher (dependant on whether the centre is shared or dedicated).

The result also demonstrates the benefit of a shared centre over a dedicated centre within both mandatory and voluntary scenarios. The difference is fairly marginal within a mandatory participation scheme but becomes rather more significant within the voluntary version (albeit not cost effective using the 7.5 tonne rigid vehicles due to the additional vehicle related staff costs of operating smaller load vehicles). With a shared centre, the overheads (warehouse equipment and staff) are shared with other cost centres in the same site but this impact is lower with mandatory participation as the overheads then can be absorbed at 100% due to the high level of throughput.

		Mandatory Participation		Voluntary Participation	
		Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
9T electric rigid	Total FCC annual cost	£ 4,691,460	£ 4,777,422	£ 672,506	£ 852,194
	Cost per pallet	£ 8.94	£ 9.11	£ 10.70	£ 13.56
	Total staff	103	105	15	21
	Total vehicles	75		9	
	Total vehicle runs per week	1262		152	
	Total mileage (per week)	15,144		1,824	
	Emissions NOx (g per week)	0		0	
	Emissions PM (g per week)	0		0	
	CO_2 (kg per week)	12,562		1,513	

Table 6 Summary of FCC using 9 tonne electric rigid vehicles in Shopping Centre scenario

Table 6 provides the same information using a fleet of 9 tonne electric FCC vehicles. This size vehicle provides the same delivery capacity as a 7.5 tonne vehicle with the extra gross vehicle weight being associated with the battery. Therefore overall mileage and staff requirement is the same as the previous example.

The emissions are reported as zero for the electric vehicle as these are created during the electricity generation stage and emissions are a local air quality issue. However carbon is a global consideration and therefore the carbon produced during electricity generation is reported here. This has been calculated based on the 2008-9 UK generation mix[13] which includes a high proportion of coal based electricity production. The electricity in an FCC could of course be sourced specifically from a renewable energy provider on the open market and therefore be reported as zero.

[13] http://www.decc.gov.uk/en/content/cms/statistics/fuel_mix/fuel_mix.aspx

		Mandatory Participation		Voluntary Participation	
		Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
17T Rigid diesel	Total FCC annual cost	£ 3,030,541	£ 3,116,503	£ 484,916	£ 664,604
	Cost per pallet	£ 5.78	£ 5.94	£ 7.72	£ 10.58
	Total staff	69	71	11	17
	Total vehicles	26		4	
	Total vehicle runs per week	721		87	
	Total mileage (per week)	8,652		1,044	
	Emissions NOx (g per week)	50,571		6,102	
	Emissions PM (g per week)	846		102	
	CO_2 (kg per week)	16,817		2,029	

Table 7 Summary of FCC using 17 tonne rigid diesel vehicles in Shopping Centre scenario

Table 7 shows the results for a 17 tonne rigid diesel and demonstrates how with extra vehicle capacity and therefore fewer overall vehicles and drivers, the total costs are reduced. For the mandatory scenarios the overall cost reduction is 24% compared to using 7.5 tonne vehicles with the voluntary scenarios 15-20% lower.

The cost per pallet within a voluntary participation setting using a shared centre is now at a more cost effective level using this larger vehicle type.

The positive benefit of reduced cost needs to be weighed against the negative impacts this vehicle provides regarding emissions. The overall NOx emissions are around 9% higher in this scenario compared with the 7.5 tonne truck with PM emissions 6.6% higher and carbon emissions 5.5% higher.

		Mandatory Participation		Voluntary Participation	
		Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
Urban artic	Total FCC annual cost	£ 2,645,333	£ 2,731,295	£ 438,275	£ 617,962
	Cost per pallet	£ 5.04	£ 5.21	£ 6.97	£ 9.83
	Total staff	56	58	9	15
	Total vehicles	19		3	
	Total vehicle runs per week	505		61	
	Total mileage (per week)	6,060		732	
	Emissions NOx (g per week)	47,190		5,700	
	Emissions PM (g per week)	729		88	
	CO_2 (kg per week)	15,675		1,893	

Table 8 Summary of FCC using Urban Articulated vehicles in Shopping Centre scenario

Table 8 summarises the results for an FCC using only 'Urban Artic' vehicles. The results show that the costs are reduced yet again as the vehicle size increases.

The Shared Centre costs for voluntary participation are a significant 29% lower than with a Dedicated Centre.

The emissions levels are broadly similar to those produced under the 7.5 tonne rigid results (approx 2% higher NOx, 9% lower PM, 1.5% lower CO_2) which are only bettered by the electric vehicles within the shopping centre scenario results.

3.2.2 Summary of Scenario Outputs

The reductions in emissions for the electric vehicle scenarios are significant, as would be expected, and the CO_2 produced is the least of all the vehicles. However, the costs of running an FCC using electric vehicles are higher than for the other vehicle types considered, adding around an extra £1 onto every pallet handled, due to a reduction in overall mileage and time that can be operated per day due to recharging requirements.

However as electric vehicle costs reduce, leasing becomes obtainable[14], and the price of diesel increases this result will change and suits an annual review.

What therefore makes commercial sense for controlling costs of operating the centre does not produce the best emissions savings. Therefore, on a purely financial basis, only the local authority is likely to be interested in covering the cost of the extra investment to get the lower emission levels and if a local authority wished to gain the benefit of the cleaner emissions possible from electric vehicles then they would

[14] It was noted during the consultations that a current cause of difficulty in leasing electric vehicles is that many leasing companies currently find it difficult to ascertain an end of lease vehicle value.

probably need to expect to subsidise the difference compared to a 7.5 tonne rigid, for example.

Where participation is voluntary there is a large cost advantage to operating a shared centre i.e. a £3-4 per pallet cost difference. This advantage comes from sharing costs of management, shift supervisors, forklift trucks and warehouse equipment with other activities at the same site rather than all costs being apportioned as in the dedicated scenario. There is a small advantage too when participation is mandatory however it's down to 10-30p cost difference in those instances. So if there is no suitable location for sharing a distribution centre in a mandatory scenario it would not seriously impact on the project viability to use a dedicated site but it would do within a voluntary scenario.

The figures back up the difference seen between the Heathrow and Bristol operations that the cost per pallet can be much lower in the mandatory scenario whilst in a voluntary setup the cost increases 50-100% making it very difficult to run on a purely commercial basis.

For some stores, supermarkets and non-franchised department stores the existing deliveries are already highly consolidated. In such cases there is little benefit of including these stores within an FCC operation given the associated costs of warehouse space and 'double handling' costs in either an optional or mandatory participation scenario.

Graphs comparing the emissions between vehicles for this scenario in a mandatory environment can be seen in Annex A.

3.3 Costs and Benefits

3.3.1 Financial costs and benefits

This section identifies where the financial benefits lie within the consulted groups as well as data on the value itself.

3.3.1.1 General

The start up period for an FCC, whether it is mandatory or voluntary for retailers to participate, requires a period of time before the throughput is at a substantial enough level to bring the cost per pallet down to a lower cost level. This can be seen below in

Figure 4.

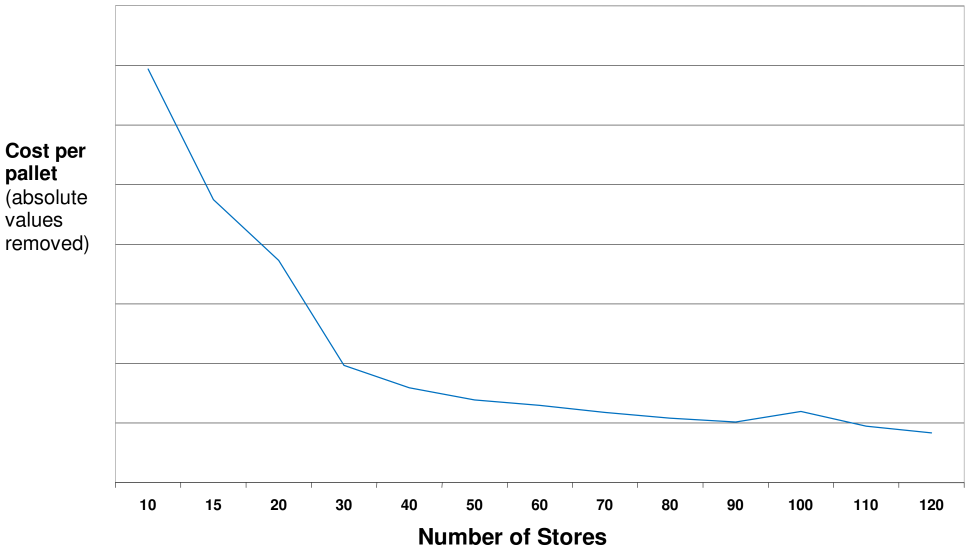

Figure 4 Graph demonstrating the effect on cost per pallet of evolving levels of retailer participation

The experience of the Bristol FCC was that it took six months to reach approximately 40% of the eventual 'business-as-usual' level of participation and a further six months to reach the eventual level.

It is an important consideration for the operation of an FCC to ensure that there is agreement on who will cover the operational costs of the scheme during the period where the cost per pallet is above the eventual level and that there is an understanding that this will take a period of time. Most FCC experience to date is that the Local Authority provides funding to cover this initial start-up period.

3.3.1.2 Local Authorities

Unless a facility uses urban artics as its delivery fleet it does not appear to be possible from our results to operate a retail FCC with only voluntary participation from retailers and little local policy incentive without subsidy from the local authority. Using these vehicles still produces a per pallet equivalent cost of £6.97 which is at the high end of the acceptable cost levels and would be susceptible to increases in the price of fuel. It is worth noting that the study does not take into account a set FCC operator profit margin either which would need to be added to this pallet cost.

The experience of local authority involvement in retail FCC provision is that pump-priming funding is required to cover the revenue gap described above until the scheme reaches its equilibrium level. This is typically a substantial capital cost in comparison to the smaller levels of subsidy which can be required from that point onwards.

As an added service which can be provided by the FCC operator there was a positive response for waste collection and recycling services from local authorities and distribution companies consulted. Local authorities identified there being value to them in this being provided as a commercial service (reduced requirement to offer as a service themselves, consistent service to area and further reduced traffic entering area). All the retailers consulted responded by stating this would be of no interest to them as this was a service already efficiently handled, although location specific surveys for other clients have suggested that this service might be of some interest to retailers.

There are a number of local authorities who, as part of the exploration of the FCC concept, are considering providing policy only support to assist the voluntary participation levels. The three main policies which have been suggested for this are (i) provision of electric vehicle only delivery bays, (ii) increased enforcement of Penalty Charge Notices (PCNs) for delivery vehicles and (iii) allowing FCC vehicles access to bus lanes. Of these measures only Norfolk CC has implemented any to date, by providing bus lane access.

3.3.1.3 Retailers

The core FCC service delivers benefits to retailers but not ones which they find easy to financially quantify. Actual benefits tend to be derived from the added value services which FCC's often provide. For example, retailers can maximise store size and retail space by reducing stockroom space and instead relying on offsite stock holdings at the FCC. This is particularly useful at times of extreme demand e.g. Christmas when peak supply management can be a key to the success of stores. Customer pick-ups of large items such as white-goods can also be arranged for collection direct from the FCC itself reducing the need for some stock to ever be delivered to the store.

Time can also be saved by retail store staff from pre-sales services such as product labelling being carried out in the warehouse environment rather than within the store. However this task can sometimes be cheaper to carry out within the store as retail staff may be lower paid than the equivalent FCC warehouse staff.

Some retailers reported pallet return and storage at the FCC as an immediate benefit in freeing up stockroom space at the store whether or not they were using off-site stock holding facilities.

Retailers who already operate a well consolidated distribution system are usually less interested in incurring the overhead of an FCC. Others can generally be more supportive, particularly if they already have experience of using one. One retailer using an existing FCC reports a £2k a year saving on their own labour costs whilst another reports a loss though is still supportive of the scheme. General feedback from the consultation is that the average retailer should expect to break even on involvement with an FCC though a regular theme was the lack of analysis in quantifying any softer benefits which may have been gained such as labour efficiency, smoothed deliveries and savings from reduced need for space allocation for stock.

The experience of existing retail FCC sites is that the recruitment of retailers under the voluntary scheme is a time consuming and thus expensive, activity for the FCC operator to undertake. This is due to the need to engage with each retailer's particular circumstances - their own supply chain as applied to the specific location in question - and understand what the benefits are for that retailer, where the value can be found and what process needs to be navigated in order to move them into the FCC served environment. This is not straightforward, as shown by the fact that the retailer referred to above who reported a cost associated with participating in the Bristol FCC, also reported a break even for Norwich and that they could realise a significant saving for operations into London.

3.3.1.4 Shopping Centre developer / landlord

The main interest in FCC's from developers is to maximise land use by having more retail space to lease out proportionally to the overall development size because of a less than usual onsite stockroom requirements and reduced delivery bay space. This requires an FCC to be part of the planning process at the design stages.

Local Authorities may wish to consider using Section 106 of the planning process to require developers to contribute to the start-up costs of an FCC. Similarly it was noted in discussions with the Low Emissions Strategy Partnership (LESP) that they would like to explore a charge on developers based on resultant air pollutant increases resulting from development which could be used on schemes for lowering overall emissions. LESP see Freight Consolidation Centres as a tool part-funded by developers to contribute to overall reductions.

3.3.1.5 FCC Operators

There are a number of financial models under which FCCs can be operated. These can be summarised into three distinct types:

- A **fully tendered** basis whereby the Local Authority pays a fixed fee for the operation of the FCC. The operator is then responsible for meeting service level targets and managing costs to ensure their profit margin which is then at their own risk. Any revenue paid for the service by participating retailers is then passed directly to the LA. The risk of low participation from retailers is then held almost solely by the LA.

- A **shared risk agreement** between Local Authority and FCC provider so that the LA underwrites an agreed fixed cost for the operation of the consolidation centre. Assuming that charges are levied for items delivered by the consolidation centre (whether after a free introductory trial or not), then the revenue is shared in such a way that increased throughput benefits both the LA through reduced overall subsidy, and the operator by increasing their revenue and so providing them with an incentive to recruit more participants to the scheme. The risk of low participation from retailers is then shared between the LA and the operator depending on the level of the underwrite.

- A purely **commercial contract** basis whereby the operator derives all revenue from participant retailers. The landlord or local authority may however mandate participation in such a way as to ensure a level of throughput which removes the risk of the centre running at a loss. The risk of low participation from retailers is then held almost solely by the operator.

The UK experience to date tends to be the adoption of the shared risk approach. The FCC also provides a base for the operators to grow revenues by the provision of additional services to the retailers who have joined the core scheme. Additional revenues can also be brought in through the sale of advertising space on the side of vehicles; this could alternatively be provided to participant retailers as an incentive to join the scheme.

Figure 5 provides a comparison of the different ratios of operating costs for the retail Shopping Centre under a range of different scenarios.

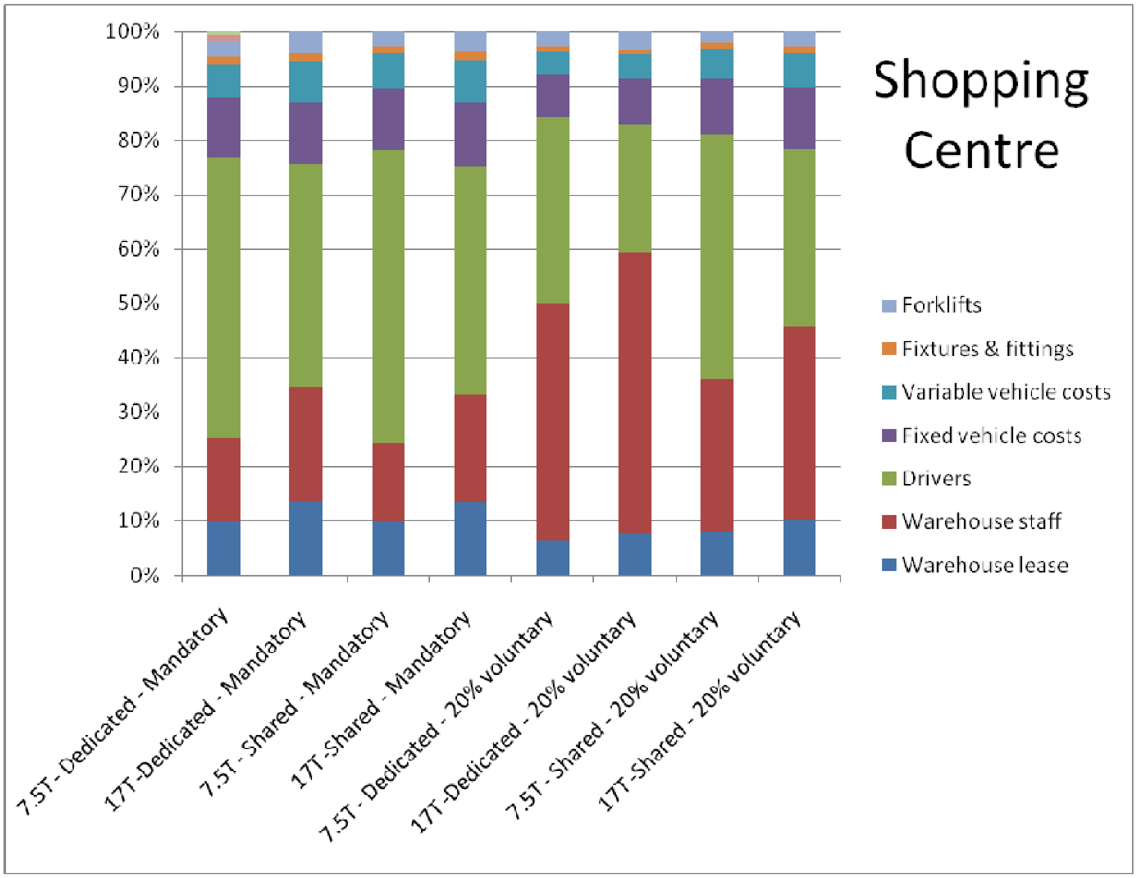

Figure 5 Graph showing the comparative costs of components of overall operational costs for a range of Shopping Centre scenarios

The graph demonstrates how significant the cost of driving staff is in the scenarios where extra staff are needed to drive the higher number of lower capacity vehicles. This is more prominent in the mandatory participation scenarios as the highly consolidated existing loads (typically delivered by urban artics) of the supermarket and department stores become transferred to these low capacity vehicles. By comparison, in the 20% voluntary scenarios where the loads are being genuinely consolidated the overall proportion of driver cost is much lower and becomes comparable with the cost of the warehouse staff.

This graph has not been replicated for the High Street scenarios within this report as the results were approximately the same.

3.3.1.6 Existing distribution chains

Distribution chains carrying heavily consolidated loads may not have much to gain from transferring goods to store via an FCC. However it has been found that some distribution channels have been able to consolidate further up the supply chain by switching from delivery with standard artics to the use of double-decker artics. This is possible because the distributor is able to group deliveries to more stores within a single outbound trunking leg. This provides a potential reduction in the total number of vehicles and drivers required in their operation.

Another benefit to distributors is from having a wider time window for delivery which opens up greater opportunity for efficient rostering of vehicles and drivers especially at off-peak times. Time and fuel are saved from having reduced congested urban mileage within the delivery schedule, although by no means all companies factor this into their costings, which would mean it is more difficult for them to calculate the true savings that result from reducing their urban mileage. For delivery to some stores there will also be savings from no longer having exposure to Penalty Charge Notices (PCNs).

However, for certain types of delivery, the vehicle is making drops to multiple stores within a regional area. If one or two stores are having their stock delivered to the FCC, whilst other deliveries continue to go direct, then there would not necessarily be a significant impact on the amount of urban local mileage and the delivery vehicle may not be able to make use of overnight deliveries as the schedule is set by the other non-FCC served stores.

3.3.2 <u>Private Sector Costs and Benefits (non-quantitative)</u>

Employment

An FCC could provide additional local employment within the distribution and logistics sector. This would be more likely within a dedicated centre whereas a shared centre may instead make use of existing staff. The staff skills which would be required are:

- LGV\HGV Drivers
- Warehouse
- Shift supervisors
- Operational management
- Commercial management
- Cleaning

The staff levels required varies with the scenarios with mandatory dedicated sites employing the most additional staff and voluntary shared sites the least.

It is likely that any new employment would actually be a transfer in activity from that which would have been part of the original delivery chain.

Freight Driver Working Conditions

A benefit identified within the consultation phase is the improved working conditions and facilities provided for drivers through freight consolidation centres compared to direct to site deliveries. When delivering directly through urban congestion drivers do not usually have the ability to leave their vehicles for breaks due to load security concerns either on route or at the delivery destination itself. They can also be trapped in congested traffic when mandated break times are due and have little or no access to toilet and canteen facilities at the destination. Freight Consolidation Centres however provide a secure environment for drivers to leave their vehicle, better facilities and reduce the likelihood of being caught in urban congestion when a mandated break is due.

These benefits cover both the retail and construction scenarios and have an increased bearing in recent years as the overall provision of lorry driver roadside facilities has reduced.

Convenience for Shopper Collections

A benefit for customers and stores for particular retail sectors such as electrical goods, furniture and hardware is to allow customers to collect large items from the FCC. This provides a benefit to the retailer in not having to have stock held onsite awaiting collection or having its delivery bays congested with customer vehicles. The customer benefits from the better delivery access, removed risk of PCN violation and potentially a greater collection time window.

Shopping Centre Security

Security concerns are high within purpose built shopping centres given the history of such sites being terrorist targets. Without an FCC there are a large number of vans and trucks with unknown drivers accessing the site. It requires a significant security effort to monitor and evaluate these vehicles as they access the shopping centre, so the use of an FCC provides control of vehicles and drivers accessing the site, producing a saving in terms of overall security costs and possibly in insurance costs. For both Heathrow and Meadowhall security was a key driver for implementation.

3.3.3 Social Costs and Benefits

Accident and casualty impacts

The numbers of accidents and resulting casualties form one of the key quantitative indicators for the appraisal of transport interventions. Combining these numbers with values for the prevention of casualties and accidents yields a monetary estimate of the accident-related costs or benefits of proposed transport interventions.

WebTAG, unit 3.4 (http://www.dft.gov.uk/webtag/documents/expert/unit3.4.php) provides data on the average value of preventing road traffic accidents as:

Accident type	Value of prevention
Fatal	£1,876,830
Serious	£215,170
Slight	£22,230
All injury	£75,610
Damage only	£1,970

Table 9 Average value of prevention of road accidents by severity (£ per type of accident)

Reducing lorry mileage will reduce the exposure of travellers to risks and reduce accidents with their consequent economic costs. The number of casualties from accidents involving lorries has been reducing by 25% from 2004-08. FCCs can assist in reducing lorry mileage but the societal benefits will only arise if the accident rates of the lorry mileage saved is less than any additional mileage from FCC delivery vehicles.

Environment Impacts

By its nature a consolidation centre may attract and generate a large number of trips each day so that while the overall impact may be environmentally beneficial, there may be negative local impacts from the concentration of vehicle movements.

It is important to recognise that some measures may increase trip numbers, vehicle kilometres and/or fuel use but will reduce other environmental impacts that have not been quantified such as vibrations and visual intrusion. Measures that reduce one environmental impact of urban freight may well increase another. However the environmental impacts evaluated in this study cover the main issues and it is unlikely that any adverse effects from the others would exceed the identified value of the societal benefits.

Noise pollution

Traffic noise makes a significant contribution to overall urban noise levels. The World Health Organisation reports[15] the effects of noise pollution on human health including:

- Lack of sleep
- Increased stress levels
- Reduced attention spans

These effects impact on the costs of health service provision, workplace productivity and child education performance.

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[15] 'Guidelines for Community Noise', edited by Birgitta Berglund , Thomas Lindvall, Dietrich H Schwela, World Health Organisation, 1999

Overview of social benefits

Table 10 provides a comparison of the overall mileage and emissions savings for each scenario variation against the baseline of no FCC. These figures drive the valuation of the social benefits.

The NOx and PM emission savings are very high in the mandatory scenarios as the older delivery vehicles from the baseline are replaced by the FCC delivery fleet which is using the latest engine efficiency technology.

	Baseline	Mandatory	Voluntary + Residual	Mandatory	Voluntary + Residual	Mandatory	Voluntary + Residual	Mandatory	Voluntary + Residual
		7.5T Rigid		9T Electric		17T Rigid		Urban Artic	
Total mileage (per week)	**17,137**	15,144	15,862	15,144	15,862	8,652	15,082	6,060	14,770
% Saving		12%	7%	12%	7%	50%	12%	65%	14%
Emissions NOx (g per week)	**177,302**	46,355	151,942	0	146,359	50,571	152,461	47,190	152,059
% Saving		74%	14%	100%	17%	71%	14%	73%	14%
Emissions PM (g per week)	**3,656**	793	3,107	0	3,011	846	3,113	729	3,099
% Saving		78%	15%	100%	18%	77%	15%	80%	15%
CO_2 (kg per week)	**27,888**	15,928	24,960	12,562	24,555	16,817	25,071	15,675	24,935
% Saving		43%	10%	53%	12%	40%	10%	44%	11%

Table 10 Shopping Centre: Comparison of mileage and emissions between baseline and FCCs using different vehicles

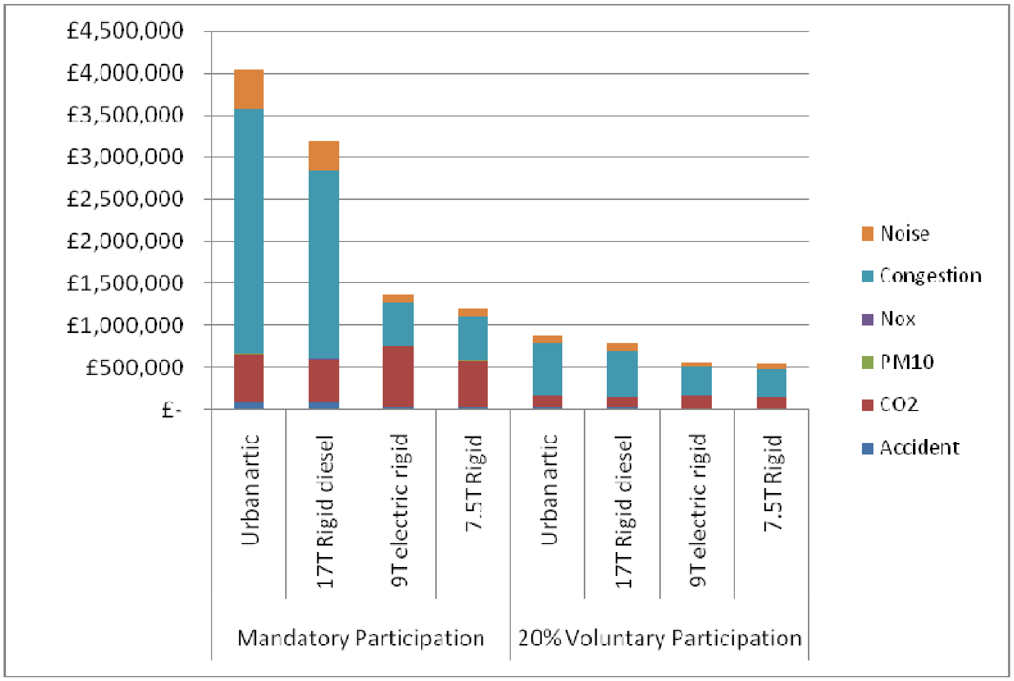


Figure 6 Graph showing the NPV of social benefits over a five year window by benefit category for Shopping Centre scenarios

Figure 6 provides a visual representation of how the different social benefits weigh up against each other for each variation of the High Street scenario. These costs reflect the Net Present Value (NPV) of benefits over the next five years from the reduced mileage which results from taking the original delivery activity away and replacing it with FCC deliveries.

The benefits are greater when removing many smaller delivery vehicles of varying engine ages with a small number of larger vehicles which are using efficient engines, the lease charges of these are included within the FCC operation costs.

The benefits from reduced congestion make up between 40-60% of the overall social benefits, dependent on scenario, which is substantial. The savings from PM10 and NOx emissions are relatively small (>1%) which is particularly interesting given that this is frequently quoted as the main driver by local authorities in either implementation or consideration of an FCC.

3.4 Break even analysis

An objective of this study is to understand the breakeven point of FCC operation where the throughput is at sufficient level to not require additional investment to cover an operational loss. It is also possible to demonstrate the levels of LA subsidy required at different throughput levels. This analysis has only been carried out for the shared centres as we have already demonstrated that they are significantly more efficient to operate than dedicated centres. The equivalent graphs for dedicated centres can be seen within Annex D.

Two approaches have been taken, both of which are over a period of one year with all costs taken as lease costs rather than capital expenditure. In the first we have assumed that retailers would be willing to pay an average price per pallet equivalent of £8. This is the same rate as the benchmark cost for FCC operation we set in the cost analysis previously. The reality is that the retailer's price may vary from retailer to retailer within the same FCC based on a range of variables including contract duration, weight of goods, value of goods, number of stores owned by the same retailer and additional pre-sales service offered.

In this first approach, using the fixed pallet rate, we have plotted the profit or loss that would be generated at that level of retailer participation.

The second approach provides a variable cost per pallet rate that would be paid by retailers at each level of user participation.

In both of these approaches please remember that this study has not included any value for the FCC operators profit margin. These would need to be added onto the values presented. A 'normal' profit margin for consideration may be 6% (3.5% gilts interest and 2.5% additional return to cover risks) in order to make the activity commercially viable.

The analysis looks at two vehicle types, the 7.5 tonne and the 17 tonne so there is a comparison between a medium goods vehicle and a heavy goods vehicle. These are also the two vehicle sizes in most common use within existing centres.

The graph plots the throughput at 20% incremental levels of retailer participation rather than of throughput itself. This distinction is key, the 'early adopters' in this analysis are those stores receiving poorly consolidated deliveries whereas at the 60-100% adoption levels the stores which already receive consolidated loads using an efficient urban distribution system switch to the FCC. For clarity, the 100% voluntary adoption level is the same as mandatory participation described previously.

	Voluntary Participation				
Store type	20%	40%	60%	80%	100%
	Shopping Centre	Shopping Centre	Shopping Centre	Shopping Centre	Shopping Centre
Supermarket	0	0	0	1	1
Department store (no.)	0	1	1	1	2
Department store - franchised (e.g. Debenhams) (no.)	1	1	1	1	1
Large store (no.)	2	4	5	7	9
Medium store (no.)	7	9	11	12	14
Small store (no.)	11	20	35	45	53
Barrow (no.)	0	3	6	10	12
Food outlets (no.)	2	7	8	13	16
Office (no.)	2	5	8	10	13
Total Stores	**25**	**50**	**75**	**100**	**121**

Table 11: Breakdown of the different retail participation levels used within the break even analysis for the Shopping Centre scenarios

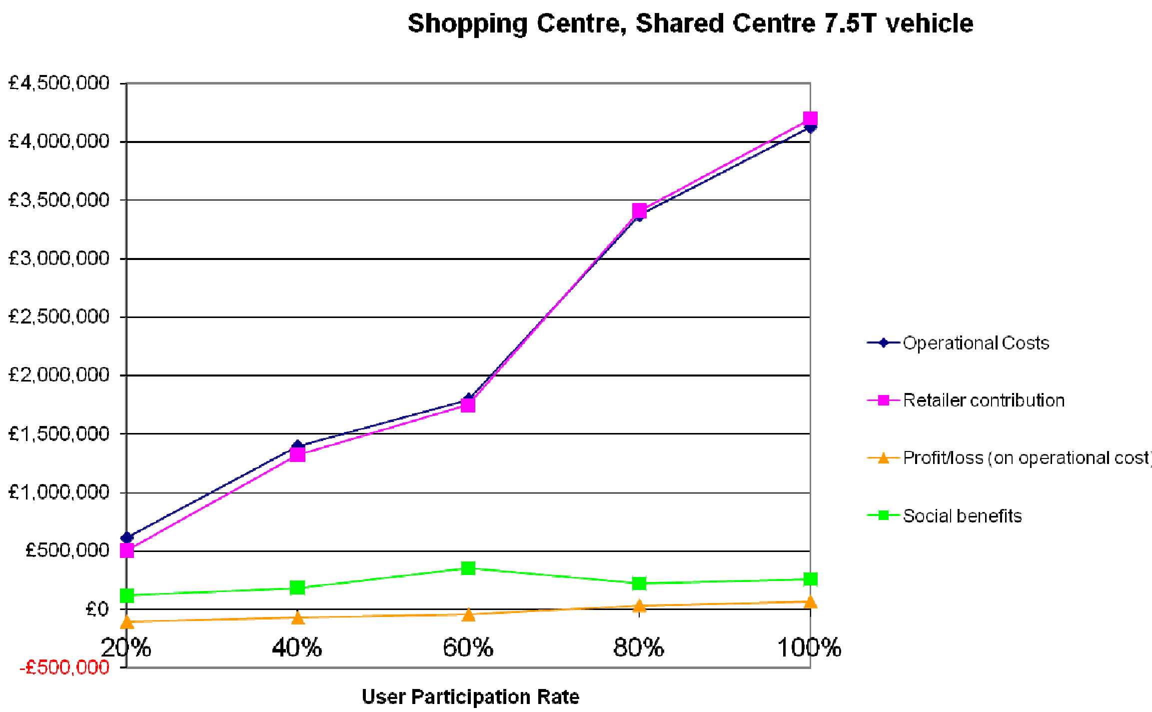


Figure 7 Analysis of operational profitability for a Shopping Centre FCC using a shared facility and 7.5 tonne vehicles

Figure 7 shows how, for the Urban Centre shared FCC using 7.5 tonne vehicles, the breakeven point is approximately at the 70% participation rate. However, even at lower participation levels the subsidy required is fairly small. If the social benefits are taken into account then, even at 20% participation, there is an overall financial benefit to society. The social benefits drop off after the 60% participation mark as the existing consolidated loads are transhipped onto smaller vehicles than they would normally be delivered on.

The alternative approach to analysing this data is below within

Figure 8. Rather than setting an indicative figure for the retail user contribution the operational costs have been displayed as the residual cost per pallet equivalent at each level. For comparison the social benefits are also displayed against the overall operational costs. This graph then demonstrates that under this technique the cost effective rate continues to improve as more retailers join, even for the fully consolidated loads but the peak of social benefit is at the 60% level.

Above the 60% participation level are the major stores, supermarkets and department stores already operating close to fully consolidated deliveries. It would be very unlikely that they could identify a business case that would (or should) support their participation with an FCC given the double handling costs and loss of control over the supply chain that would entail.

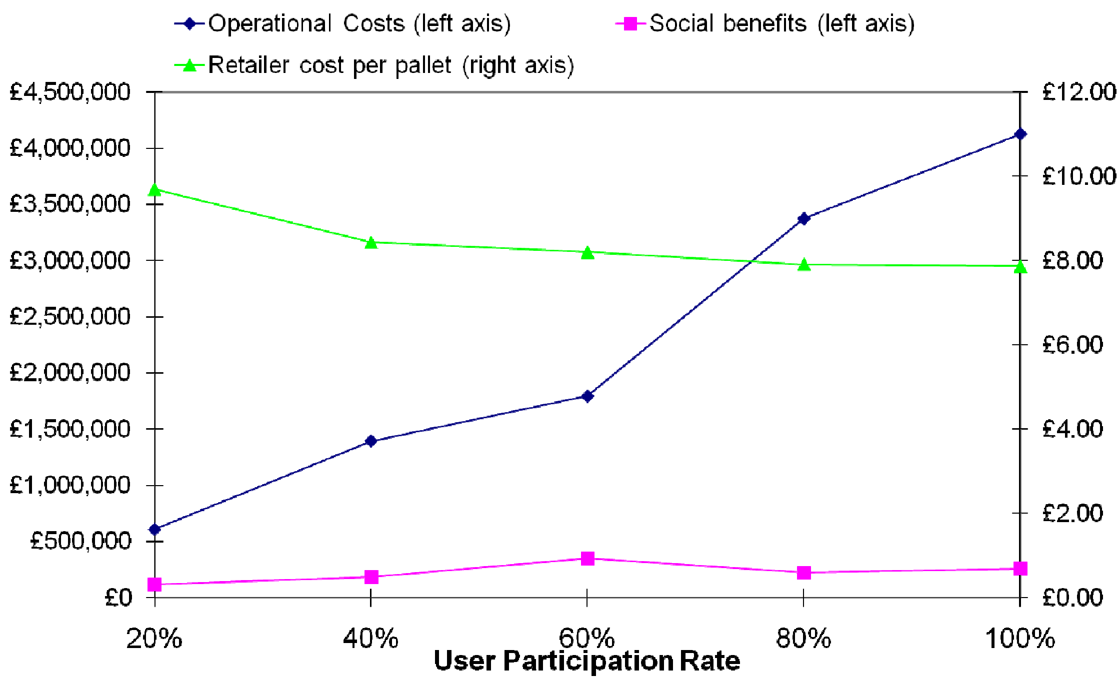


Figure 8 Analysis of annual operational costs, social benefits and the residual financial cost per pallet required for a Shopping Centre FCC using a shared facility and 7.5 tonne vehicles

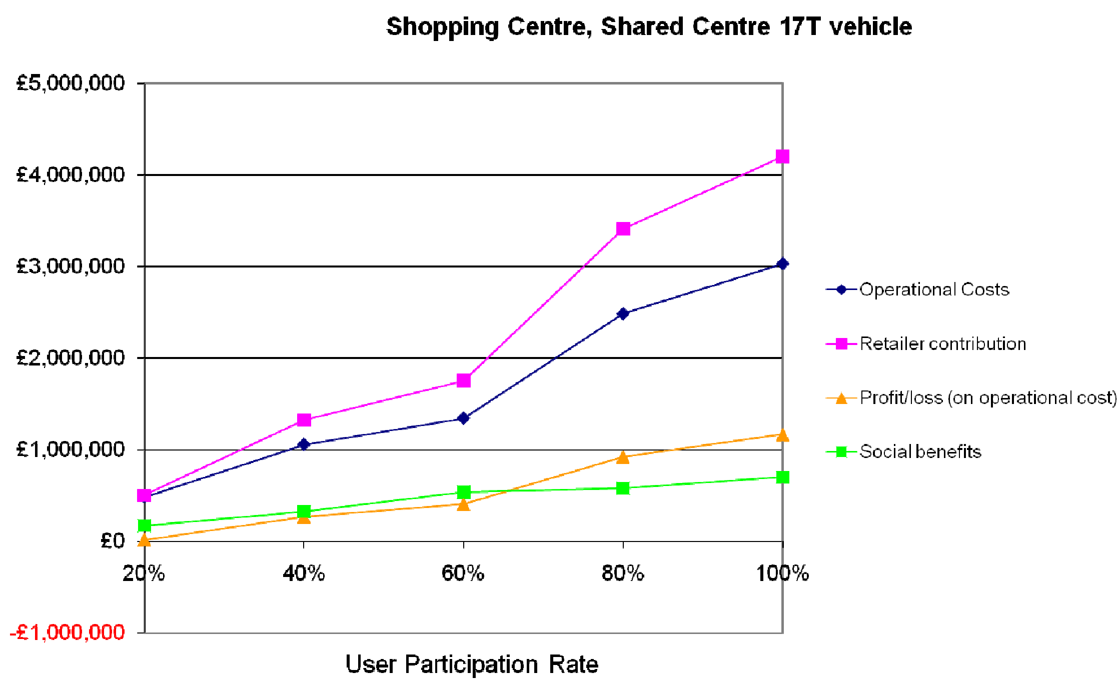


Figure 9 Analysis of annual operational profitability for a Shopping Centre FCC using a shared facility and 17 tonne vehicles

Figure 9 demonstrates the same approach as

Figure 7 with the use of 17 tonne vehicles. This scenario operates in complete profit, though it is marginal at the 20% participation level and this is based upon all retailers paying the fixed fee of £8 per pallet. The FCC appears to get increasingly profitable after the 60% level though it is important to remember that retailers between the 60%-100% participation level will find it very difficult to justify the contribution costs as they are already, in the main, operating efficient urban distribution systems.

In

Figure 10 the retailers cost per pallet for shared centre using 17 tonne vehicles is almost at its cheapest at the 60% participation level. The actual operational cost at the point though is significantly cheaper than in the 7.5 tonne shared scenario. The social benefits are also more considerable mainly as a result of the larger vehicles taking more miles off the road. The cheaper pallet rate is also a result of the relative lower costs in vehicles and drivers compared to the operation of a centre using small vehicles.

After the 60% level the social benefits begin to plateau but though there is a small cost per pallet benefit in increasing participation higher. This is in contrast to the 7.5 tonne vehicle scenario where social benefits tailed off after a 60% peak because smaller vehicles would be used to replace consolidated high capacity vehicles as used by the larger stores, especially supermarkets.

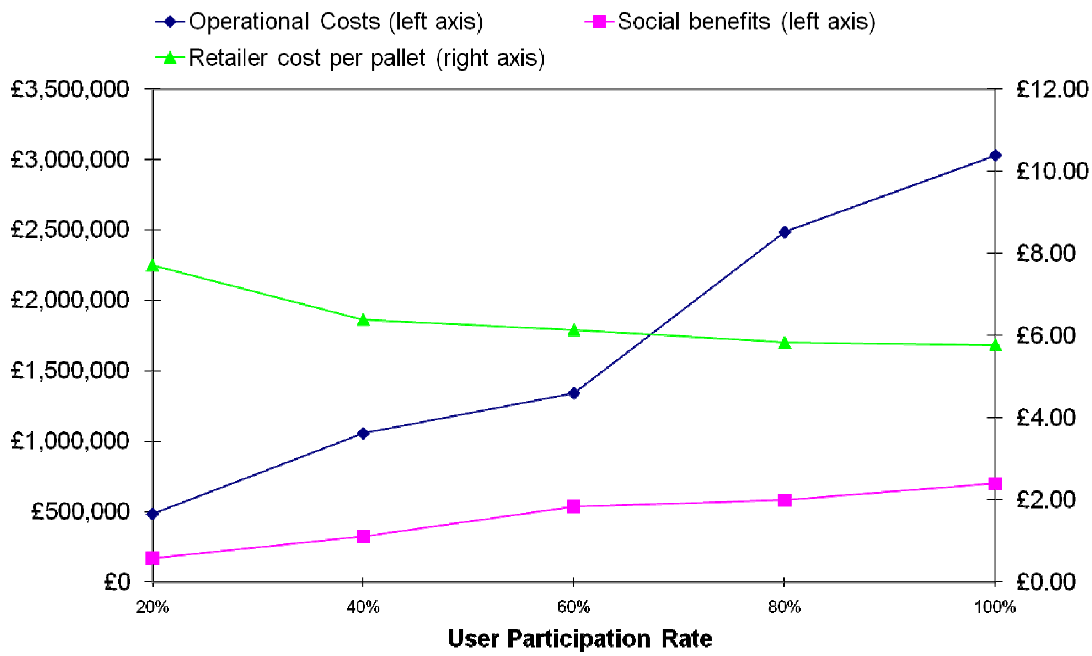
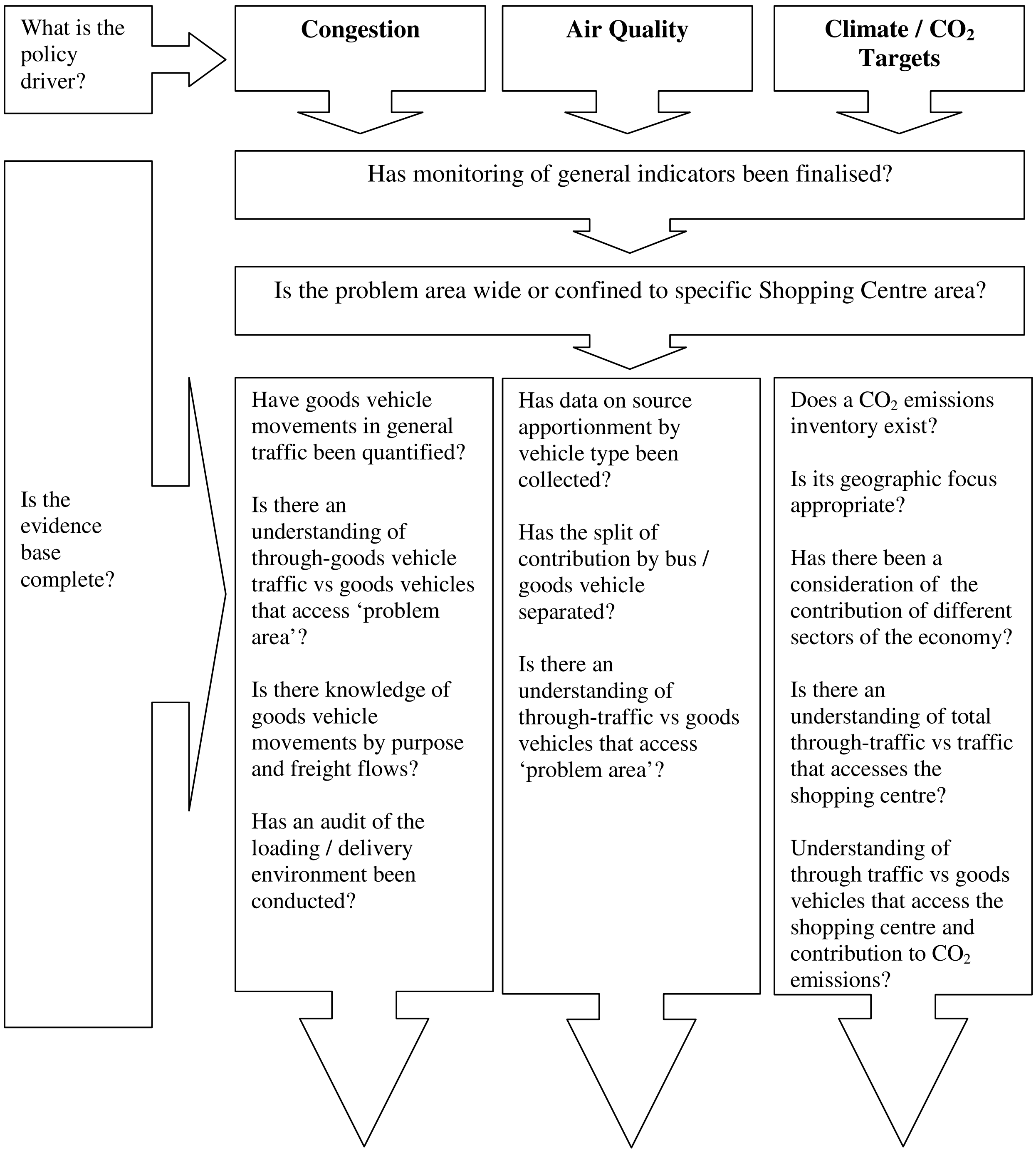
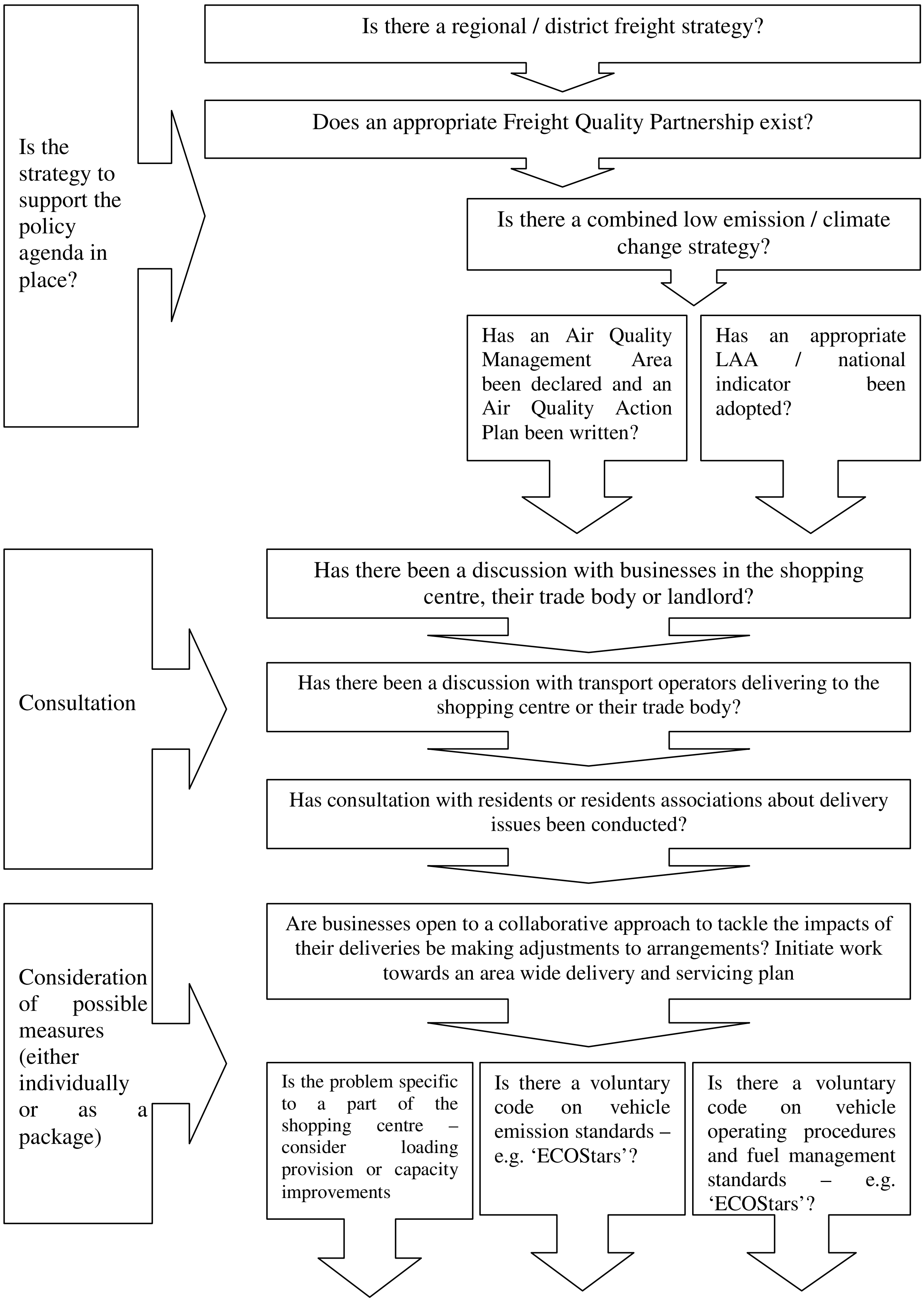
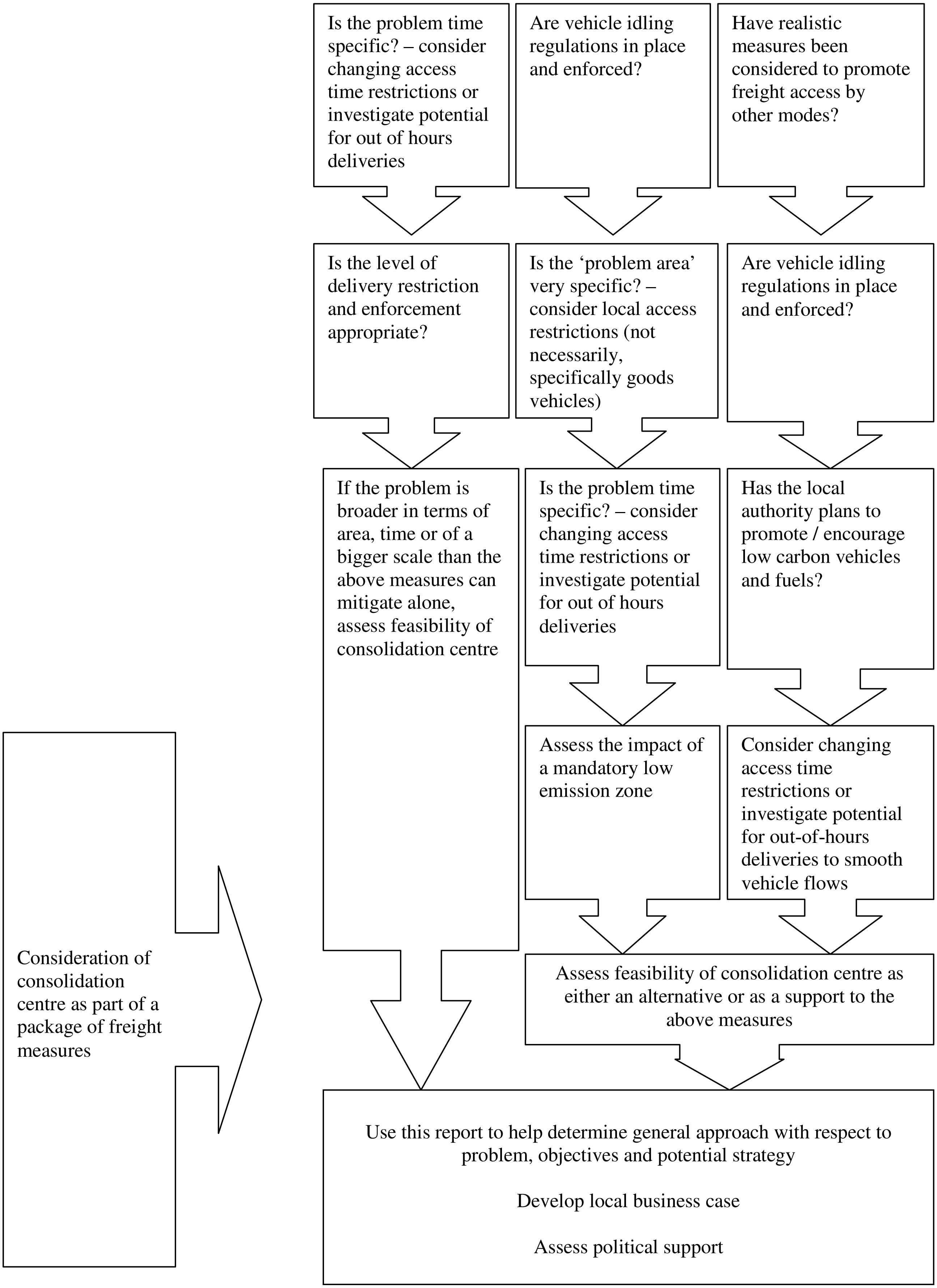


Figure 10 Analysis of annual operational costs, social benefits and the residual financial cost per pallet required for a Shopping Centre FCC using a shared facility and 17 tonne vehicles

3.5 Implementation decision tree (Shopping Centre)




Is the strategy to support the policy agenda in place?
Is there a regional / district freight strategy?
Does an appropriate Freight Quality Partnership exist?
Is there a combined low emission / climate change strategy?
Has an Air Quality Management Area been declared and an Air Quality Action Plan been written?
Has an appropriate LAA / national indicator been adopted?
Consultation
Has there been a discussion with businesses in the shopping centre, their trade body or landlord?
Has there been a discussion with transport operators delivering to the shopping centre or their trade body?
Has consultation with residents or residents associations about delivery issues been conducted?
Consideration of possible measures (either individually or as a package)
Are businesses open to a collaborative approach to tackle the impacts of their deliveries be making adjustments to arrangements? Initiate work towards an area wide delivery and servicing plan
Is the problem specific to a part of the shopping centre – consider loading provision or capacity improvements
Is there a voluntary code on vehicle emission standards – e.g. 'ECOStars'?
Is there a voluntary code on vehicle operating procedures and fuel management standards – e.g. 'ECOStars'?


Is the problem time specific? – consider changing access time restrictions or investigate potential for out of hours deliveries
Are vehicle idling regulations in place and enforced?
Have realistic measures been considered to promote freight access by other modes?
Is the level of delivery restriction and enforcement appropriate?
Is the 'problem area' very specific? – consider local access restrictions (not necessarily, specifically goods vehicles)
Are vehicle idling regulations in place and enforced?
If the problem is broader in terms of area, time or of a bigger scale than the above measures can mitigate alone, assess feasibility of consolidation centre
Is the problem time specific? – consider changing access time restrictions or investigate potential for out of hours deliveries
Has the local authority plans to promote / encourage low carbon vehicles and fuels?
Assess the impact of a mandatory low emission zone
Consider changing access time restrictions or investigate potential for out-of-hours deliveries to smooth vehicle flows
Consideration of consolidation centre as part of a package of freight measures
Assess feasibility of consolidation centre as either an alternative or as a support to the above measures
Use this report to help determine general approach with respect to problem, objectives and potential strategy
Develop local business case
Assess political support

3.6 Key Findings and Recommendations

The graph below provides a strong visual representation of the different FCC costs using the cost per pallet equivalent measure. The benchmark cost threshold of £8 per pallet equivalent which has been agreed with FCC service providers as a reasonable rate is used for guidance.

Four key observations can be identified from this:

- Electric vehicles currently add a premium that might affect commercial viability though as the technology is rapidly becoming more affordable this may change within a year or two. A local authority that gains the value of lower emissions may, however, want to consider covering the difference in cost.
- Within the voluntary scenario there is a significant cost advantage to operating as part of a shared site because costs of management, supervision and warehouse equipment are then apportioned across multiple activities of which the FCC is only one.
- The cost savings in reduced lease and driver costs from running one of the two larger capacity HGV classes of vehicle are substantial.
- Mandatory participation drives down the cost per pallet significantly though it should be remembered that these figures include some high capacity loads which are already substantially consolidated. It is extremely unlikely that retailers (supermarkets, department stores) operating close to fully consolidated loads would (or should) participate with an FCC given the double handling costs and loss of control over the supply chain.

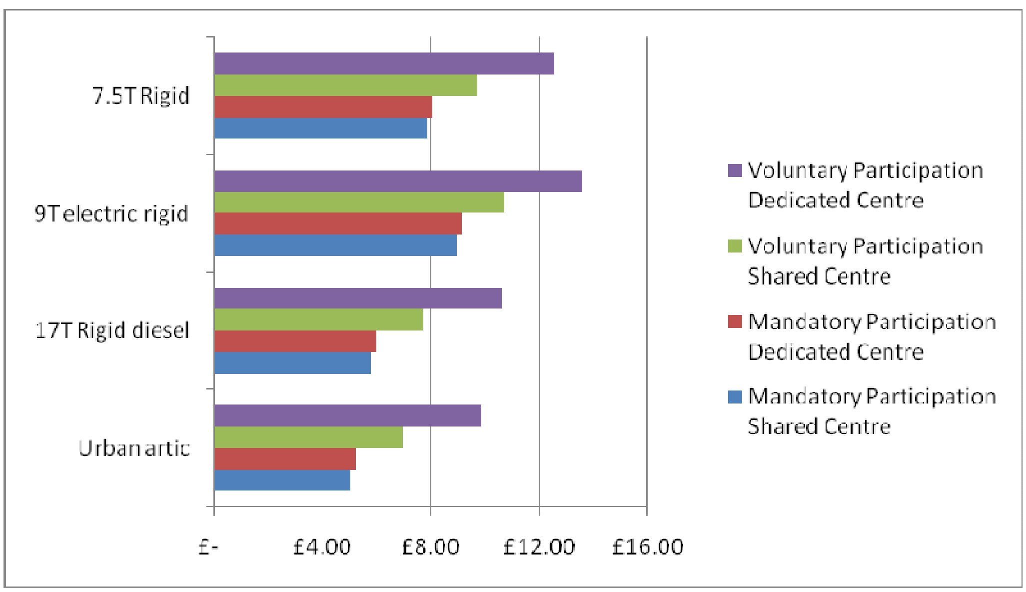


Figure 11 Graph comparing the FCC financial cost per pallet rates using different vehicle types within the Shopping Centre scenario

Further observations:

- Urban Artics should be well suited to a modern shopping centre environment where the delivery bays and access road will almost certainly have been designed to handle that size of vehicle.

- For some stores, supermarkets and non-franchised department stores the existing deliveries are already highly consolidated. Therefore there is no benefit of including these stores within an FCC operation given the associated costs of warehouse space and 'double handling' costs in either an optional or mandatory participation scenario.

- Given the similar nature, in terms of lorry movements, the calculations for a shopping centre FCC are broadly comparable to those we see in the next section for a town centre/ high street FCC. However the Net Present Value (NPV) of the social benefits is lower; at best, just over £4 million over five years when using urban artics at a mandatory participation FCC. Mandatory participation would be unlikely though given that a business already operating fully consolidated loads and an efficient urban delivery network would be unlikely to justify FCC pallet charges (be it £4 or £8).

- The main benefits arise from reduced congestion, although noise is also quite important. If the benefits of reduced congestion were to be reduced to 83% of that forecast then the most significant impact would be to reduce the advantages of a mandatory FCC using urban artic vehicles to £2,511,780 over a five year period. Again the benefits of using electric vehicles probably underestimate their impact on noise reduction.

	Mandatory	**Voluntary**
7.5T Rigid	£1,200,000	£540,000
9T Electric rigid	£1,370,000	£560,000
17 Rigid diesel	£3,200,000	£780,000
Urban Artic	£4,050,000	£885,000

Table 12 Net Present Value of Social Benefits to Shopping Centre Scenario over 5 years

4 HIGH STREET

4.1 Scenario Detail

The second scenario modelled is the High Street or Town Centre area. In practice, this is not too dissimilar from the Shopping Centre scenario, though it would reflect a location comprising of mixed retail and office space, with greater control on parking and deliveries from the local authority. Other scenario features include:

- Numerous landlords or property owners
- Limited and various delivery facilities
- A mixture of chain store companies and local sole trader businesses
- Parking, road and delivery restrictions are actively managed by the local authority
- The area would tend to develop organically – evolving rather than have large development changes implemented at once

An example of this type of implementation would be Regent Street in Central London.

4.1.1 Scenario Assumptions

Sharing many characteristics with the Shopping Centre scenario the following assumptions on the operation of the FCC have been made within the model:

- The FCC would be open to receive deliveries on a 24/7 basis
- The FCC would make deliveries to stores 6 ½ days a week, 7am-7pm
- The FCC is located approximately 6 miles by road from the area being served
- No operator's management charge or profit margin has been added into the FCC operating costs
- Deliveries would be made to the store as a simple drop-off at the delivery entrances to the stores (or other applicable entrance)
- The retail\office mix and total number of stores used in the model is based on an average from five different town centre studies.
- The voluntary participation scenario assumes a 20% take up primarily focused on the medium sized stores.
- There are sufficient problems with direct deliveries that there is some incentive to retailers to participate

4.2 Findings of High Street Scenario

The following tables detail the results of the High Street scenarios outputted from the study model. As with the Shopping Centre scenario we have looked at the differences which occur between mandatory/ voluntary participation and whether or not the consolidation centre is shared/ dedicated and also investigated the differences in cost and impact between four different vehicle types.

The initial observation to be made is that, whilst the scenario has a number of characteristic differences to the Shopping Centre model, there is a general consistency in the results between the two.

		Baseline for 100% of retail stores (equiv. to mandatory)	Baseline for 20% of retail stores (equiv. to voluntary scenario)
Baseline (no FCC)	Total mileage (per week)	18,495.7	3,081.4
	Emissions NOx (g per week)	188,262.3	30,446.5
	Emissions PM (g per week)	3,902.1	637
	CO_2 (kg per week)	29,531.4	4,755.3

Table 13 Summary of non-FCC baseline in High Street scenario

Table 13 provides weekly baseline data for the scenario of no freight consolidation centre. The factor difference of approx 6:1 between total mileage and emissions isn't the same as the voluntary participation level of 20% as the profile of delivery loads and delivery vehicles for the stores that would typically participate within a 20% uptake level is different to that for an overall average of the stores..

	Mandatory Participation		Voluntary Participation	
	Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
Facility size required (square foot)	39,762	40,000	3,716	4,000
Throughput (pallet equivalents per week)	9,940		929	

Table 14 Summary of FCC space requirements in High Street scenario

Table 14 provides us with a useful measurement for facility size, particularly the difference between mandatory and voluntary participation by retailers which changes the size requirement by a factor of 10:1 even though the participation levels are at 20%. This is an even greater difference than that in the Shopping Centre scenario. The primary reason for this discrepancy is that the high throughput and heavily consolidated supermarkets and non-franchised department stores have been excluded from the voluntary participation scenario. There are also a greater proportion of supermarkets in the High Street scenario compared to the Shopping Centre.

As with the Shopping Centre results, in the tables below those scenarios which have produced a cost per pallet of approx £8 or less have been highlighted in green for easy identification as a benchmark cost per pallet.

		Mandatory Participation		Voluntary Participation	
		Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
7.5T Rigid	Total FCC annual cost	£ 4,065,690	£ 4,128,518	£ 500,647	£ 688,099
	Cost per pallet	£ 7.87	£ 7.99	£ 10.36	£ 14.25
	Total staff	101	104	12	19
	Total vehicles	45		5	
	Total vehicle runs per week	1243		117	
	Total mileage (per week)	14,916		1,404	
	Emissions NOx (g per week)	45,657		4,297.6	
	Emissions PM (g per week)	781		73.5	
	CO_2 (kg per week)	15,688.3		1,476.7	

Table 15 Summary of FCC using 7.5 tonne rigid vehicles in High Street scenario

Table 15 shows the results of using Medium Goods Vehicles as the FCC delivery fleet. This demonstrates the difference between the operations of a mandatory participation system against a voluntary system. The former has much higher overall costs which are needed to handle the throughput required but can also then achieve a lower cost per pallet rate. The voluntary system costs approx 12-17% of the mandatory scenario but the cost per pallet rate is 32-78% higher (dependant on whether the centre is shared or dedicated respectively).

The result once again demonstrates the benefit of a shared centre over a dedicated centre within both mandatory and voluntary scenarios. The difference remains marginal within a mandatory participation scheme but becomes rather more significant within the voluntary version (albeit not cost effective using the 7.5 tonne rigid vehicles).

		Mandatory Participation		Voluntary Participation	
		Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
9T electric rigid	Total FCC annual cost	£ 4,624,948	£ 4,687,776	£ 546,001	£ 733,453
	Cost per pallet	£ 8.95	£ 9.07	£ 11.30	£ 15.18
	Total staff	94	96	12	19
	Total vehicles	74		7	
	Total vehicle runs per week	1243		117	
	Total mileage (per week)	14,916		1,404	
	Emissions NOx (g per week)	0		0	
	Emissions PM (g per week)	0		0	
	CO_2 (kg per week)	12,373		1,165	

Table 16 Summary of FCC using 9 tonne electric rigid vehicles in High Street scenario

Table 16 provides the same information using a fleet of 9 tonne electric vehicles. As with the Shopping Centre results, the emission savings over the baseline are significant as would be expected and the CO_2 produced is the least of all the vehicles.

As before, the use of the electric vehicle results in a set of costs per pallet that is above our predefined benchmark of £8 per pallet equivalent. However the mandatory participation and shared centre scenario is within a pound of this level so as costs reduce in this area (or increase for diesel vehicles) then the electric vehicle may soon become commercially viable.

		Mandatory Participation		Voluntary Participation	
		Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
17T Rigid diesel	Total FCC annual cost	£ 2,994,097	£3,056,925	£ 399,523	£ 586,974
	Cost per pallet	£ 5.79	£ 5.91	£ 8.27	£ 12.15
	Total staff	68	70	9	16
	Total vehicles	26		3	
	Total vehicle runs per week	711		67	
	Total mileage (per week)	8,532		804	
	Emissions NOx (g per week)	49,869.9		4,699.4	

		Mandatory Participation		Voluntary Participation	
		Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
	Emissions PM (g per week)	834		78.6	
	CO_2 (kg per week)	16,584.1		1,562.8	

Table 17 Summary of FCC using 17 tonne rigid diesel vehicles in High Street scenario

Table 17 shows the results for a 17 tonne rigid diesel and demonstrates how with extra vehicle capacity and therefore fewer overall vehicles and drivers, the total costs are reduced. For the mandatory scenarios the overall cost reduction is 26% compared to using 7.5 tonne vehicles with the voluntary scenarios 15-20% lower.

The cost per pallet within a voluntary participation setting using a shared centre remains short of being at a cost effective level using this larger vehicle type whilst within the Shopping Centre scenario this had reached an affordable level.

The positive benefit of reduced cost is not matched by a reduction in emissions. The overall NOx emissions are around 9% higher in this scenario compared with the 7.5 tonne truck with PM emissions 6.8% higher and carbon emissions 5.7% higher.

		Mandatory Participation		Voluntary Participation	
		Shared Centre	Dedicated Centre	Shared Centre	Dedicated Centre
Urban artic	Total FCC annual cost	£2,597,717	£2,660,545	£ 359,803	£ 547,255
	Cost per pallet	£ 5.03	£ 5.15	£ 7.45	£ 11.33
	Total staff	55	57	8	14
	Total vehicles	18		2	
	Total vehicle runs per week	498		47	
	Total mileage (per week)	5,976		564	
	Emissions NOx (g per week)	46,536.3		4,392	
	Emissions PM (g per week)	718.6		67.8	
	CO_2 (kg per week)	15,457.3		1,458.8	

Table 18 Summary of FCC using urban articulated vehicles in High Street scenario

Table 18 summarises the results for an FCC using only Urban 'Artic' vehicles. The results show that the costs are reduced yet again to lower levels as the vehicle size increases.

The Shared Centre costs for voluntary participation are a significant 29% lower than with a Dedicated Centre.

The emissions levels are broadly similar to those produced under the 7.5 tonne rigid results (approx 2% higher NOx, 9% lower PM, 1.5% lower CO_2) which are only bettered by the electric vehicles within the shopping centre scenario results.

Graphs comparing the emissions between vehicles for this scenario in a mandatory environment can be seen in Annex A.

4.3 Costs and Benefits

4.3.1 Financial Costs and Benefits

The costs and benefits for the high street scenarios are broadly in line with the shopping centre analysis in Section 3. This section examines any differences between the two retail scenarios rather than duplicating any analysis.

4.3.1.1 Landlords and Developers

Unlike the shopping centre scenario the urban centre area is likely to have a large number of landlords. Most development carried out in such an area is likely to be piecemeal, on a building by building or a street by street basis. Therefore it is a more difficult environment to agree mandating retailer participation through an agreement with a landlord or to negotiate a single revenue stream from the developer under a section 106 agreement or similar.

4.3.1.2 Local Authorities

As there is no single landlord the local authority is a more significant party in the urban centre in terms of organising the direction of development, controlling / enforcing delivery access, considering security implications and the traffic management within the area itself (e.g. vehicle waiting locations). This provides the local authority with greater challenges but with more scope for gaining value from the benefits of a consolidation centre.

4.3.1.3 Distributors

The business case for the retailers and their distribution chain is likely to be stronger than in the shopping centre scenario. Limitations on loading bays, street access, obstructions in the road network, exposure to penalty charge notices are all existing disincentives to direct deliveries. The particular environment of the urban centre being reviewed and the delivery circumstances of each store relate to how likely participation in a FCC scheme would be.

4.3.2 Private costs and benefits

The detail for the following benefit is the same as in the Shopping Centre scenario:

- Freight driver working conditions

An additional benefit identified for the urban centre environment is that of increasing the level of pedestrianisation.

Pedestrianisation of road space

A benefit of the Bristol FCC was the ability to be able to introduce more pedestrianised street space around the Broadmead urban centre as a result of fewer delivery vehicles requiring access. This has an impact on the attractiveness of the area for shopping, creating a more welcoming and safer environment. It becomes much easier to train and provide guidance for how to conduct deliveries to the area when the deliveries are mainly coming from the same distribution site (i.e. the FCC) than when they are coming from numerous suppliers and distribution chains.

4.3.3 Social costs and benefits

The explanatory detail for the following benefits is the same as in the Shopping Centre scenario:

- Accident and casualty impacts
- Environment impacts
- Local employment
- Noise pollution

Overview of social benefits

Table 19 provides a comparison of the overall mileage and emissions savings for each scenario variation against the baseline of no FCC. These figures drive the valuation of the social benefits.

	Baseline	Mandatory	Voluntary + Residual	Mandatory	Voluntary + Residual	Mandatory	Voluntary + Residual	Mandatory	Voluntary + Residual
		7.5T Rigid		9T Electric		17T Rigid		Urban Artic	
Total mileage (per week)	**18,496**	15,144	16,818	15,144	16,818	8,652	16,218	6,060	15,978
% Saving		18%	9%	18%	9%	53%	12%	67%	14%
Emissions NOx (g per week)	**188,262**	46,355	162,113	0	157,816	50,571	162,515	47,190	162,208
% Saving		75%	14%	100%	16%	73%	14%	75%	14%
Emissions PM (g per week)	**3,902**	793	3,339	0	3,265	846	3,344	729	3,333
% Saving		80%	14%	100%	16%	78%	14%	81%	15%
CO_2 (kg per week)	**29,531**	15,928	26,253	12,373	25,942	16,817	26,339	15,675	26,235
% Saving		46%	11%	55%	12%	43%	11%	47%	11%

Table 19 High Street: Comparison of mileage and emissions between baseline and FCCs using different vehicles

Figure 12 provides a visual representation of how the different social benefits weigh up against each other for each variation of the High Street scenario. These costs reflect the Net Present Value (NPV) of benefits over the next five years.

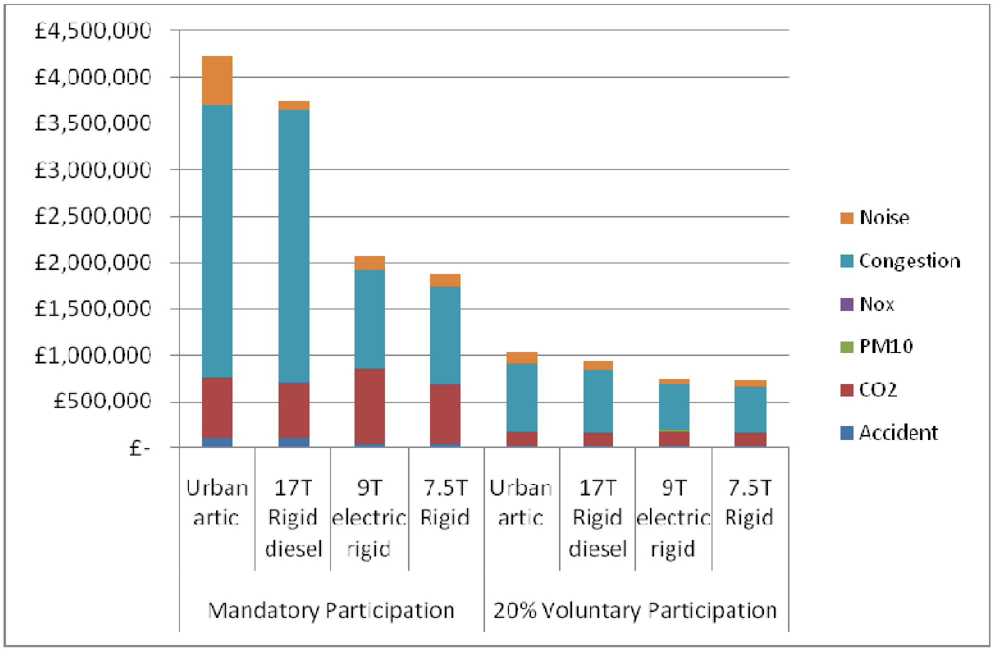


Figure 12 Graph showing the NPV of social benefits over a five year window by benefit category for High Street scenarios

The benefits from reduced congestion make up between 52-78% of the overall social benefits, dependent on scenario, which is substantial. The savings from PM10 and NOx emissions are fairly small (>0.5%) which is particularly interesting given that this is frequently quoted as the main driver by local authorities in either implementation or consideration of an FCC.

4.4 Break even analysis

An objective of this study is to understand the breakeven point of FCC operation where throughput is at sufficient level to ensure operational profitability. This analysis has only been carried out for the shared centres as we have already demonstrated that they are significantly more efficient than dedicated centres. The equivalent graphs for dedicated centres can be seen within Annex D.

Two approaches have been taken. In the first we have assumed that retailers would be willing to pay an average price per pallet equivalent of £8. This is the same rate as the benchmark cost for FCC operation we set in the cost analysis previously. The reality is that the retailer's price may vary from retailer to retailer within the same FCC based on a range of variables including contract duration, weight of goods, value of goods, number of stores owned by the same retailer and additional pre-sales service offered.

The second approach assumes a variable cost per pallet rate that would be paid by retailers at each level to cover the operational costs.

In both of these approaches please remember that this study has not included any value for the FCC operators profit margin. These would need to be added onto the values presented. A ‘normal’ profit margin for consideration may be 6% (3.5% gilts interest and 2.5% additional return to cover risks) in order to make the activity commercially viable.

The analysis looks at two vehicle types, the 7.5 tonne and the 17 tonne so there is a comparison between a medium goods vehicle and a heavy goods vehicle. These are also the two vehicle sizes in most common use within existing centres.

The graph plots the throughput at 20% incremental levels of retailer participation rather than of throughput itself. This distinction is key, the ‘early adopters’ in this analysis are those stores receiving poorly consolidated deliveries whereas at the 60-100% adoption levels the stores which already receive consolidated loads using an efficient urban distribution system switch to the FCC. For clarity, the 100% voluntary adoption level is the same as mandatory participation described previously.

	Voluntary Participation Level				
Store type	20%	40%	60%	80%	100%
Supermarket	0	0	0	1	2
Department store (no.)	0	0	1	1	1
Department store - franchised (e.g. Debenhams) (no.)	0	0	0	0	0
Large store (no.)	1	1	2	2	2
Medium store (no.)	8	12	15	18	21
Small store (no.)	10	23	35	48	57
Barrow (no.)	1	1	1	1	1
Food outlets (no.)	4	10	16	23	29
Office (no.)	2	5	8	10	13
Total Stores	**26**	**52**	**78**	**104**	**125**

Table 20: Breakdown of the different retail participation levels used within the break even analysis for the Urban Centre scenarios

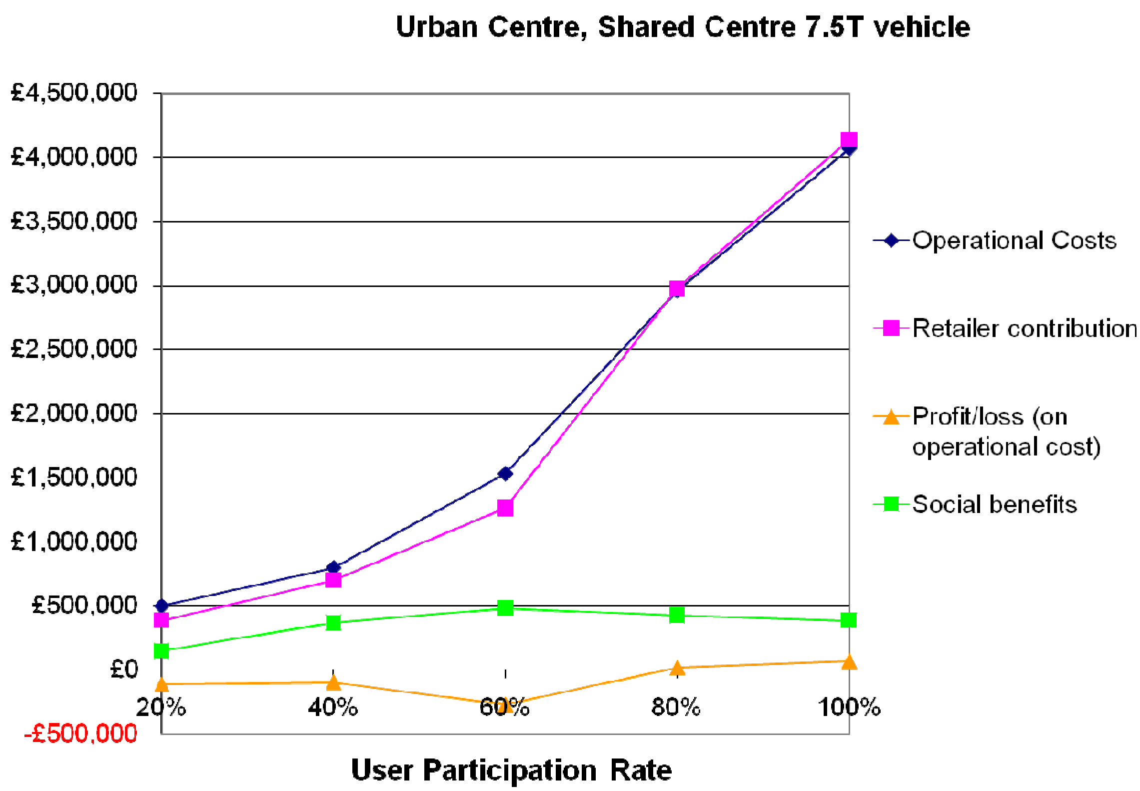


Figure 13 Analysis of operational profitability for a High Street/Urban Centre FCC using a shared facility and 7.5 tonne vehicles

Figure 13 shows how, for the Urban Centre shared FCC using 7.5 tonne vehicles, the breakeven point is at the 80% participation rate. However, if the social benefits are taken into account then this gives an overall financial benefit to society from the 20% participation point onwards.

An alternative approach to analysing this data is below within

Figure 14. Rather than setting an indicative figure for the retail user contribution the operating costs that are have been displayed as the retailer cost per pallet equivalent at each level. This graph then demonstrates that under this technique the most cost effective rate for retailers will be found at the 80-100% participation level though the overall operational cost does increase sharply after 80% (thus the risk of exposure to an operator would also be increased after this point). The peak of social benefit is at the 60% level.

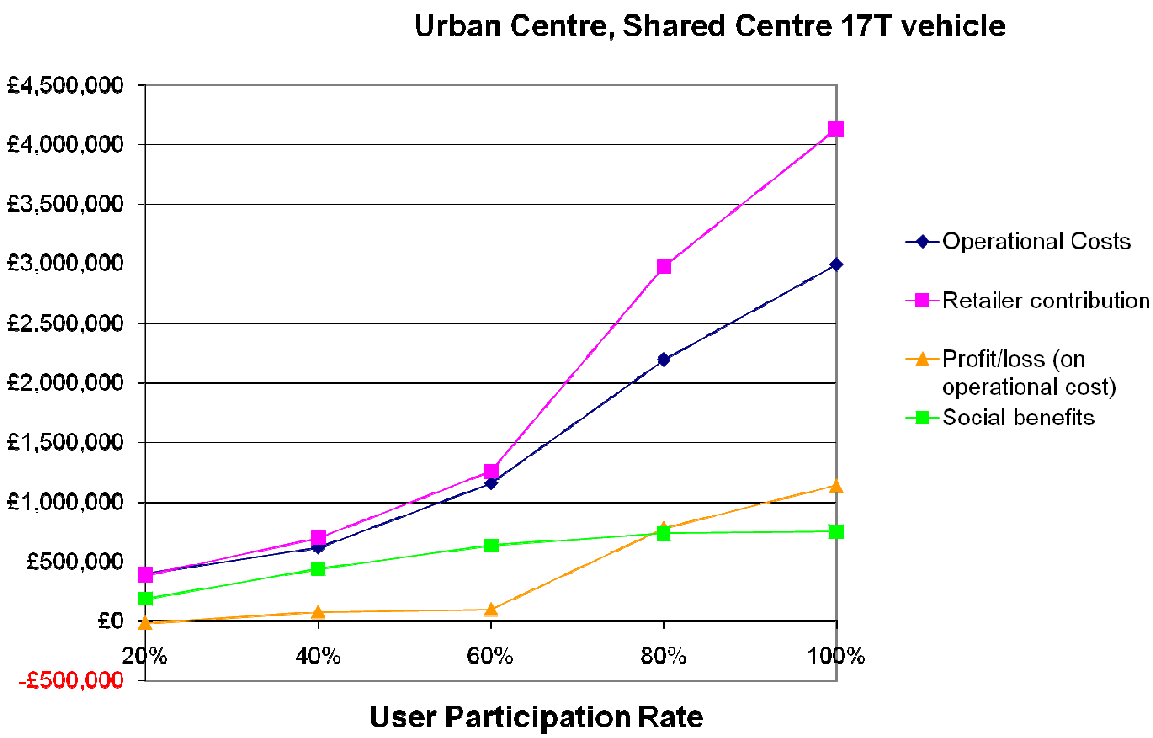


Figure 14 Analysis of annual operational costs, social benefits and the residual financial cost per pallet required for a High Street/Urban Centre FCC using a shared facility and 7.5 tonne vehicles

Figure 15 (overleaf) demonstrates the same approach as

Figure 13 with the use of 17 tonne vehicles. As with the Shopping Centre the FCC operates in profit from a fairly low participation point, of around the 25% level in this instance (extrapolated figure). After this point there is little need for additional investment to cover the difference between retailers paying a fixed fee of £8 per pallet and the FCC operational costs. The FCC appears to get increasingly profitable after the 60% level though it is important to remember that retailers between the 60%-100% participation level will find it very difficult to justify the contribution costs as they are already, in the main, operating an efficient urban distribution system. The social benefits plateau after the 80% mark.

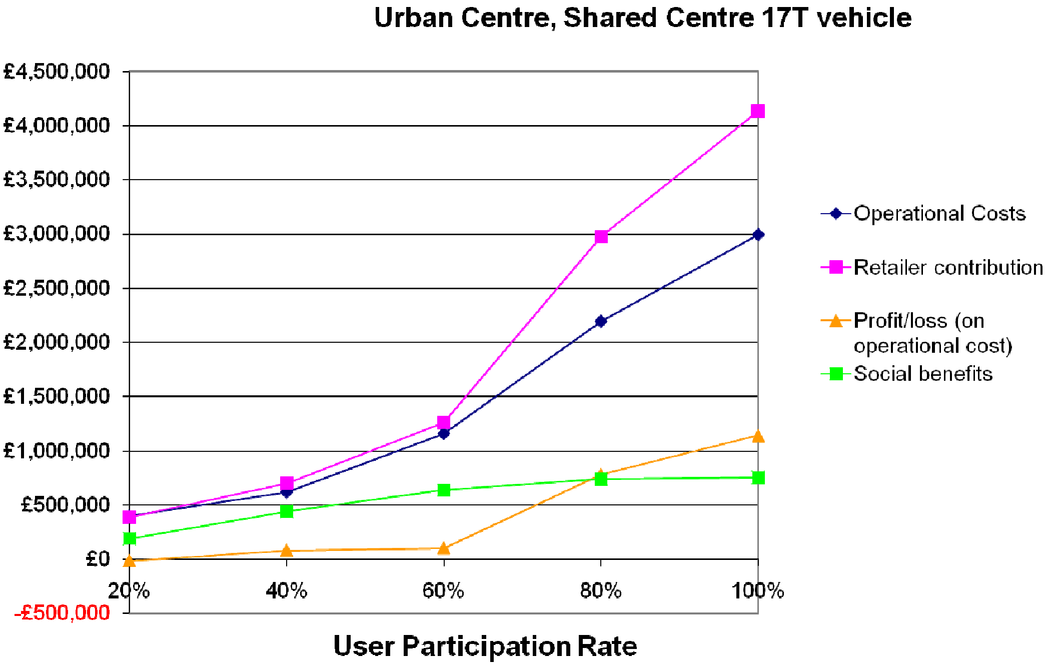


Figure 15 Analysis of operational profitability for a High Street/Urban Centre FCC using a shared facility and 17 tonne vehicles

In Figure 16 the residual cost per pallet for a shared centre using 17 tonne vehicles plateaus at its cheapest at the 80% participation level. The actual pallet costs at are significantly cheaper than in the 7.5 tonne shared scenario. This is driven by the relative lower costs in vehicles and drivers compared to the operation of a centre using small vehicles. The relative increase in social benefits compared to the 7.5 tonne scenario is mainly as a result of the larger vehicles reducing overall mileage.

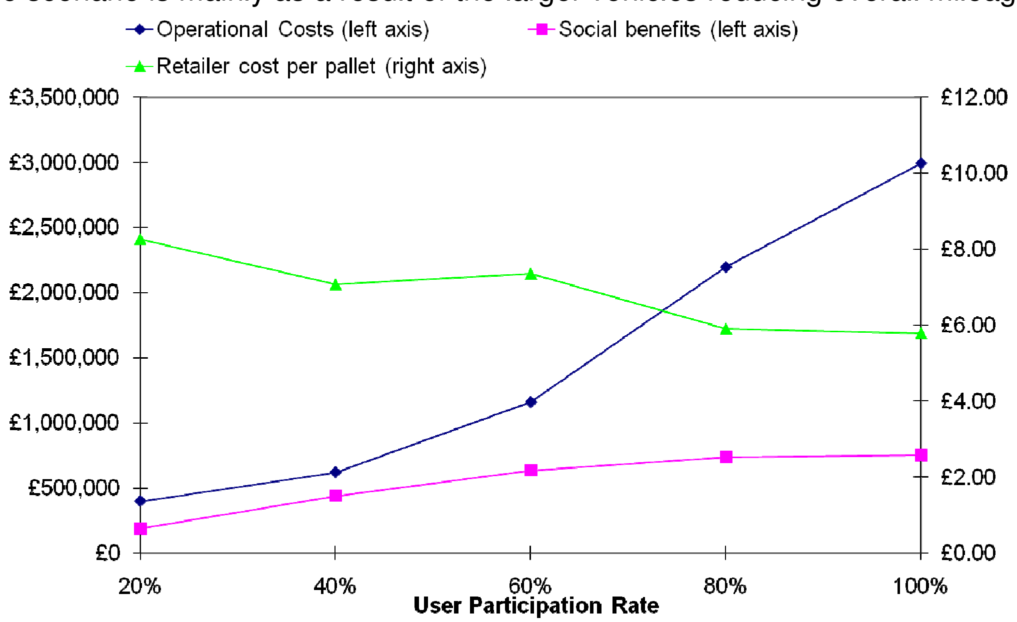
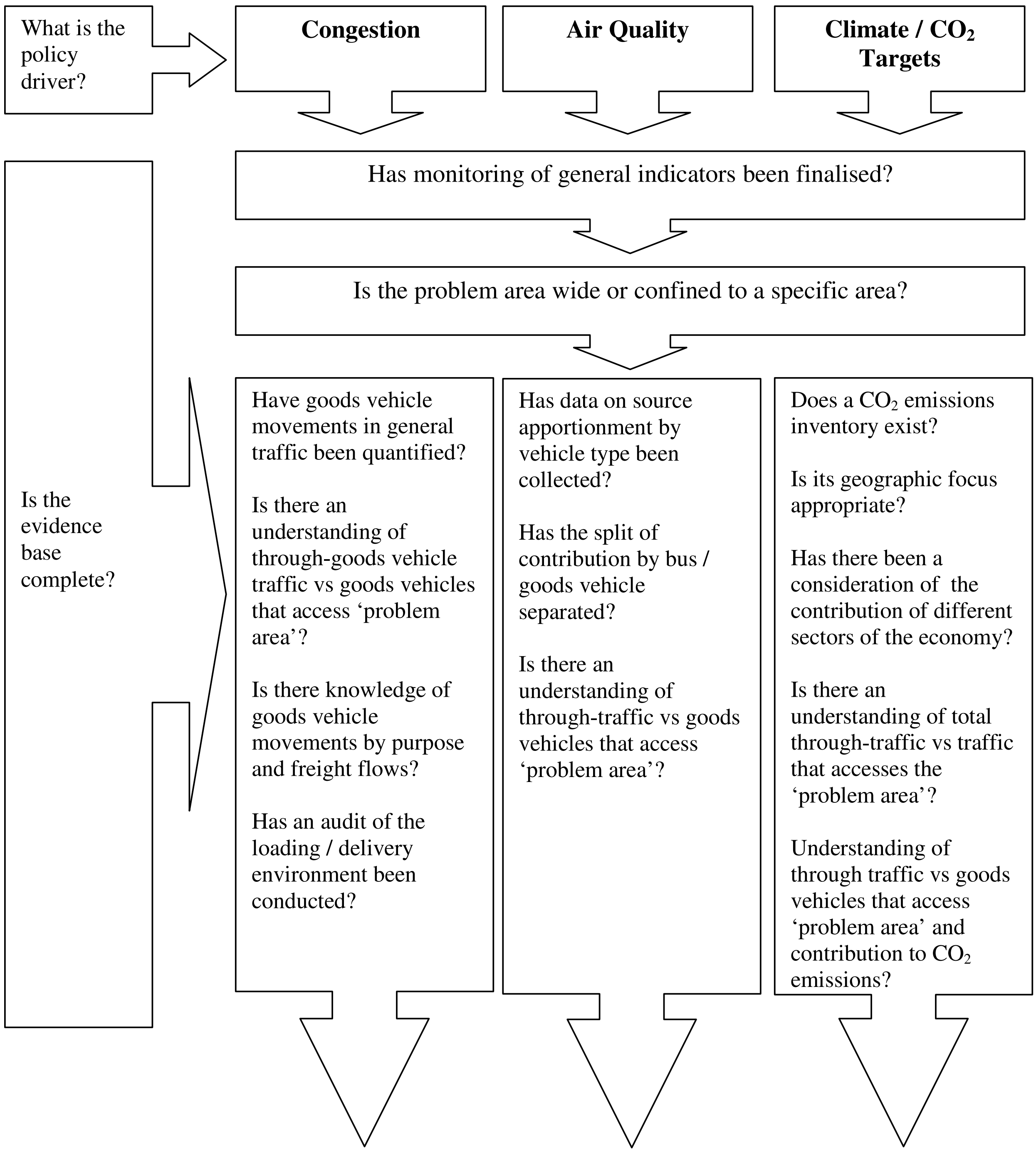
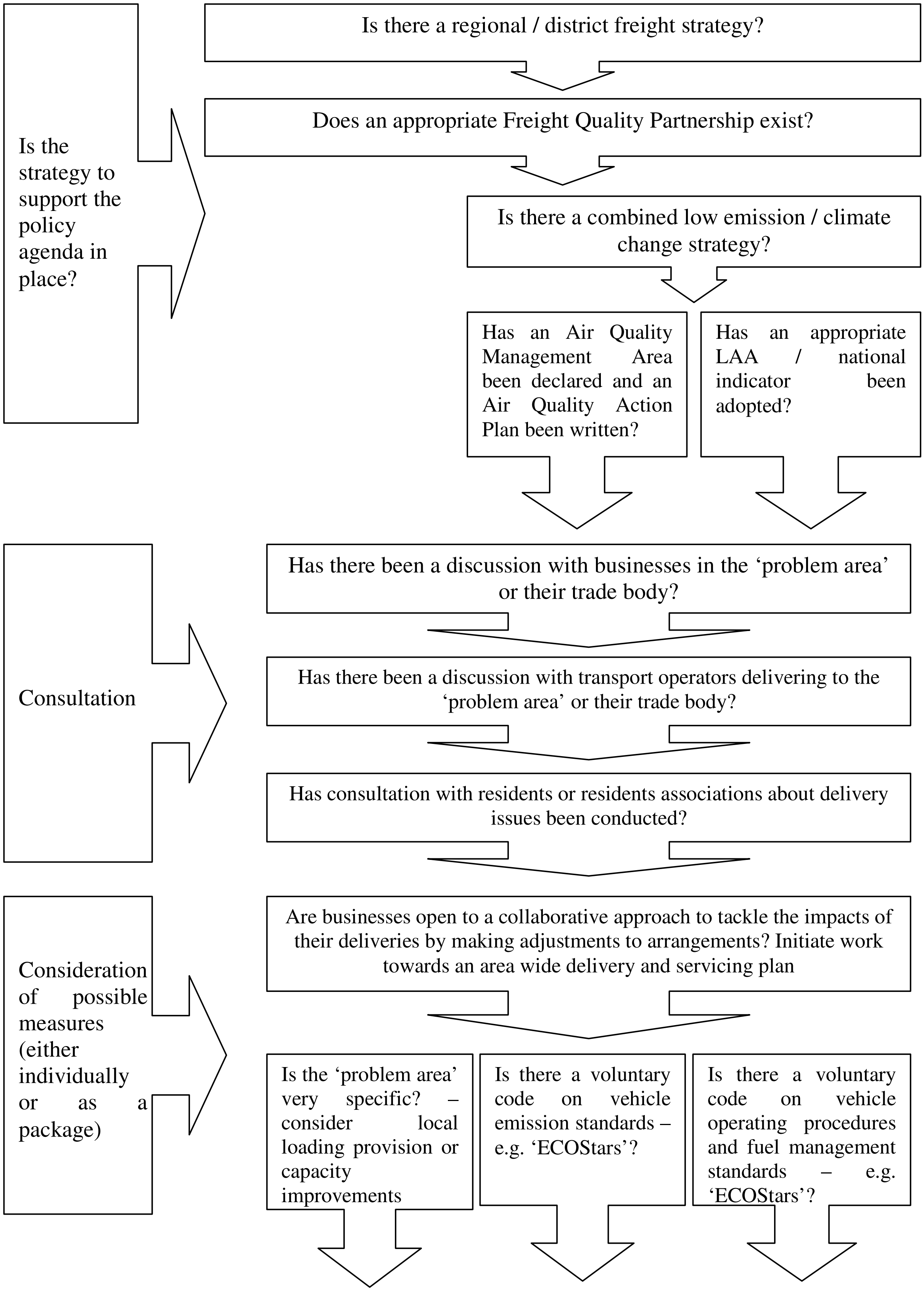
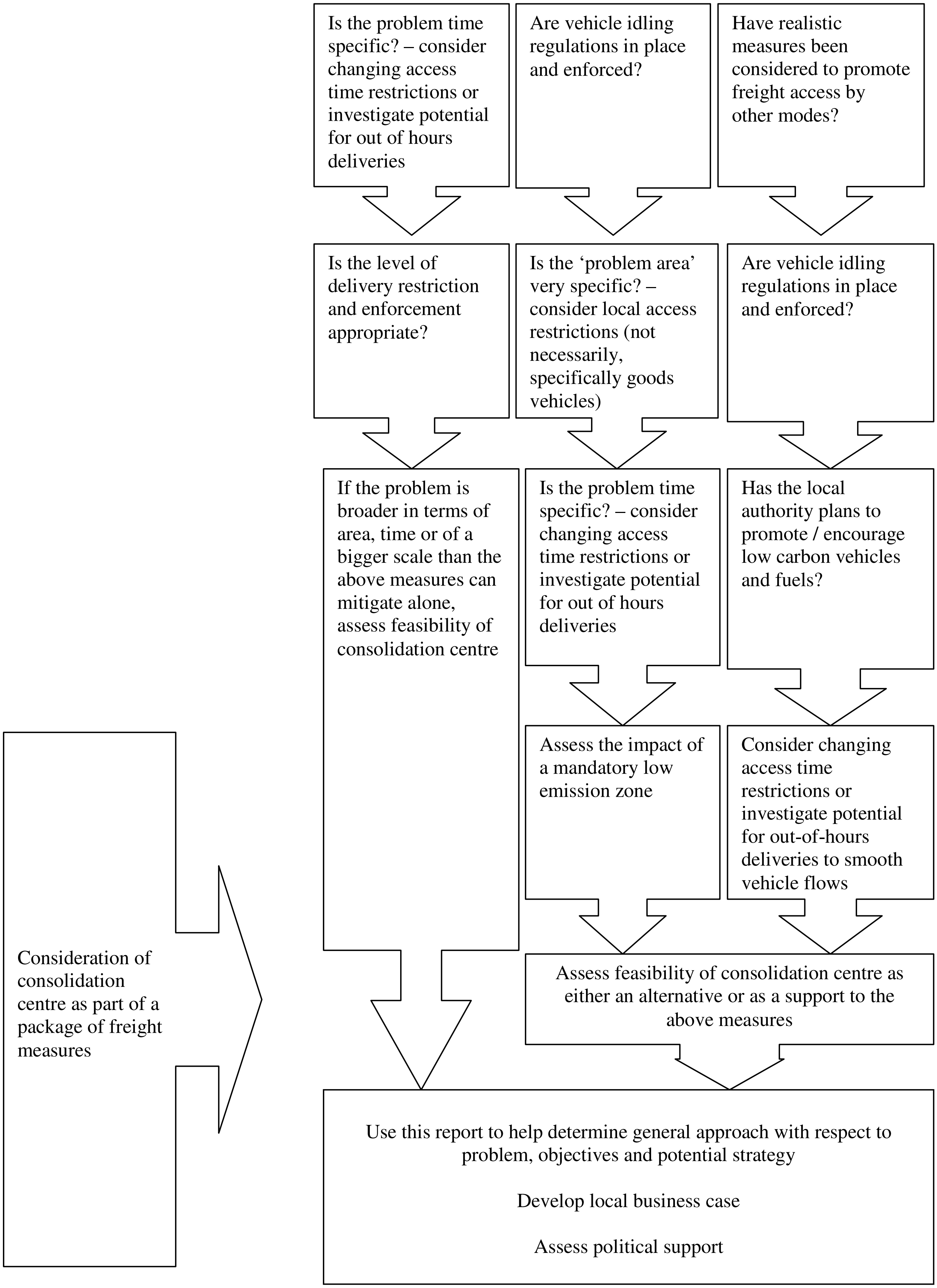


Figure 16 Analysis of annual operational costs, social benefits and the retailer financial cost per pallet required for a High Street/Urban Centre FCC using a shared facility and 17 tonne vehicles

4.5 Implementation Decision Tree (High Street)




Is the strategy to support the policy agenda in place?
Is there a regional / district freight strategy?
Does an appropriate Freight Quality Partnership exist?
Is there a combined low emission / climate change strategy?
Has an Air Quality Management Area been declared and an Air Quality Action Plan been written?
Has an appropriate LAA / national indicator been adopted?
Consultation
Has there been a discussion with businesses in the 'problem area' or their trade body?
Has there been a discussion with transport operators delivering to the 'problem area' or their trade body?
Has consultation with residents or residents associations about delivery issues been conducted?
Consideration of possible measures (either individually or as a package)
Are businesses open to a collaborative approach to tackle the impacts of their deliveries by making adjustments to arrangements? Initiate work towards an area wide delivery and servicing plan
Is the 'problem area' very specific? – consider local loading provision or capacity improvements
Is there a voluntary code on vehicle emission standards – e.g. 'ECOStars'?
Is there a voluntary code on vehicle operating procedures and fuel management standards – e.g. 'ECOStars'?


Is the problem time specific? – consider changing access time restrictions or investigate potential for out of hours deliveries
Are vehicle idling regulations in place and enforced?
Have realistic measures been considered to promote freight access by other modes?
Is the level of delivery restriction and enforcement appropriate?
Is the 'problem area' very specific? – consider local access restrictions (not necessarily, specifically goods vehicles)
Are vehicle idling regulations in place and enforced?
If the problem is broader in terms of area, time or of a bigger scale than the above measures can mitigate alone, assess feasibility of consolidation centre
Is the problem time specific? – consider changing access time restrictions or investigate potential for out of hours deliveries
Has the local authority plans to promote / encourage low carbon vehicles and fuels?
Assess the impact of a mandatory low emission zone
Consider changing access time restrictions or investigate potential for out-of-hours deliveries to smooth vehicle flows
Consideration of consolidation centre as part of a package of freight measures
Assess feasibility of consolidation centre as either an alternative or as a support to the above measures
Use this report to help determine general approach with respect to problem, objectives and potential strategy
Develop local business case
Assess political support

4.6 Key Findings and Recommendations

The graph below provides a strong visual representation of the different FCC costs using the cost per pallet equivalent measure. The benchmark cost threshold of £8 per pallet is used for guidance.

Four key observations can be identified from this:

- Electric vehicles are currently not quite affordable enough to be commercially viable though as the technology is rapidly becoming more affordable this may change. A local authority that gains from the value of lower emissions may, however, want to consider covering the difference in price.
- Within the voluntary scenario there is a significant cost advantage to operating as part of a shared site.
- The cost savings in reduced lease and driver costs from running one of the two larger capacity HGV classes of vehicle are substantial.
- Mandatory participation drives down the cost per pallet significantly though it should be remembered that these figures include some high capacity loads which are already substantially consolidated. It is extremely unlikely that retailers (supermarkets, department stores) operating close to fully consolidated loads would (or should) participate with an FCC given the double handling costs and loss of control over the supply chain.

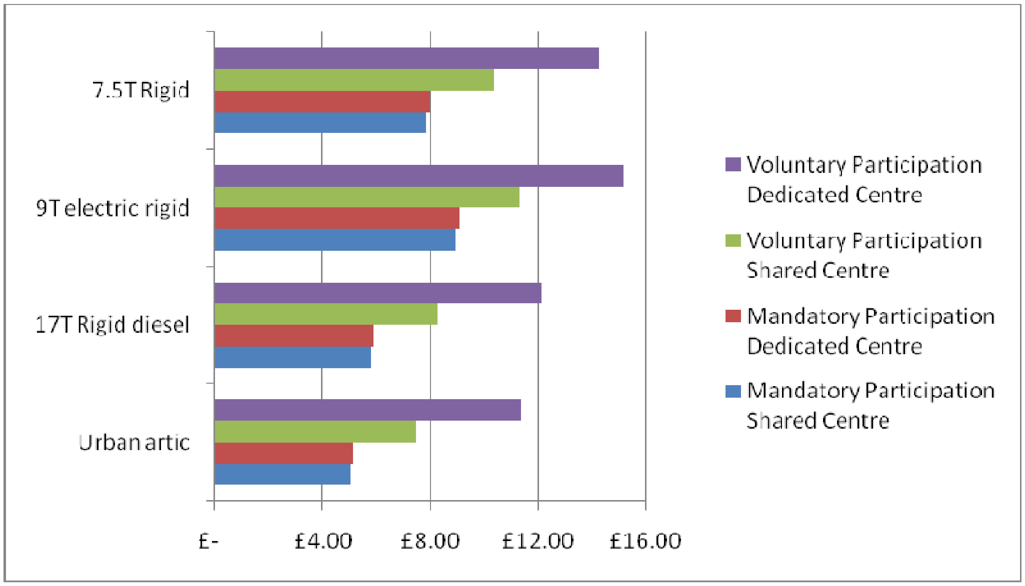


Figure 17 Bar graph comparing FCC financial costs per pallets based on vehicle type used for High Street scenario

- Urban Artics may be better suited to the high street delivery environment due to improved manoeuvrability in comparison to a heavy rigid.

- If implementing an urban centre/ high street FCC the greatest social benefits would arise from using 17T diesel or urban artic lorries (at a mandatory FCC). Benefits of around £4 million might be achieved over a 5 year period if these vehicles were to be used; the explanation being the large reduction in vehicle mileage that could be secured, especially in urban areas. Use of smaller rigid vehicles could also bring substantial benefits however. The benefits of 9T electric rigid vehicles are probably understated since these would bring greater noise advantages over the larger lorries. Noise benefits account for around 8-12% of the total benefits whatever the type of vehicle used.

- If the congestion benefits are reduced in line with the Government's estimates (2010 as 83% of the original forecast) then the values would reduce; the largest reduction being for urban artics at a mandatory FCC. The value of the congestion benefits alone would be reduced by almost £500,000 to £3,188,500 over a five year period.

	Mandatory	Voluntary
7.5T Rigid	£1,890,000	£735,000
9T Electric rigid	£2,000,000	£746,000
17 Rigid diesel	£3,740,000	£940,000
Urban Artic	£4,235,000	£1,030,000

Table 21 NPV of social costs over five years for the high street scenario

5 CONSTRUCTION

5.1 Scenario Detail

The Construction Consolidation Centre, whilst operating on the same general principles as a retail centre, has a number of distinct differences. The consultation also uncovered a number of different commercial and operational models which are used within the construction industry. These include materials storage close to site, use of a remote consolidation centre for selected phases of the project, specification of a dedicated consolidation centre for a project with capacity to cope with peak demand, and shared use facilities throughout build. Often these are included in upfront costings as a single lump sum cost which is easily cut without thought to longer term impacts if budgets are placed under pressure.

The original DfT brief was to investigate the scenario based upon a single construction site. Whilst this is what we have modelled we also recognise as a result of the consultation that many of the cost efficiencies in centre operation come with serving a number of construction projects with overlapping construction phases and have reflected this within our recommendations.

Useful characteristics of Construction Consolidation Centres to bear in mind are:

- CCCs can be a requirement of planning permission
- CCCs are of most use to serve construction sites within areas of heavy congestion, e.g. a city centre, not locations close to the trunk road network
- Suit builds where there are limitations on site access (e.g. a single narrow delivery entrance)
- Suit builds with limitations on space at site for materials storage
- The space requirement for throughput levels is significantly greater than for retail due to lag times that are potentially much longer before delivery to site for many items with long manufacturing lead times and the need for greater 'movement' space both for items that are generally (considerably) bulkier than retail, to allow space for off-site pre-fabrication / checking and larger aisles to accommodate heavier duty forklifts.

5.1.1 <u>Assumptions</u>

The following assumptions have been made within the model in the preparation of the construction scenarios:

- A single large construction project
- Fully consolidated loads are taken direct to site
- The scale of the construction project is 1 million ft^2
- The centre receives deliveries 24/7
- The centre delivers to the site 5 days a week between 8am-5pm
- The centre is at least 6 miles from the construction site

5.1.2 The Construction Lifecycle

A key feature of large scale construction projects of a type which could be served by a Construction Consolidation Centre is that the project can be split into a series of phases, all of which require significant load traffic to the site, but only some of which can be improved on by used of a CCC. The following table provides an indicative view of phases which could be part of a typical large scale project. It is important to remember that phases overlap as skilled trades are moved around the site or shared with other projects.

Phase No.	Description	Freight Activity
1	Make safe (e.g. removal of asbestos or other dangerous items)	Lower volume of traffic to site – smaller vehicles typically.
2	Demolition	Largest volume of trucks in these phases, though loads are full and often travelling away from site, so no practical scope for being served by consolidation centre.
3	Ground works	
4	Sub structure build	Typically direct to site deliveries by truck, this has been included within the study model, split between direct to site and via FCC where appropriate.
5	Super structure build	
6	Exterior cladding / making structure watertight	Typically direct to site with scope for handling some materials through CCC.
7	Internal fit out	Most likely phase for use of a Consolidation Centre
8	Furniture/stock etc	Potential phase for Consolidation Centre usage

Table 22 Example phases of a construction project. Phases 4-8 have been included within the study model

The consolidation centre model has been developed to allow different delivery distributions for each project phase. Figure 18 shows how the delivery activity relating to different phases of the build can be spread across the construction period. Figure 19 shows the total delivery mileage by vehicle type on a month-by-month basis across the construction project. These both illustrate how a construction project has peaks of activity rather than a constant throughput. Having multiple construction projects with non-clashing peaks going through the same consolidation centre would help to smooth out the throughput levels and make the centre more commercially viable to operate.

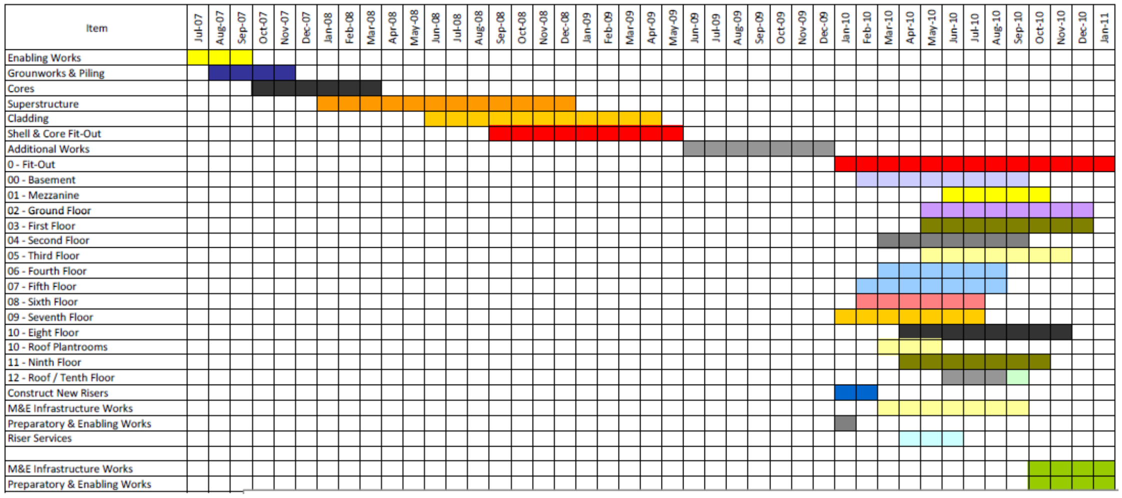


Figure 18 An example schedule of site delivery activity during different construction phases (courtesy of Alandale Logistics and CSB Logistics)

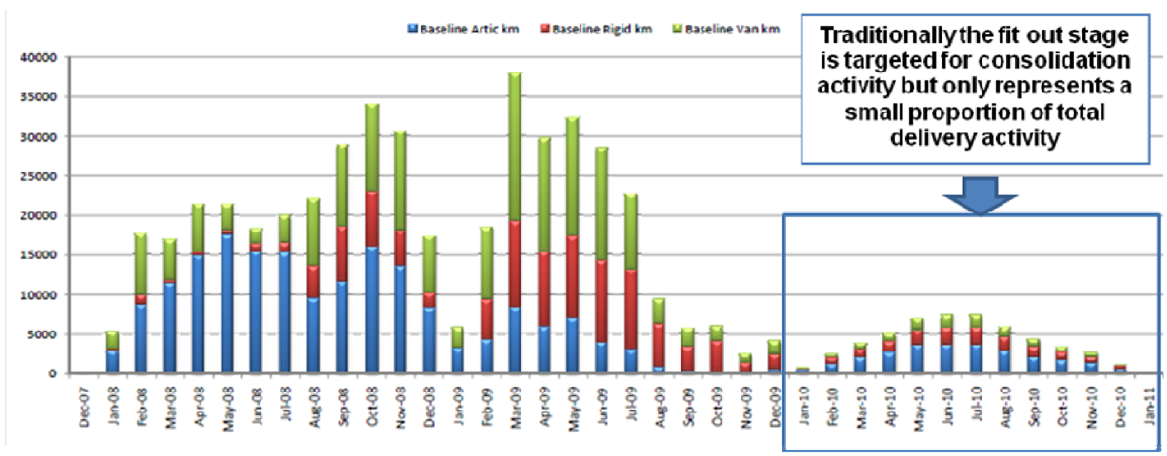


Figure 19 Example distribution of total mileage by vehicle type over the build of a large scale construction project without an FCC (courtesy of Alandale Logistics and CSB Logistics)

5.2 Findings

The following tables detail the results of the construction site scenarios as outputted from the study model. The results look at the difference between whether or not the centre is shared use or dedicated to only the project in question. There is less scope for use of alternate vehicle types within the construction scenario so we have modelled a split in activity between a 17 tonne truck and a 7.5 tonne truck. The model also assumes that an amount of activity is best served by being delivered direct to site rather than through the FCC, this is detailed in the findings below.

		Mandatory Participation	
		Shared Centre	Dedicated Centre
Baseline (no FCC)	Total mileage (for build duration)	198,525	
	Emissions NOx (g for build duration)	1,532,958.7	

		Mandatory Participation	
		Shared Centre	Dedicated Centre
	Emissions PM (g for build duration)	40,302.7	
	CO_2 (kg for build duration)	247,410.9	

Table 23 Baseline delivery activity for the construction scenario

As a construction project has a finite period of operation with peaks and troughs in the amount of material being delivered to the site, the figures for the construction project here are provided on the basis of the overall project, rather than the weekly figures used in the two retail scenarios.

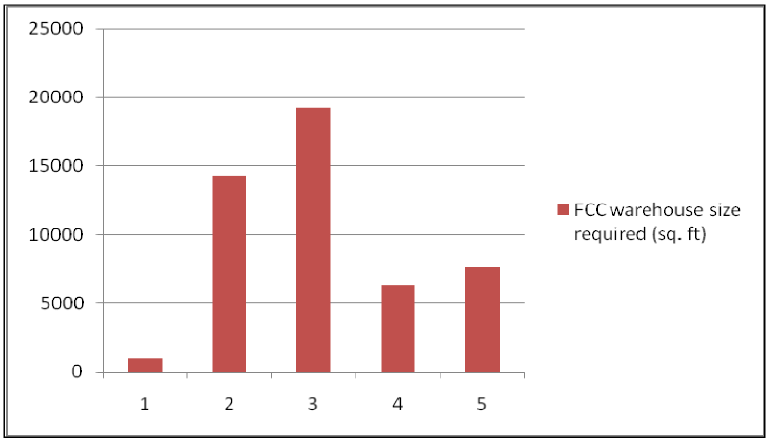


Figure 20 Variations in warehouse size required for each phase of the build (50% van participation)

The scenario has not been modelled from the perspective of mandatory vs voluntary participation as the decision on whether or not to participate on the scale considered in this report will rest solely with either the developer, if they specify it within the initial construction specification, or with the main construction contractor managing the site (subject to external forces to decide one way or another by other parties e.g. the local [planning] authority). Therefore the results within Table 24 are for mandatory participation with a factor included for the significant proportion of deliveries which it would remain sensible to deliver direct to site. However, the data has been modelled in two alternative ways with one scenario looking at 50% of van traffic going via the FCC and the second with 100% of van traffic via the FCC. The definition of van used in this study is a vehicle of up to 3.5 tonnes.

	50% Van Participation		100% Van Participation	
	Dedicated Centre	Shared Centre	Dedicated Centre	Shared Centre
Total FCC annual cost	£ 1,486,787	£ 668,462	£ 1,697,322	£ 731,174
Cost per pallet	£ 22.83	£ 10.27	£ 23.25	£10.01
Peak Facility size required (square foot)	19,232.5		22,357.5	

Total staff	7-11 staff (depending on phase)	7-12 staff (depending on phase)
Total FCC vehicle runs(for build duration)	5,186	6,173
Total non-FCC vehicle runs to site (for build duration)	9,558	5,676
Total mileage (for build duration)	165,562.87	136,641.00
Emissions NOx (g for build duration)	1,203,638.35	1,113,789.62
Emissions PM (g for build duration)	27,170.37	21,452.45
CO_2 (kg for build duration)	235,672.19	218,393.44

Table 24 Model outputs for operation of an FCC for a construction project using a mixture of 17T and 7.5T delivery vehicles

As can be seen in Table 24 the results show that whilst 5,186 delivery trips are made by the FCC during the construction phase there remains a need for 9,558 trips to still be made direct to the site.

The cost effectiveness of shared site over a dedicated site is even greater than in the retail scenarios. The shared site is approximately 35% of the cost per pallet of the dedicated centre which can be attributed to the overheads of the wasted capacity which the dedicated centre has to carry in order to meet the throughput of the peak demand stage.

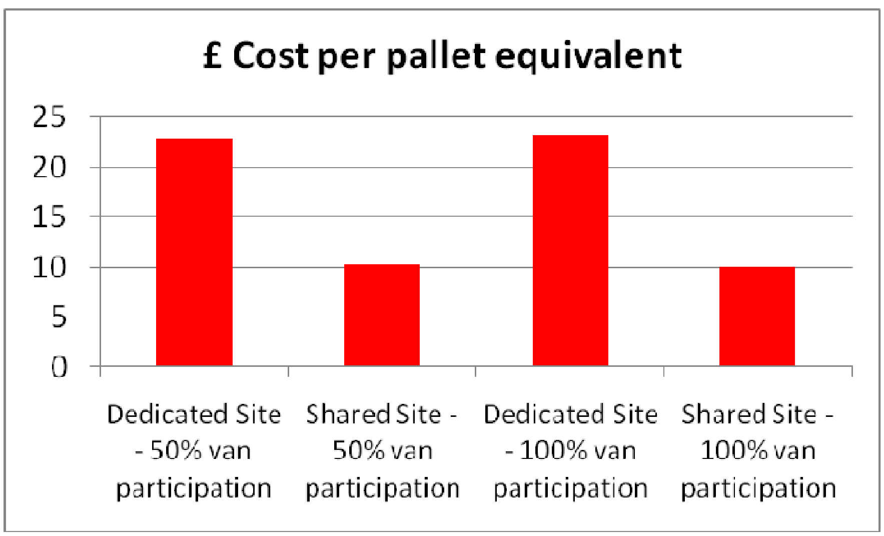


Figure 21 Graphical summary of the different £ cost per pallet equivalent rates for the variations of construction scenario

Figure 21 provides a graphical representation of the results above for the different cost per pallet equivalents achieved under each variation. The operational cost rate on this basis does not significantly differ for either the dedicated or shared centres if the van participation rate varies.

	FCC activity		Residual activity direct to site			
	17T	7.5T	Artic	Large rigid	Small rigid	Van
Total mileage (for build duration)	47,244.28	14,990.63	5,451.84	35,959.94	24,676.62	37,239.56
Emissions NOx (g for build duration)	276,145.01	45,885.41	117,444.37	500,935.62	178,288.19	84,939.75
Emissions PM (g for build duration)	4,617.99	784.95	2,305.67	9,919.57	3,824.74	5,717.45
CO_2 (kg for build duration)	83,105.08	14,268.56	17,593.29	70,660.65	26,373.05	23,671.56

Table 25 Detailed results based on the delivery vehicle mix using an FCC for a construction project (50% van participation scenario)

Table 25 provides a breakdown of the different types of vehicle making the deliveries for both the FCC and the direct to site trips. It demonstrates the emission output of the vehicles which need to continue to deliver directly are more than 3.5 times the emissions produced by the FCC activity, reflecting that the majority of materials actually go straight to site.

Figure 22 provides a visual comparison to how much of the total local mileage is actually transferred via the FCC in each of the scenarios. The impact of increasing vans to full participation is noticeable. At this point around half the total project mileage is now being transferred via the FCC with a significant reduction on the overall local mileage position compared to that of the 50% participation scenario variation.

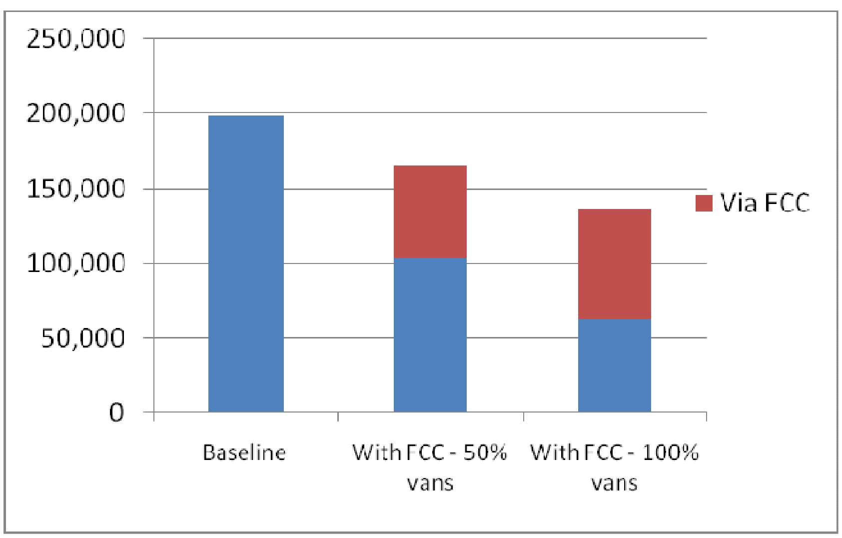


Figure 22 Comparison of local mileage under three construction scenarios

5.3 Costs and Benefits

5.3.1 Financial Costs and Benefits

5.3.1.1 Local Authorities

For local authorities the benefits are the same as the retail centres in terms of reduced emissions with an additional benefit being that our consultation suggests that Construction Centres do not usually require a subsidy as part of their operation.

5.3.1.2 Construction Contractor

There are a number of benefits for the Construction Contractor in the operation of a Freight Consolidation Centre and in modern logistics techniques.

The majority of identifiable cost savings to the contractor in previous studies have been through waste transfer savings. The traditional approach to construction was to order enough stock to ensure staff always have materials to hand including a buffer to take into account onsite damages and theft. The secure and organised environment of the FCC reduces the need for this additional stock as well as making stock returns to suppliers simpler to carry out. Having a reduced amount of material stored on site makes the site a safer place to work.

Most of the savings come from the management and reduction of risk from potential interruptions to the overall construction schedule. One example of the ways that FCC's achieve this is through the implementation of a damage and quality checking regime. An FCC allows for the inspection of materials from the supplier during the holding period before stock is passed to the site. Therefore, any returns can take place without holding up the onsite build process. This has been shown to provide an average saving of 2 weeks in rectification activity over the direct to site delivery scenario for critical items that turn out to be damaged.

Although not commonly publicised to date, the FCC can also provide a storage buffer for long lead time items needed for shell, core, lifts, curtain walling and Mechanical & Electrical (M&E) phases. Having this stock near the site where it can be called in at short notice helps to avoid construction delays.

Existing construction FCCs have demonstrated a saving of 25 minutes per man day of construction tradesman time through having enough material readily available to hand on site and not having to deal with site deliveries to get it[16].

For larger items significant amounts of time can be saved at site if large items coming from the manufacturer are first unloaded at the FCC and then transferred to a loading and handling mechanism that is easier to manage at the site gate; for example through the pre-slinging of materials at the FCC before the delivery to site. This reduces vehicle dwell time at a potentially congested site and reduces the potential for on-site unloading damage though it does in itself introduce an extra set

[16] London Construction Consolidation Centre: Final Report', Transport for London, October 2008 revision

of handling activity requiring resource and insurance which the FCC operator will require payment for taking on the risk. An advantage to the FCC offering is that they will have experienced staff and the appropriate handling equipment in comparison to the onsite contractors who may not.

5.3.1.3 Developer

Construction Consolidation Centres are of interest to the developer only in terms of being a tool for the Construction Contractor to reduce project risk and thereby reducing the overall development cost. The decision to use a CCC or not would be driven by the Construction Contractor rather than the developer unless the local authority has requested use of one as part of planning conditions.

In the instance of the latter, experience shows the consultation that in some instances it's possible for Construction Consolidation Centre operational costs to be added as an extra item to the Construction Contractor's bill to the Developer rather than implemented as a cost saving measure within the build programme. Therefore local authorities may wish to consider if requesting a CCC as part of a build programme is desirable if it is going to be added on as an extra cost to the development rather than as an efficiency saving.

5.3.1.4 FCC Operators

Freight consolidation is now being provided largely on a commercial basis, meaning particularly where either large individual projects or groups of projects are being handled by FCCs which have a significant economy of scale there is a financial return for doing so.

Figure 23 illustrates the different ratios for the different operating costs for the dedicated centre compared to the shared operation centre. As a useful comparison a retail example has also been included to demonstrate how the balance of costs in the construction centre switches more to the warehouse leasing costs and staff rather than the costs of the drivers and vehicles as in retail. This is driven by the requirement to hold construction materials at the FCC for a number of days (up to as many as ten from the experience of those consulted) rather than the few hours to half day of time that retail stock is held before transfer.

The graph also demonstrates an advantage in having an outsourced agreement for transport so that driver and vehicle costs are not being apportioned solely to the FCC. The model for the Shared Centre adopts the methodology used by CSB Logistics of calling in different vehicle types as required, dependant on the material which is being transferred. This approach, as well as reducing vehicle costs overall, allows the FCC to support a wider range of materials than would be possible if the centre was restricted to 3 or 4 of its own vehicle types.

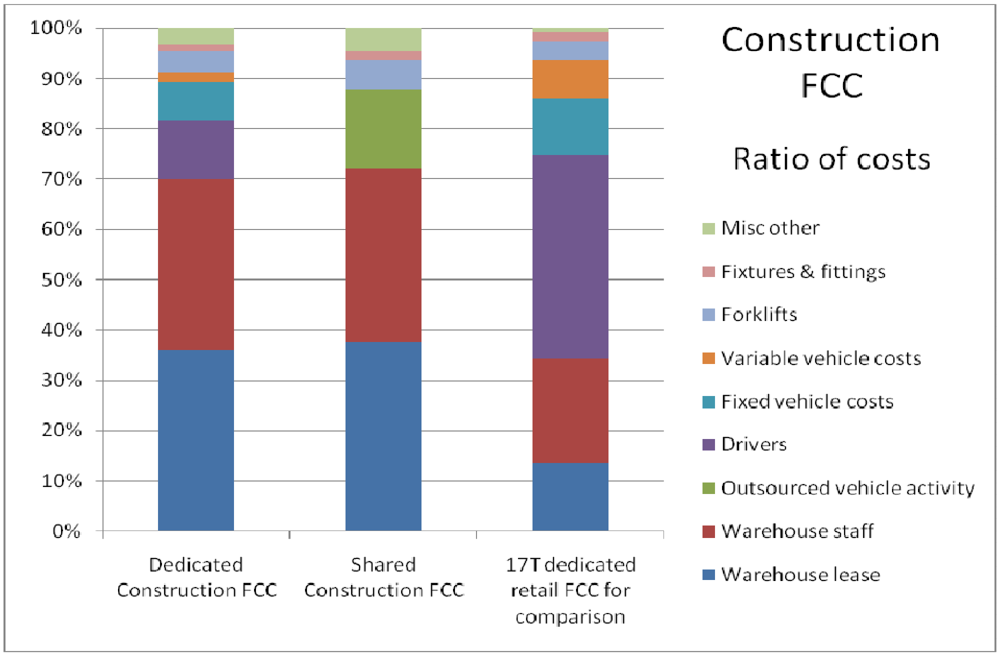


Figure 23 Graph comparing ratio of different operating costs for construction FCC

5.3.1.5 Suppliers

Suppliers are providing a service that meets client needs in terms of improving efficiency as well as taking a significant amount of road miles out of the total supply chain as loads are consolidated, and more importantly reduced congestion as the products are managed into the delivery point on an 'as and when needed' basis. Everyone benefits as suppliers get assured unloading times and the end client gets vital control of the final delivery schedule: 'Right products at the right time'

5.3.2 Private costs and benefits (non-quantitative)

The detail for the following benefit is the same as in the Shopping Centre scenario:

- Freight driver working conditions

5.3.3 Social costs and benefits

The details for the following benefits are the same as in the Shopping Centre scenario:

- Accident and casualty impacts
- Environment impacts
- Local employment
- Noise pollution

An additional social benefit specific to the Construction Scenario is from landfill savings:

Land-fill

One by-product of construction sites is the generation of waste products that, often, end up in land-fill. This incurs charges for local authorities who have to meet EU targets to reduce waste being sent to land-fill. Land-fill is therefore a cost to any local authority and a FCC might help reduce this.

The current rate of landfill tax for non-inert waste is £48/tonne. This is rising at £8/year to discourage sending waste to landfill, and will continue to rise at this rate until 2014 (when it will be £72/tonne). Non-inert waste includes packaging, wood, plasterboard, plastic, metal and organic material, so includes most construction waste. The rate is the same for all local authorities across the UK. The rate for inert material is much lower, £2.50/tonne, but the definition of inert is relatively restricted; soil and stones, crushed rock, concrete, bricks and tiles and glass – all by-products of construction activities.

The amount of construction waste that was sent to landfill was estimated to be about 12.5 million tonnes for 2008 according to the BRE, which is the baseline year for the halving waste to landfill commitment. Any reduction in land-fill resulting from an FCC would therefore benefit the delivery of the target.

Overview of Social Benefits

Figure 24 (overleaf) provides an overview of the value of £49,400 which can be derived from the social benefits. These figures are for the scenario where 50% of the van traffic is using the FCC.

As with the retail scenarios the overwhelming social benefit is derived from the reduction in congestion at £39,225 or 79% of the overall total. An added social benefit for the construction site is waste, though the social saving from this is not as beneficial as the financial savings of reduced material waste is to the construction itself.

The emissions benefits are relatively small at only £2,200 for CO_2, £88 for PM10 and £30 for NOx.

The overall number of benefits is much smaller than with the retail scenarios. This implies that a substantial social benefit only really comes from serving cumulatively a large number of projects rather than the single project modelled here.

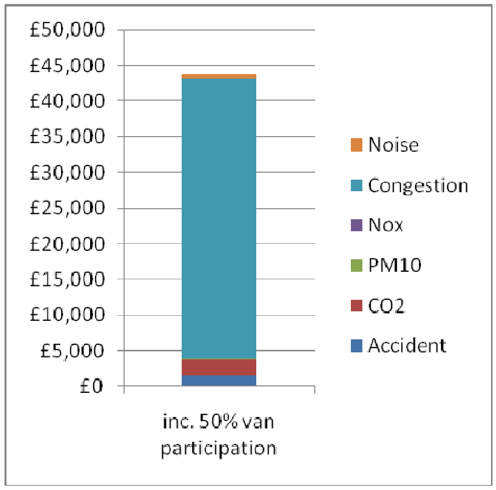


Figure 24 NPV of Social Benefits derived from Construction FCC Scenario (including participation of 50% van deliveries) over lifetime of construction build

5.4 The Wider Construction Toolkit

Whilst the purpose of this study is to address the benefits and costs of Consolidation Centres it would be inappropriate not to look at the wider toolkit of complementary and alternative tools particularly as the construction industry is traditionally less optimised in its usage of logistics techniques.

- **Just in time delivery**: the delivery of materials to site ‘just in time’ for usage thereby reducing the need for onsite stock storage and the associated loss of materials through damage and theft.
- **Reverse logistics:** an enhanced delivery chain which allows for the return of unused goods back to the source supplier. Reduces waste and costs for construction projects.
- **Demand smoothing:** organising deliveries to site so that there are less peaks with associated congestion on site and in traffic and fewer troughs with delivery management staff unable to carry out any activity.
- **Web based delivery booking and tracking systems:** the use of IT systems to track the expected and actual arrival of vehicles and goods in order to provide greater control over delivery management. Without this there is often little grasp on where building materials are at any given time.
- **Consolidation through onsite marketplace:** the provision of an onsite storeroom with shared materials for builders and craftsmen onsite to avoid multiple deliveries of the same basic items.
- **Offsite fabrication:** the building of larger items offsite to limit deliveries of smaller items and site congestion.
- **Better control of materials ordering:** linked to onsite marketplace and facilitated by a consolidation centre, as a measure on its own closer control of ordering has been shown to yield significant benefits.

5.4.1.1 Summary

Previous discussions suggest that by taking this broader approach to improved supply chain management practices in the construction sector (i.e. including, but not limited to, freight consolidation) can save up to 8% of the total cost of the project through the investment in a system that costs no more than 3% of the total project cost. The balance of 5% of total project cost offers a substantial potential saving that should be of real interest to developers if it can be realised[17].

5.5 Break even analysis

An objective of this study is to understand the breakeven point of FCC operation where throughput is at sufficient level to require no continuing investment to cover losses. However in the case of construction FCC's, at least since the experiences of the London Construction Consolidation Centre have been applied, there has not been any external subsidy for a construction consolidation centre. Therefore unlike the retail scenarios this section will only look at the second approach identifying the cost per pallet at different demand levels.

Please remember that this study has not included any value for the FCC operators profit margin. These would need to be added onto the values presented.

The graph plots the throughput at two levels of supplier participation rather than of throughput itself, a level of 50% van delivery participation and of 100% van participation.

Figure 25 and
Figure 26 show that the residual financial contribution per pallet is not overly affected by changes to the participation rate of van deliveries. The social benefits are fairly marginal in comparison to the overall operating costs of the centre. The contribution is greater with the shared centre but the primary driver for the residual financial cost per pallet equivalent being less is the reduction in overall operating costs which come with the shared centre approach.

[17] South London Freight Quality Partnership Construction Logistics Workshop, Croydon Town Hall, March 2008

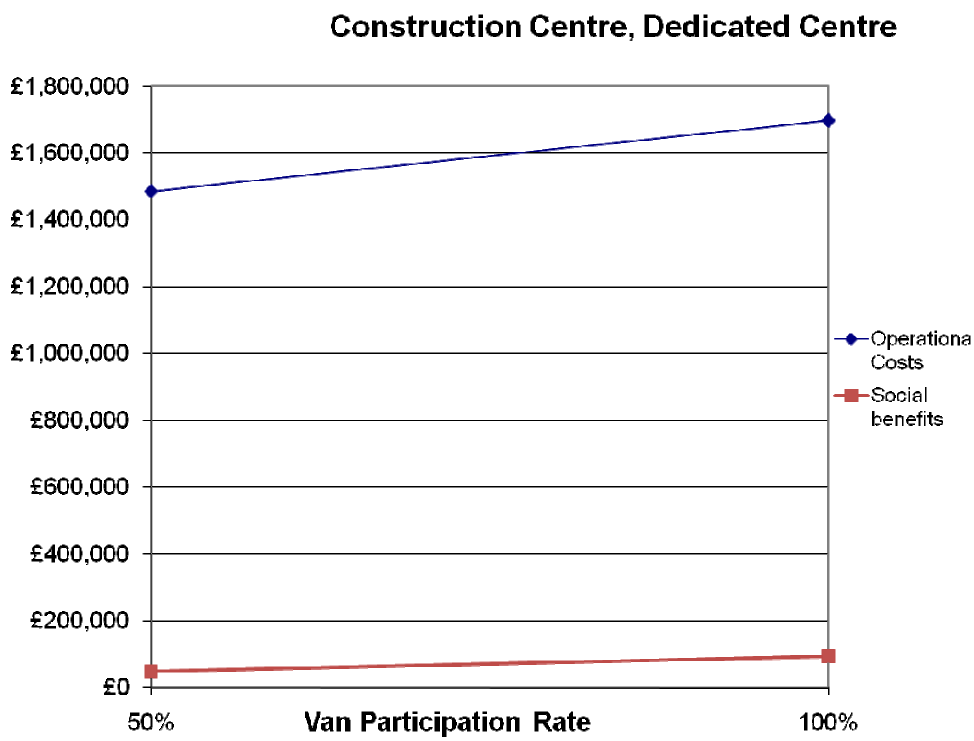


Figure 25 Overview of operational costs, social benefits and residual financial contributions per pallet equivalent for a dedicated construction consolidation centre over the lifetime of the construction project.

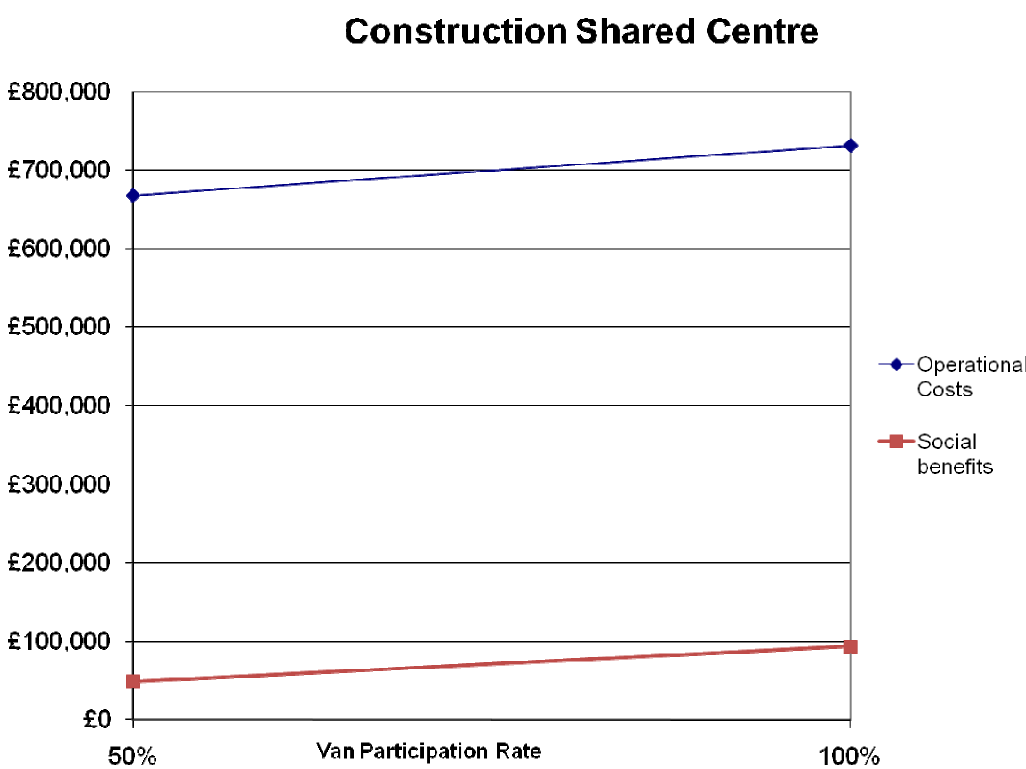
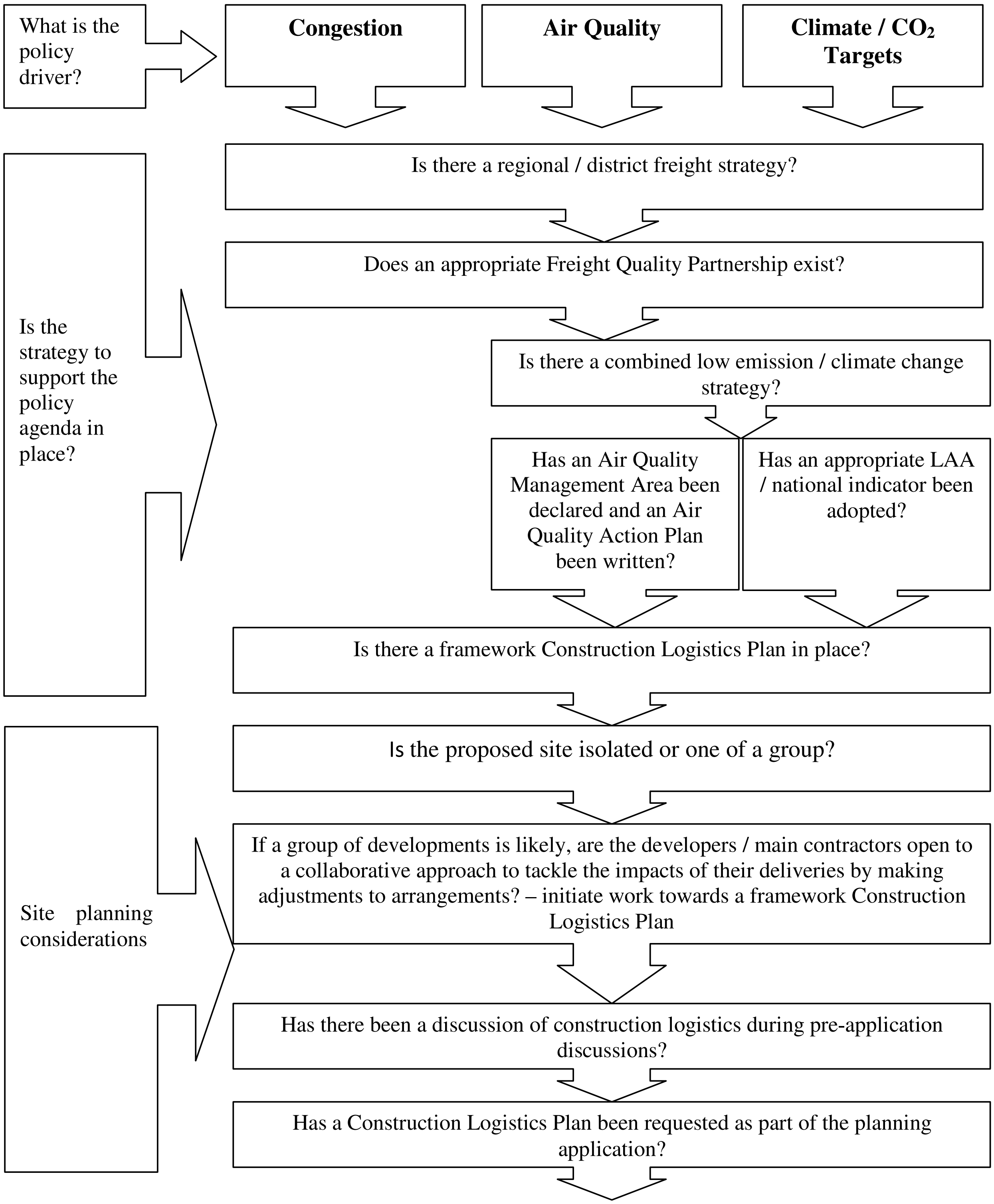
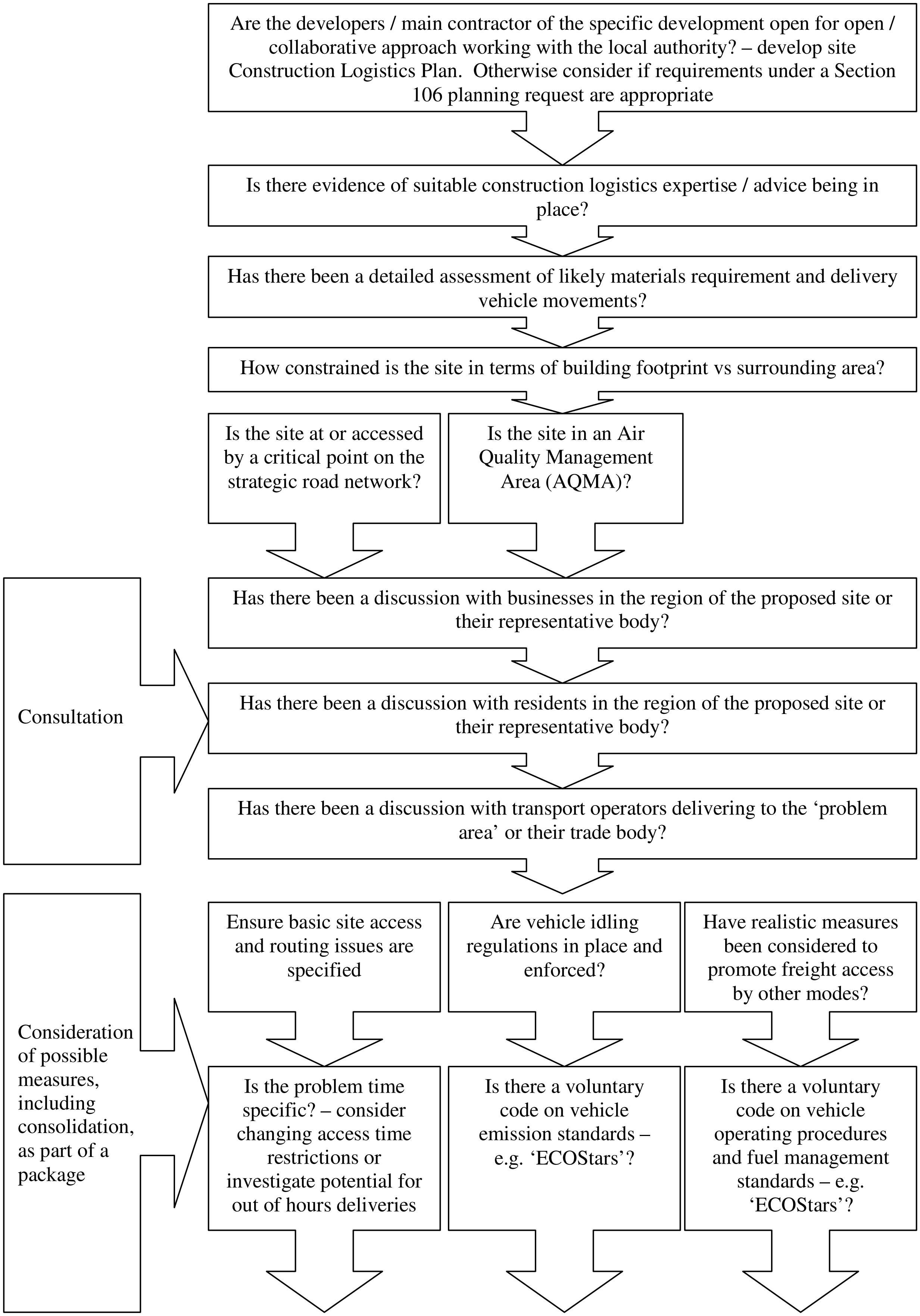
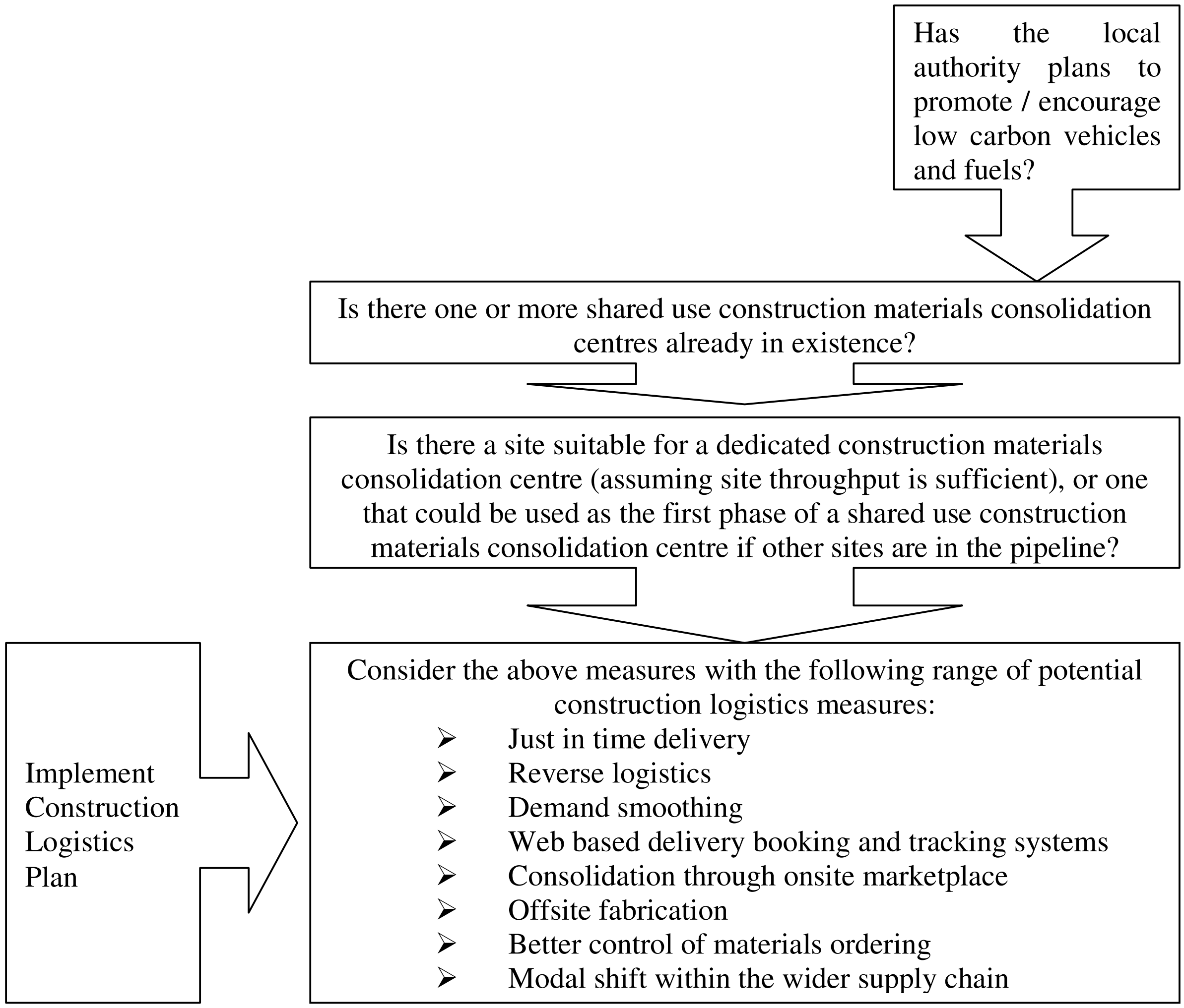


Figure 26 Overview of operational costs, social benefits and residual financial contributions per pallet equivalent for a shared construction consolidation centre over the lifetime of the construction project.

5.6 Implementation Decision Tree for Construction




Are the developers / main contractor of the specific development open for open / collaborative approach working with the local authority? – develop site Construction Logistics Plan. Otherwise consider if requirements under a Section 106 planning request are appropriate
Is there evidence of suitable construction logistics expertise / advice being in place?
Has there been a detailed assessment of likely materials requirement and delivery vehicle movements?
How constrained is the site in terms of building footprint vs surrounding area?
Is the site at or accessed by a critical point on the strategic road network?
Is the site in an Air Quality Management Area (AQMA)?
Consultation
Has there been a discussion with businesses in the region of the proposed site or their representative body?
Has there been a discussion with residents in the region of the proposed site or their representative body?
Has there been a discussion with transport operators delivering to the 'problem area' or their trade body?
Consideration of possible measures, including consolidation, as part of a package
Ensure basic site access and routing issues are specified
Are vehicle idling regulations in place and enforced?
Have realistic measures been considered to promote freight access by other modes?
Is the problem time specific? – consider changing access time restrictions or investigate potential for out of hours deliveries
Is there a voluntary code on vehicle emission standards – e.g. 'ECOStars'?
Is there a voluntary code on vehicle operating procedures and fuel management standards – e.g. 'ECOStars'?



5.7 Key Findings and Recommendations

To-date the pricing of construction consolidation options has often been based around defining the maximum specification required for implementing this for a specific project and then testing this against the depth of the developer's pockets! However, the model scenarios suggest that this can lead to significant inefficiency as the maximum specification may only be required for a small part of the total build. Where projects have been served by construction consolidation centres, the benefits are not always apparent as they are subsumed within the generally smoother running and servicing of the site.

Therefore there may be a need to investigate pricing policies that are more flexible, with different commercial options being provided which relate to the implementation in question:

- An upfront charge for capital costs to set up the construction specific CCC

- Weekly charges (covering all costs) based on usage by one (or a mixture) of volume of stock, time stored and delivery trips. This suits CCCs covering multiple construction sites.

If construction consolidation activity is to occur throughout the project build it is likely to require a number of vehicles of different types suitable for a wide variety of items. In such circumstances it is more appropriate to have access to a wide range of vehicles on call at short notice through a transport partner. Vehicles can be brought in from third parties on an as required basis to handle unusual requests rather than the centre having to have each specific type.

The more traditional approach to construction consolidation which is more restricted in terms of the phases of construction served sets tight parameters on the types of stock that can be handled making use of a limited, dedicated fleet of more standard specification viable.

The consultations noted the benefit of using smaller vehicles for construction consolidation when appropriate to give greater delivery flexibility at the site. Having a call on a range of vehicles helps this – e.g. shared centre.

Consideration should be given to the full toolkit of construction delivery techniques rather than FCCs in isolation in the context of a construction logistics plan.

Whilst a construction FCC can introduce a significant saving on emissions and congestion there remains a larger number of deliveries direct to site, producing substantially more emissions which need to deliver or collect direct from the site as their loads are already heavily consolidated and not easily double-handled.

In addition to the expected benefits of reductions in emissions and mileage, a construction FCC would also help reduce the amount of waste that might go into land-fill, thereby saving the local authority expenditure. However, the overall benefits are lower for a construction FCC than for the other types (at over £49,000) because the calculations are based on the impact of the duration of the build (rather than the data used for the urban and shopping centre scenarios which is discounted over five years). Again the main benefits are in terms of congestion and noise reduction (around 79% and 11% respectively). While the accident benefits are relatively small due to the calculations being based on the duration of the build they would be increased if light good vehicles were used rather than HGVs due to their lower accident rate.

In planning a construction FCC there is a need to have the flexibility in leasing arrangements to change the location of the centre if the proximity to the current developments being served becomes inefficient. However, for certain sites their location close to or within a large urban area would provide a level of guarantee on being close to future work. This position also allows the addition of more specialist lifting equipment within the facility as there is a longer term business plan.

6 SUMMARY OF FINDINGS

6.1 Local Authority Perspective

The data modelling and consultation exercises have identified that operating a retail Consolidation Centre on a purely commercial basis requires a significant level of throughput. On this basis FCC operators need to anticipate level of investment that will cover the shortfalls in operating costs during the start up period before the potential business-as-usual levels of throughput are reached. Local Authorities may be able to influence the participation of retailers in a scheme through various policy levers explored below which will contribute to attaining the required level of throughput.

Local authorities can assist with relevant policy measures to help drive retailer participation. However most 'stick' led incentive policy measures which could be implemented by a local authority are seen as potentially controversial, with concerns about driving away business from the location concerned. This is likely to be why most LA's with experience of FCCs to date have pursued a 'carrot' approach with some subsidy (often as part of EU programmes etc). However, this study proves that given sufficient throughput through an FCC there is no need for a subsidy towards operating costs.

LESP is investigating with its local authority partners a process for low emission project funding based on construction development funding formulas so that monies to LA's from developers could be based upon their impact on emissions – this could be offset by the developer providing a contribution towards the FCC operating costs.

6.1.1 Importance of Evidence Base

For local authorities and industry who wish to understand the suitability of a Freight Consolidation Centre for a particular location and purpose it is important to collect accurate data initially in order to have a full evidence base on which an informed assessment can be made. An outline of the types of data needed and questions to be asked are presented within the FCC decision trees.

6.1.2 Consideration of the wider toolkit

The wider toolkit of freight and logistics efficiency measures should be considered by local authorities before the detailed development of an FCC implementation is begun in order to ensure that the most appropriate solutions are implemented and that the most appropriate support mechanisms are in place to support any FCC, as a number of these schemes can work either as complementary or alternative options to FCC introduction and can deliver similar benefits for less cost and risk.

Examples of the wider toolkit for retail

- Delivery and servicing plans
- Quiet overnight deliveries
- Retailers sharing distribution chains
- Improved provision of delivery facilities

Examples of the wider toolkit for construction[18]

- Construction Logistics Plans
- Just in time delivery
- Reverse logistics
- Demand smoothing
- Web based delivery booking and tracking systems
- Consolidation through onsite marketplace
- Offsite fabrication

6.1.3 Local Policy Support

We have identified a series of potential local policy measures which have been rated by some of the interested parties during the consultation phase as being of benefit to the demand levels of an FCC. These have been categorised into three groups, (i) measures which are simple to implement within the short term, (ii) more difficult tasks to implement in terms of political will and cost and (iii) longer term costly measures which may require national policy support.

Simple measures:

- Stronger enforcement of existing parking restrictions
- Stronger enforcement of existing delivery restrictions

Medium difficulty measures:

- Tightening of delivery time windows for non-FCC vehicles or vehicles that do not meet a certain environmental standard
- Allow wider window for deliveries by FCC vehicles or vehicles that do meet a certain environmental standard
- Mandate use of an FCC for new developments
- Mandate certain environmental vehicle categories/classifications for delivery to site, (though this is difficult given that many delivery companies meet and exceed typical targets, e.g. Euro3, and as the target is moving it would need updating every 2-3 years to continually provide an incentive to use FCC).
- Provide financial incentives to FCC operator
- Provide financial incentives (e.g. reduced business rates) to companies who demonstrate they manage their supply chain only to accept deliveries from vehicles that are fully consolidated for the location in question

[18] 'Material Logistics Plan: Good Practice Guidance', WRAP, (December 2007)

Difficult measures:

- Provide better access for FCC vehicles via bus lanes, bus gates, road charging rates etc
- Mandate use of an FCC for existing retail areas
- Provide land or facility for the operation of an FCC

Note that some local authorities will have more control over the implementation of these policies that others. Close consultation with other organisations with transport responsibilities would be required, e.g. within Greater London collaboration between the London Boroughs and TfL would be a prerequisite.

6.1.4 Political Support

In deciding whether or not an FCC is appropriate it is important that interested parties accept whether a clear need has been established or not. Then if the decision has been made to implement an FCC there needs to be a clear statement of the political aspirations and support for the success of the centre.

A successful FCC implementation will require strong local political support to be a success, particularly if, to encourage adoption, direct delivery disincentives are introduced which make the traditional deliveries more costly or unreliable.

The participation should be sought of local retail groups (though it is helpful if national retail bodies are also involved to support the scheme). The consultation process frequently identified this as a critical activity in encouraging the involvement of retailers within a voluntary scheme.

Additionally the local Freight Quality Partnership should be strongly involved in advising on the implementation. If one does not exist in the area then the creation of one as a precursor stage may be advisable to help bring together relevant interested parties.

The participation of other councils or equivalent bodies (e.g. Integrated Transport Authority) in the area who have involvement in either transport or possibly planning related matters is also essential.

6.2 Industry Perspective

There is a wide spectrum of views within the logistics and distribution industry on the benefits or otherwise of retail and construction consolidation centres. Some companies are promoting and supporting the concept whilst others take the opposing view that they are not the best approach to achieving overall levels of better consolidation within the full supply chain. The majority for those consulted were supportive of the concept though again there was a significant split of views on how these should be organised, particularly within the commercial businesses.

Some interested parties raised the view that retail FCCs would discourage the potential within the market for suppliers and retailers to group together and consolidate their freight and warehousing capacity.

The opposing view was that powers needed to be provided to mandate the use of consolidation centres amongst retailers to ensure the levels of participation resulted as a cost effective service.

Between these polar views is the current situation for most of the retail FCCs that have either been implemented or are in the planning stages. This is the view that retail FCCs are of positive benefit but they need to be voluntary to allow retailers the decision of what works best for them. The result of this is that retail consolidation centres require a level of subsidy to cover operational costs until they achieve enough throughputs to be self sustaining. The model results presented in this report generally represent the situation once a significant level of businesses have been recruited, even for the voluntary scenarios, and to get to that point there is generally a long and difficult recruitment phase.

The results shown are generally beyond those experienced at UK FCCs to date in terms of throughput, and space / staff / vehicle requirements due to the difficulty encountered in generating participation on a voluntary basis; and of course absolute values of the potential benefits.

The industry view for construction consolidation centres is, however, much more aligned. The view is that these are self funding ventures if operated in the correct way with varying views on the best way to get the most benefit from them.

For retail scenarios the optimal position for an FCC operation is for a retailer participation rate of approx 40-80%, which consist of those retailers who do not already have consolidated loads and efficient urban delivery operations. The actual figure would be dependent on the retail mix of the specific location.

As part of the need to gather political support for an FCC it is recommended to present any scheme under a clear brand identity. The failure to do this initially in Norwich is seen as a primary reason by some of the participants for the slow recruitment process of retailers as it impacted on the marketing message that the site was a recognised scheme.

6.3 Social Cost Benefit Analysis

In all cases for all scenarios the introduction of a FCC is likely, on the evidence analysed, to bring substantial societal benefits.

The main social benefits arise from reductions in congestion, sometimes accounting for as much as 40-60% of the total discounted benefits over five years. The other main benefits arise from carbon dioxide reductions and improvements in road safety. These are real and substantial social benefits for which estimates of their values, sometimes in the millions of pounds, have been generated.

For both the urban centre/high street and the shopping centre scenarios, implementing a mandatory scheme rather than a 20% participation voluntary one brings much greater social benefits, in some cases three times the level over a 5-year period. Although as the breakeven graphs demonstrate that the peak point of return is 40-80% of retailer participation dependant on the operating cost variables. After this point the final 20-40% of retailers are already operated highly consolidated loads and efficient urban delivery operations. For this group the loads are destined for supermarkets, department stores and other larger stores. These stores and their distribution networks would see additional handling costs, loss of control of their supply chain and delays to the Just In Time nature of some of their deliveries.

All the figures generated by the spreadsheet model should be interpreted with a degree of caution as the values inevitably have a significant degree of uncertainty around them. Variations in the valuation of different pollutants would change the overall value of the social benefits as would changes to the value of accident savings and, particularly, congestion costs. Much will depend on the exact nature and circumstances in which any individual FCC is to be developed. The distances involved, the location of the FCC relative to the final destinations and the types of vehicles used, will all have an impact on the values.

The study has not identified any significant societal costs for inclusion in the cost benefit analysis although there could be some small increase in unemployment (or at least a redistribution of employment) as a result of introducing a FCC. Depending upon the extent to which they would be able to find alternative employment there could be some additional costs to society in the form of unemployment and other benefits for a period of time.

If implementing an urban centre/ high street FCC the greatest social benefits would arise from using 17T diesel or urban artic lorries (at a mandatory FCC). Benefits of £3.7- £4 million might be achieved over a 5 year period if these vehicles were to be used; the explanation being the large reduction in vehicle mileage that could be secured, especially in urban areas. Use of smaller rigid vehicles could also bring substantial benefits, however. The benefits of 9T electric rigid vehicles are probably understated since these would bring greater noise advantages over the larger lorries. Noise benefits account for around 10% of the total benefits whatever the type of vehicle used with Carbon savings at a 15-30% level.

Given the similar nature, in terms of lorry movements, the calculations for a shopping centre FCC are broadly comparable to those for a town centre/ high street FCC. However the NPV of the social benefits are lower, at just over £3-4million over five years when using urban artics or 17T rigid lorries at a mandatory FCC. Nevertheless these are still highly significant.

In addition to the expected benefits of reductions in emissions and mileage, a construction FCC would also help reduce the amount of waste that might go into land-fill, thereby saving the local authority expenditure. However, the overall benefits are lower for a construction FCC than for the other types (at over £49,000) because the calculations are based on the impact of the duration of the build (rather than the data used for the urban and shopping centre scenarios which is discounted over five years). The main benefits for construction are in terms of congestion and noise reduction (around 79% and 11% respectively). While the accident benefits are relatively small, due to the calculations being based on the duration of the build, they would be increased if light goods vehicles were used rather than HGVs due to their lower accident rate.

An important feature of this study has been the focus upon three scenarios. In reality, the outputs of applying the spreadsheet model to a specific FCC could generate different outputs. A more precise specification of the location and routes used to access and distribute from a FCC would allow more accurate calculations of both the private and social costs and benefits to be made, especially the noise impacts for example. Information on the types of vehicles used would also enable more detailed estimations to be made, for example on CO2 emissions. Other features, such as the likely impact upon road traffic accidents could be refined with further knowledge.

Glossary of terms

BAA Ltd	the owner and operator of six British airports, including Heathrow
CIVITAS	European initiative to promote better and cleaner transport in cities
Cross-docking	a logistics practice involving offloading inbound vehicles and loading outbound vehicles with little or no storage of product in between
DfT	Department for Transport, the Government Department responsible for transport in England and non-devolved transport matters in Scotland, Wales and Northern Ireland
Franchised Department Store	A department store which contains space reserved by a number of franchised smaller stores. Deliveries to this type of store are not consolidated in the same way that they would be to a store operated by a single retailer.
Freight consolidation	the practice of aggregating multiple less than full vehicle loads of freight onto single full load vehicles, for onward delivery
Freight Consolidation Centre	a distribution centre designed for consolidating loads for the 'final mile' urban leg of the delivery
FQP	Freight Quality Partnership, established to bring a range of parties together to find local solutions to local freight issues
HGVs	Heavy Goods Vehicles (over 7.5 Tonnes Maximum Permissible Weight)
Just in Time (JIT)	Logistics technique to reduce costs in warehouse storage by delivering stock and material as it is required on site
LEZ	Low Emission Zone, a geographically defined area which aims to restrict or deter access to certain polluting vehicles, with the aim of improving local air quality
LGVs	Light Goods Vehicles (up to 7.5 Tonnes Maximum Permissible Weight)
SLFQP	South London Freight Quality Partnership, established to bring a range of parties together to find local solutions to local freight issues in South London
TfL	Transport for London, the local government body responsible for implementing transport strategy and managing transport services across Greater London
Transhipment	the practice of moving goods to an intermediate destination, potentially for short-term storage, then onward movement to a final destination
Van	The definition of van used within this report is a delivery vehicle of up to 3.5 tonnes weight.

Vehicle Emission Standards	If diesel vehicles are operated from the freight consolidation centre it has been assumed that these are to the latest available emission standard – currently Euro V. The baseline scenarios assume a range of emissions standards as found in the overall vehicle fleet – primarily Euro III and Euro IV, with some Euro V that are working their way into the fleet and some Euro II that have not quite yet been displaced.

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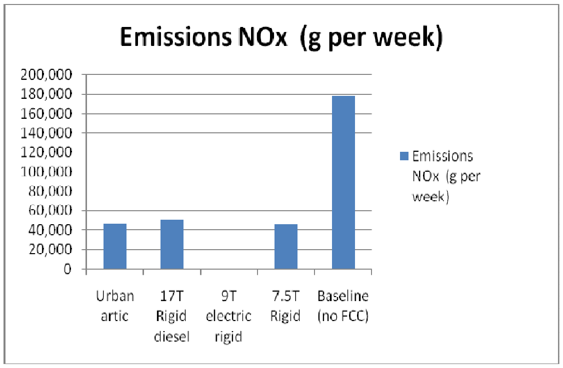
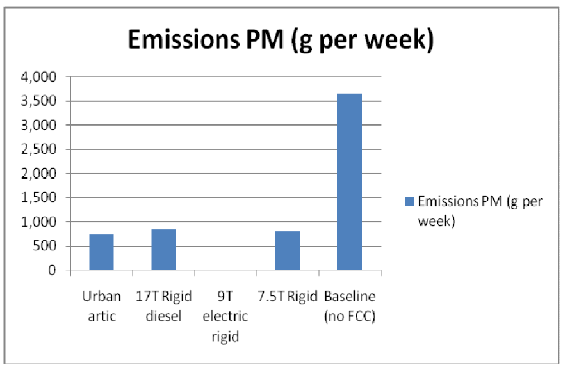
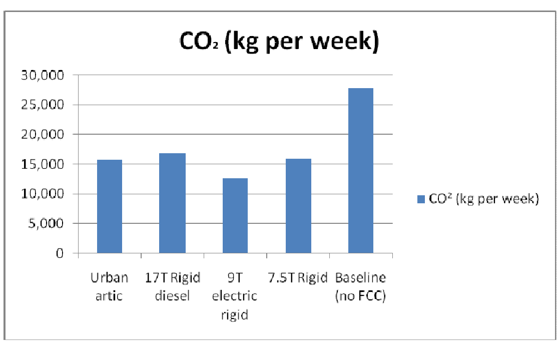
Annex A: Retail Emissions Outputs

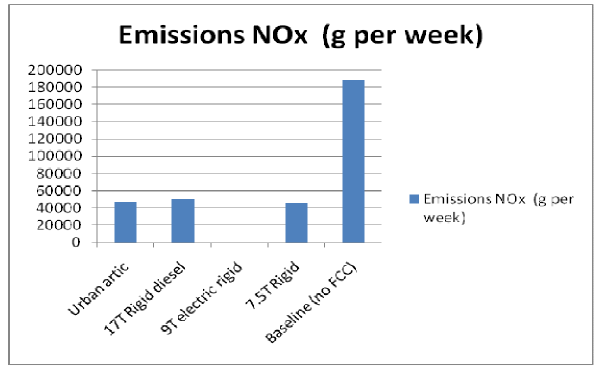
Shopping Centre Mandatory Scenario

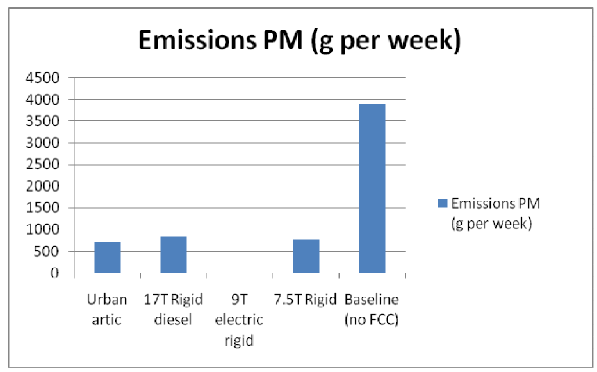


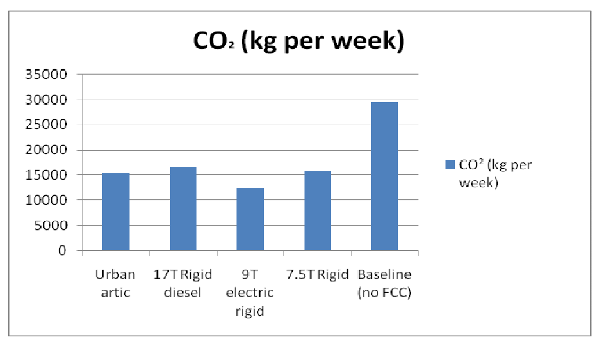




High Street Mandatory Scenario







Annex B: Construction Scenario Emission Graphs

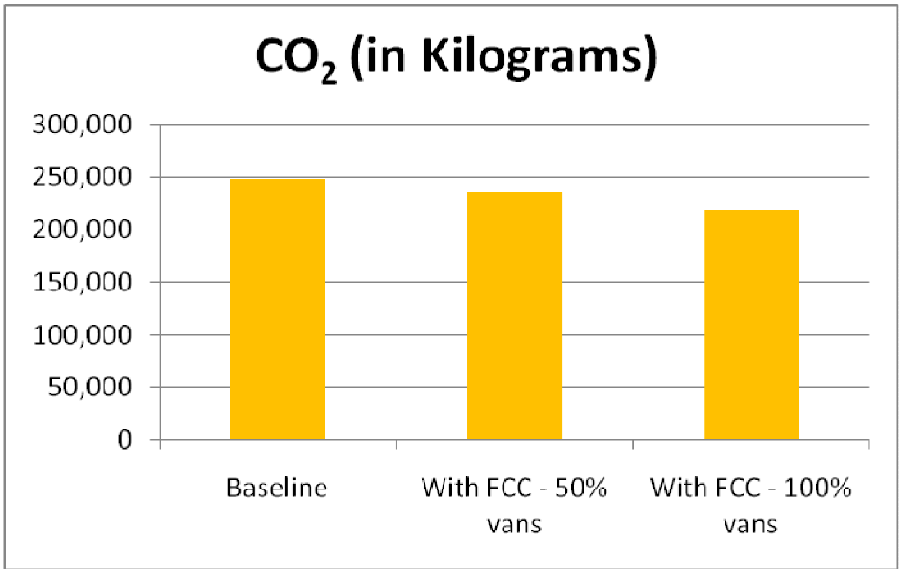
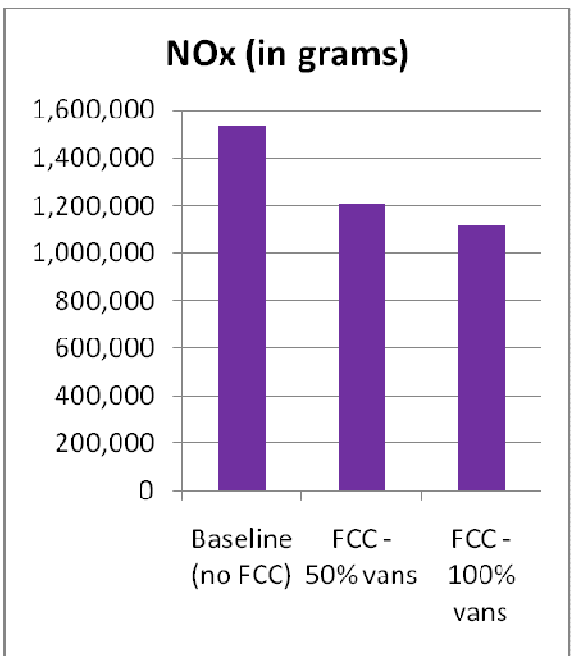


Figure 27 CO2 emissions for lifecycle of construction project under different scenarios



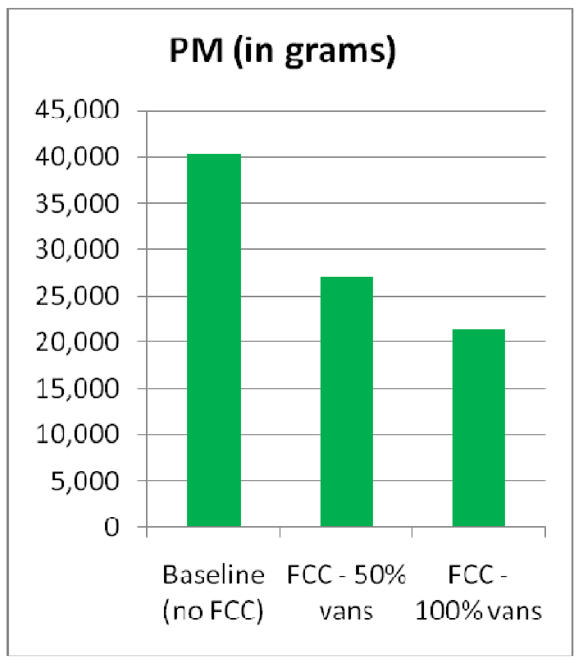


Figure 28 NOx and PM emissions for lifecycle of construction project under different scenarios

Annex C: Full Model Data Specification

Detailed within this section is the full data specification required to build the model. As the model is being built, interested parties are interviewed and data is received then minor refinements to the data specification may be required.

FCC Operation Module

Variable	Description	Data Value	Data source
User Environment	Switch to select scenario: Construction, Urban Centre or Shopping Centre.		As per DfT requirement
Dedicated or shared facility	Switch to select modelling option		As per DfT requirement
Vehicle type	Switch to select from four vehicle types: 7.5 tonne, 9 tonne electric, 17 tonne and Urban Artic.	Vehicles selected based on experience of existing FCC sites and urban delivery practices.	
Dedicated facility - size	Need to determine the size required of a suitable warehouse facility	Size in square feet of minimum requirement for a dedicated facility based upon need for $4ft^2$ needed per pallet per week (retail) and 20 ft^2 per pallet equivalent per week (Construction). Rounded up to nearest 500 ft^2 for dedicated facility.	DHL, existing FCC sites, logistics warehouse providers (retail and construction)
Shared facility – minimum area	Understanding the minimum space requirement within an existing facility that would be required to operate FCC	Size in square feet of minimum requirement for a dedicated facility based upon need for $4ft^2$ needed per pallet per week (retail) and 20 ft^2 per pallet equivalent per week (Construction)	Existing FCC sites using shared facilities, logistics providers
Staff required by type	Staff required by grade, with values set for both dedicated and shared centres. Dedicated requires full time staff whilst Shared site can use a proportion of people.	Ratios set for the following roles based on calculated inputs: - General Manager - Operations Manager - Shift Supervisors - Marketing / recruitment staff - Forklift driver / warehouseman - Delivery driver - Cleaner	DHL, existing FCC sites, logistics warehouse providers (retail and construction)
Forklifts	Number of forklift trucks required to operate centre.	One forklift truck per $4000ft^2$ of warehouse space of dedicated space	Existing FCC sites, logistics warehouse providers (retail and construction)

Average pallets per hour by warehouse staff	Average work rate of staff based upon pallet equivalents per hour – used to drive calculation on number of warehouse staff needed	Rate set at 1.3 pallet equivalents per hour.	DHL, existing FCC sites, logistics warehouse providers (retail and construction)
Distance from delivery target (in miles)	Distance in road miles of FCC from the area being served.	Set at 6 miles	Average of existing FCC sites and planned sites (LA sources) – excluding outliers Norwich and Meadowhall
Size of Construction site being served	Size in ft² of the single construction site being modelled	Set at 1m ft²	

Urban & Shopping Centre FCC Cost Module

Note: all costs are annual

Variable	Description	Data Value	Data source
Annual cost of warehousing	Average cost per square foot of warehousing space	Set at £10 though national price range from approx £5-£15	Freight Transport Association, DHL
Cost per staff type	Cost of Full Time Equivalents (FTEs) per annum, fully loaded with associated costs of employment – by grade	General Manager £45,000, Operations Manager £40,000, Supervisor £29,000, Marketing recruitment staff £29,000 , Forklift driver / warehouseman £21,350, Delivery driver £28,000, Cleaner £12,000	Data sanity checked by multiple logistics companies to produce an average.
Fixed vehicle costs: Lease	Per annum vehicle lease costs	Urban artic - £11,800, 17T Rigid diesel - £10,600 9T electric - £12,660 7.5T Rigid - £8,440	Freight Transport Association, logistics companies
Fixed vehicle costs: Insurance and licenses	Per annum associated vehicle costs	Urban artic - £4,085 17T Rigid diesel - £2,780 9T electric - £2,475 7.5T Rigid - £1,780	Freight Transport Association, logistics companies
Variable vehicle costs: Urban fuel	Fuel rate for urban mileage (£ per mile)	Urban artic £0.70 17T Rigid diesel £0.42 9T electric rigid £0.10 7.5T Rigid £0.24	
Variable vehicle costs: maintenance	Maintenance costs including tyres apportioned cost £ per mile	Urban artic £0.18 17T Rigid diesel £0.11 9T electric rigid £0.11 7.5T Rigid £0.10	Freight Transport Association, Road Haulage Association, logistics companies
Forklifts (p.a.)	Lease cost per forklift truck – 2 tonnes	£10,800	Freight Transport Association
Warehouse fixtures	Racking, pump trucks,	£1.24	Averaged costs from

and fittings	hanging rails, packaging, roll cages and misc equipment (ladders, steps, shelving etc)(p.a. Per warehouse ft²)		several logistics companies
Goods In Transit insurance (per pallet)	Insurance costs for handling goods	£0.02	Professional judgement.
Marketing materials	Venue hire, marketing literature	£2000	Professional judgement.
Office equipment		£1000	Professional judgement
Legal costs		£2000	Professional judgement
IT systems		£11,000	Professional judgement

Construction Centre FCC Cost Module

Note: all costs are annual, as per costs above with the following exceptions

Variable	Description	Data Value	Data source
Fixed vehicle costs: Lease	Per annum vehicle lease costs including on vehicle crane	Urban artic - £18,000, 17T Rigid diesel - £13,000 7.5T Rigid - £10,500	Construction logistics companies

Retail User Environment module

Variable	Description	Data Value			Data source
Number of stores	Number of each type of store for Urban Centre and Shopping Centre scenarios at 20% retailer participation level and 100% participation (plus at 40%, 60% and 80% for break even calculations)	100% level:	Urban Centre	Shop. Centre	Urban Centre averages from combined TTR surveys of Covent Garden, Purley, Bromley, TACTRANS, Wimbledon Station. Shopping Centre average number of stores for 14 Capital Shopping Centre sites
		Supermarket	2	1	
		Department store	1	2	
		Department store - franchised (e.g. Debenhams)	0	1	
		Large store	2	9	
		Medium store	21	14	
		Small store	57	53	
		Barrow	1	12	
		Food outlets	29	16	
		Office	13	13	
Penalty Charge Notice Cost	Cost of illegal parking penalty	£60			Average of a sample set of urban PCN rates (assumes early payment)
Penalty Charge Notice probability	Probability of collecting a PCN notice during delivery	5%			Based on TTR survey observations
Ease of access to loading bay	Queuing time in minutes to reach loading bay	2 minutes			Based on TTR survey observations
Vehicle speed	In miles per hour	10.5mph			TfL

in urban area			
Deliveries to store type per week	Average number of separate vehicle based deliveries to each store type	Supermarket 86 Department store 29 Department store - franchised 0 Large store 27 Medium store 8 Small store 60 Barrow 5 Food outlets 25 Office 26	Based on TTR survey observations
Delivery size distribution per store type (pallet equivalent)		Not sufficient space to replicate here.	Based on TTR survey observations

Baseline delivery chain - retail

Variable	Description	Data Value	Data source
Vehicle size distributions	Vehicle size distribution for four types of delivery chain – Courier, 3PL, Direct/Inhouse, food wholesaler	Not sufficient space to replicate here.	
Vehicle age distributions	Age distribution of engine for four types of delivery chain. Based on Euro standards (2-5)	Not sufficient space to replicate here.	
Degree of local delivery activity	% value on degree of other local deliveries likely to be made by the same delivery vehicle – by delivery chain type.	Not sufficient space to replicate here.	
Delivery time at store	Amount of time (in mins) needed for different delivery types	Not sufficient space to replicate here.	

User Environment - construction

Variable	Description	Data Value	Data source
Deliveries by phase	Number of deliveries per day for each construction phase	Not sufficient space to replicate here.	Alandale, CSB Logistics, other logistics companies
Duration of each phase	Duration in weeks of each construction phase	Not sufficient space to replicate here.	Alandale, CSB Logistics, other logistics companies
Delivery size distribution (pallet equivalent)	Delivery size distribution by construction phase	Not sufficient space to replicate here.	Alandale, CSB Logistics, other logistics companies

Baseline delivery chain – construction

Variable detail as per retail delivery chain but with different distributions. The delivery chain types are defined as (i) manufacturer, (ii) Builders merchant\wholesaler, (iii) Trade contractor.

Annex D: Additional Breakeven Cost Graphs

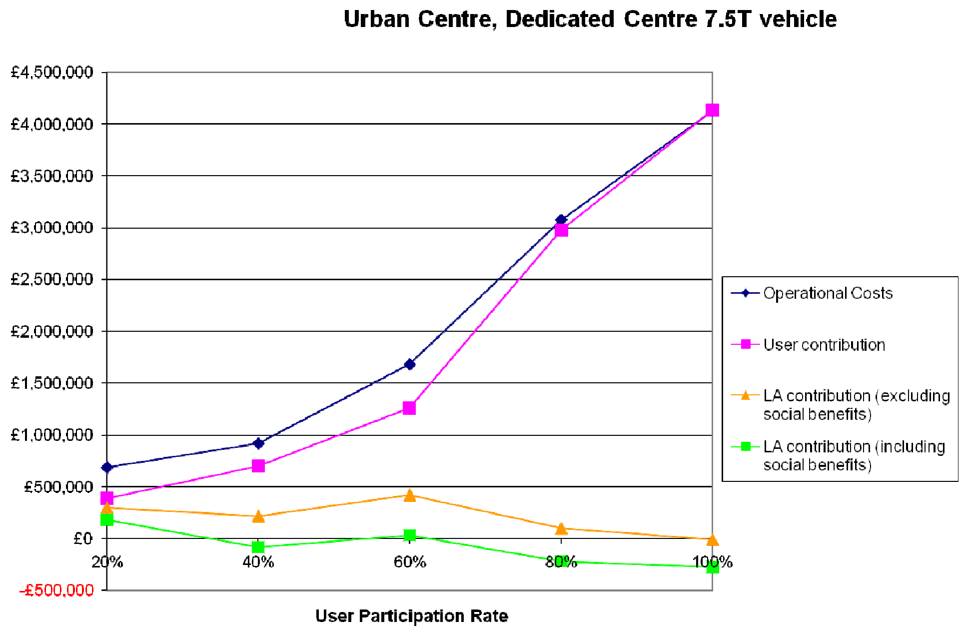


Figure 29 Analysis of annual operational profitability for a High Street/Urban Centre FCC using a dedicated facility and 7.5 tonne vehicles

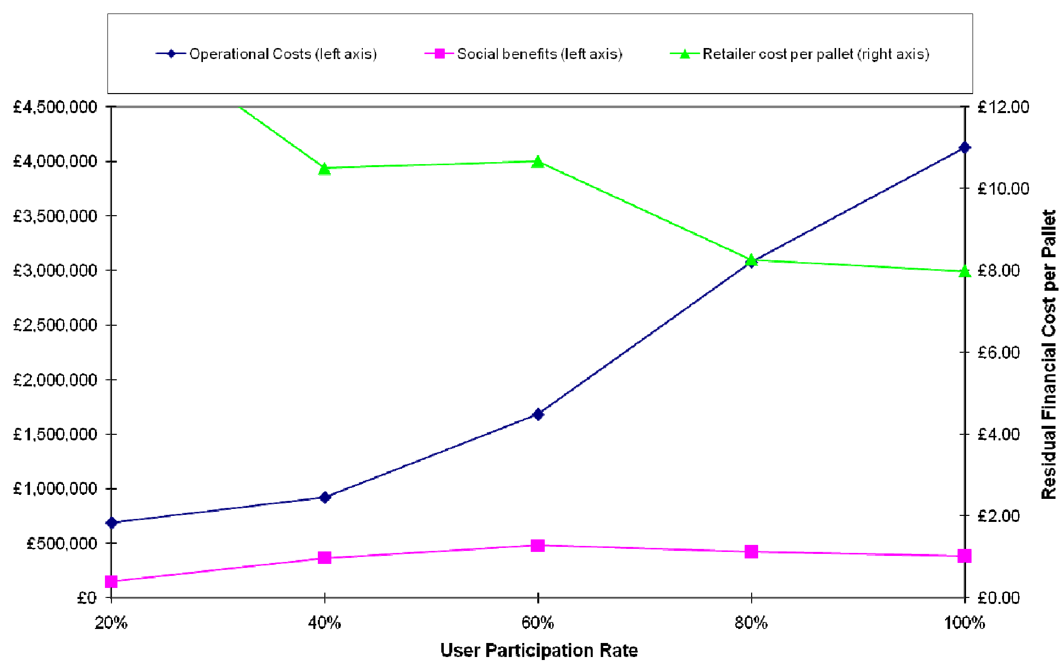


Figure 30 Analysis of annual operational costs, social benefits and the retailer financial cost per pallet required for a High Street/Urban Centre FCC using a dedicated facility and 7.5 tonne vehicles

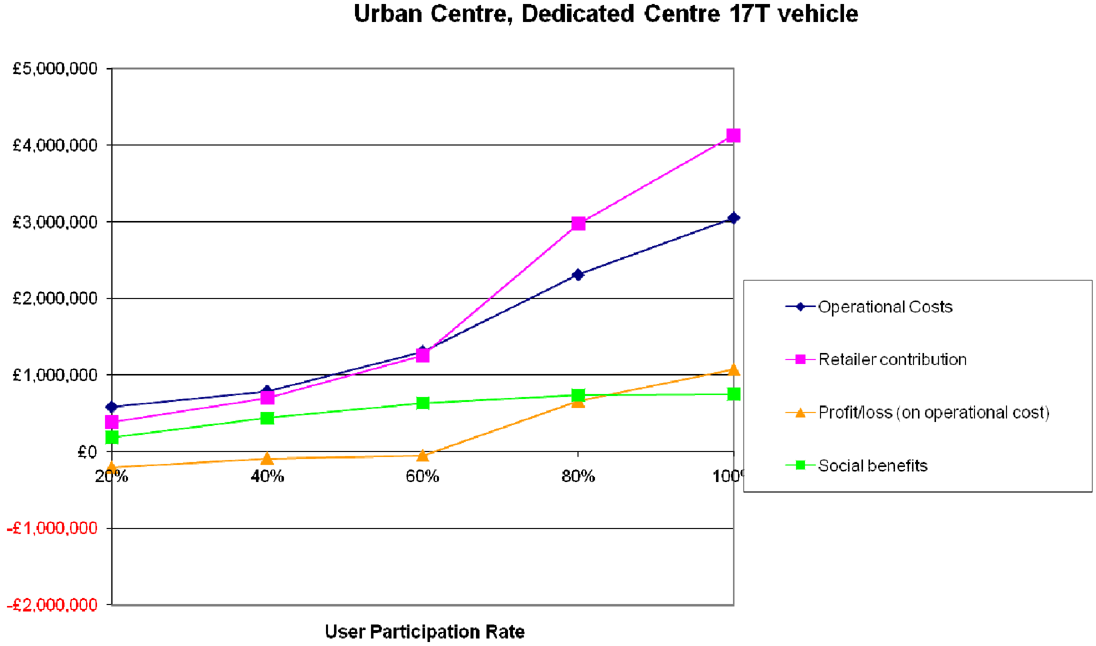


Figure 31 Analysis of operational profitability for a High Street/Urban Centre FCC using a dedicated facility and 17 tonne vehicles

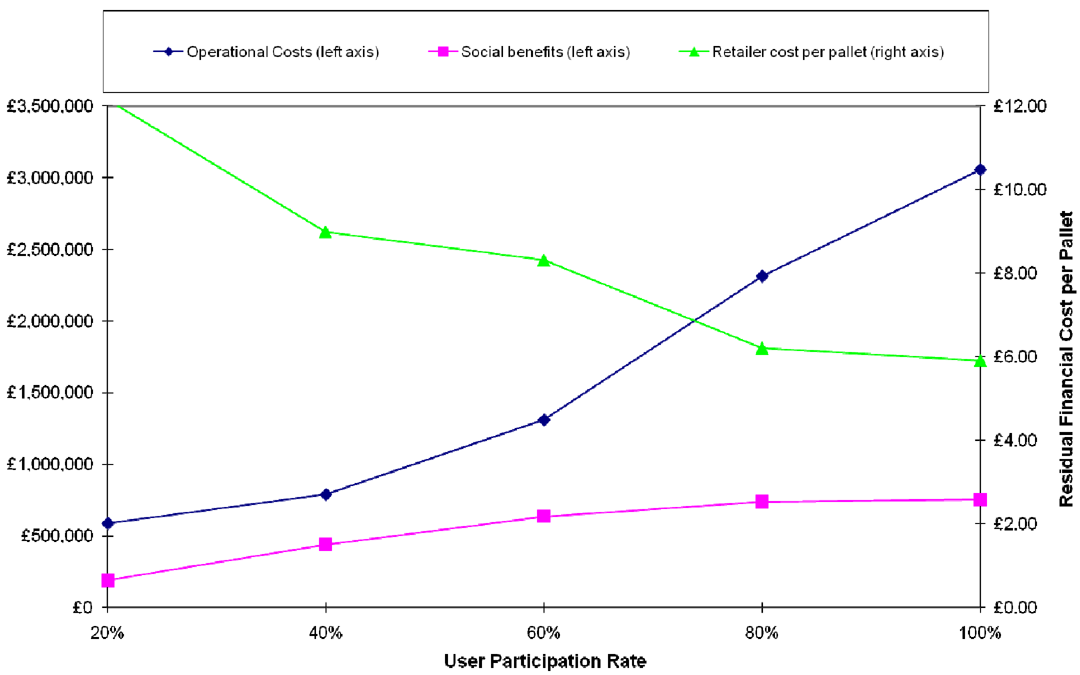


Figure 32 Analysis of annual operational costs, social benefits and the retailer financial cost per pallet required for a High Street/Urban Centre FCC using a dedicated facility and 17 tonne vehicles

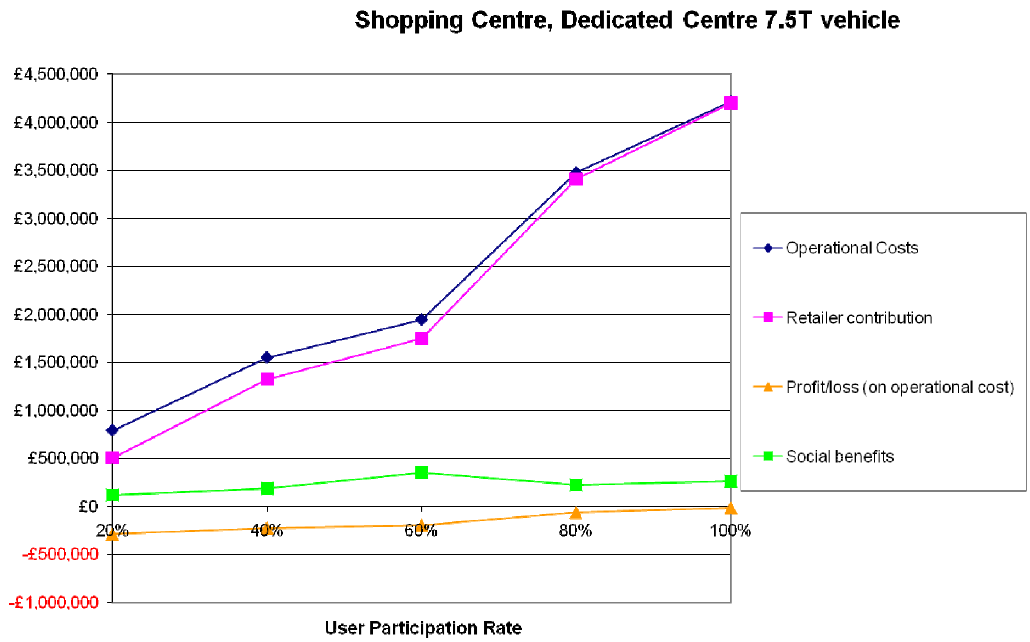


Figure 33 Analysis of annual operational profitability for a Shopping Centre FCC using a dedicated facility and 7.5 tonne vehicles

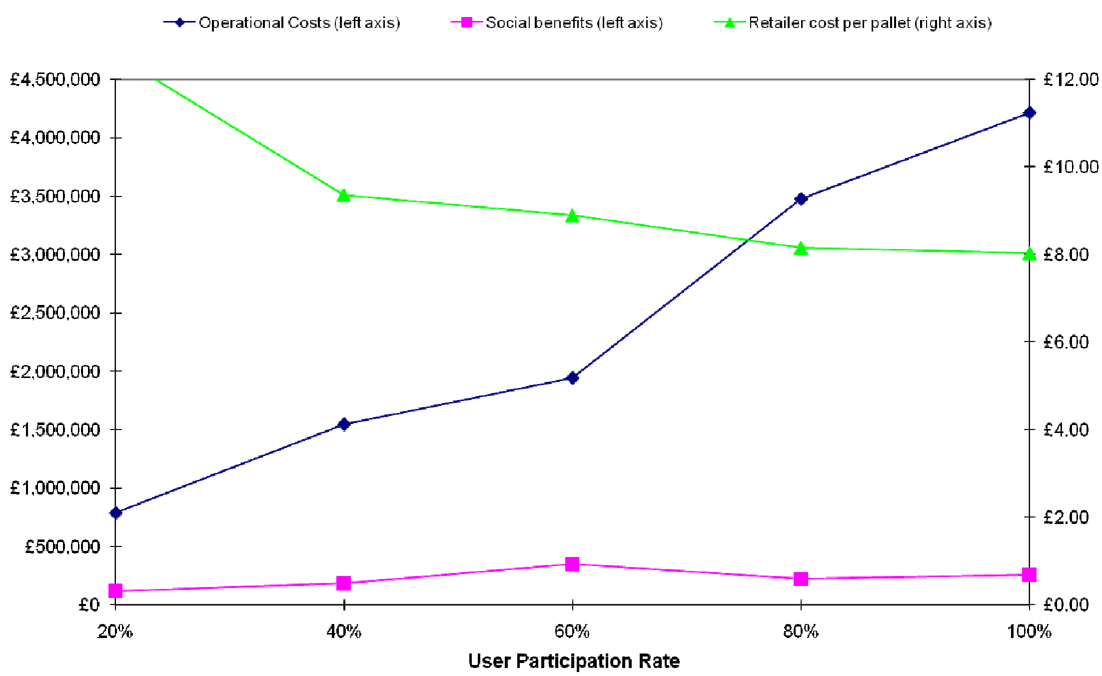


Figure 34 Analysis of annual operational costs, social benefits and the retailer financial cost per pallet required for a Shopping Centre FCC using a dedicated facility and 7.5 tonne vehicles

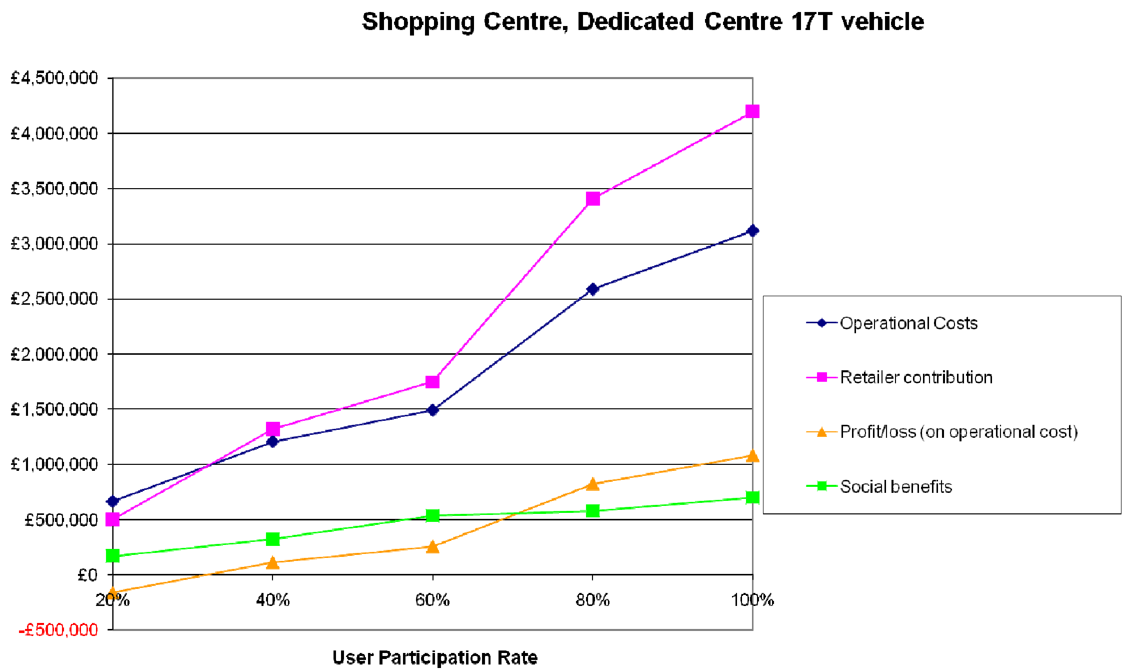


Figure 35 Analysis of annual operational profitability for a Shopping Centre FCC using a dedicated facility and 17 tonne vehicles

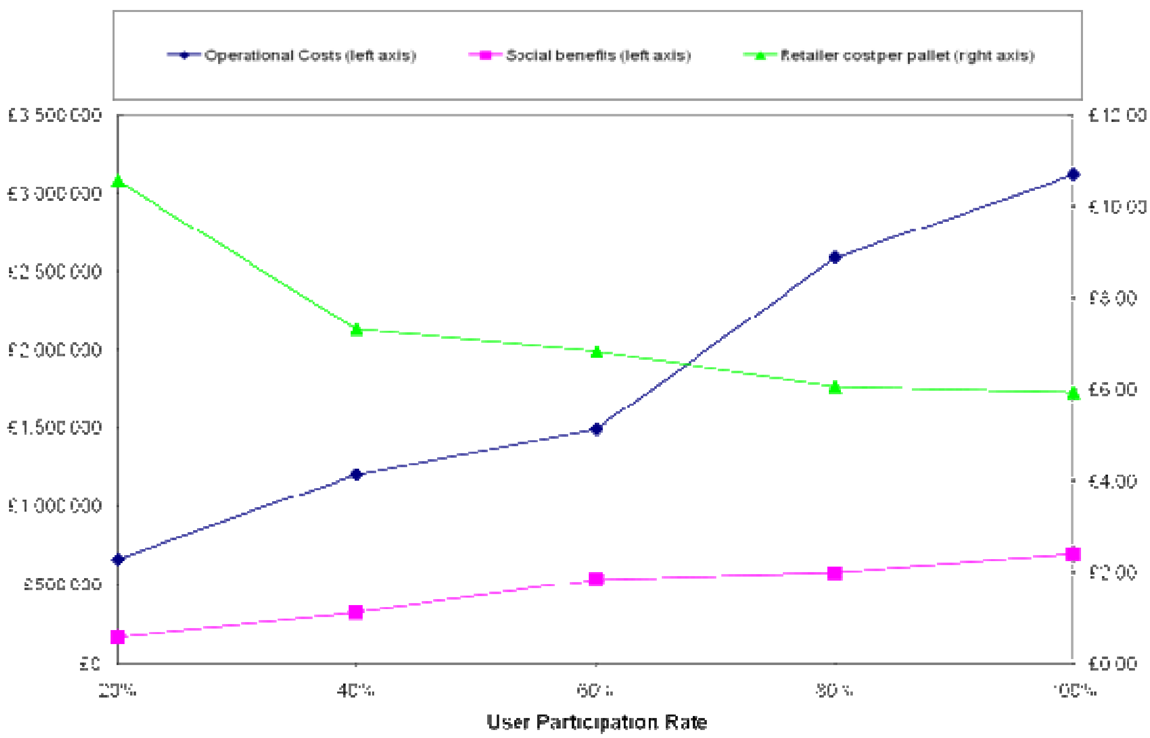


Figure 36 Analysis of annual operational costs, social benefits and the retailer financial cost per pallet required for a Shopping Centre FCC using a dedicated facility and 17 tonne vehicles

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