CATAPULT
Transport Systems

FUTURE PUBLIC SECTOR LOGISTICS CONSOLIDATION

FINAL REPORT - March 2018

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Department for Transport

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UNIVERSITY OF Southampton

University Hospital Southampton NHS
NHS Foundation Trust

MEACHERS GLOBAL LOGISTICS

EXECUTIVE SUMMARY

The freight and logistics sector is vital to the success of the UK economy, both as an enabler of economic growth and as a major source of employment. However, it generates several well-known externalities, such as congestion and emission of pollutants, that both industry and policy makers have sought to tackle. One solution that has been developed to tackle these externalities is Urban Consolidation Centres (UCCs). A UCC is a logistics facility that is situated in relatively close proximity to the area that it serves. Goods destined for this area are dropped off at the UCC and are sorted and consolidated onto goods vehicles, preferably low emission vehicles, for delivery to their final destinations.
By consolidating deliveries, the number of goods vehicles are reduced and thus are the externalities associated with them. The concept of UCCs has been around since the 1970s but their success up to now has been limited.

In April 2017, the Department for Transport (DfT) commissioned Transport Systems Catapult (TSC) to understand why uptake of UCCs has been low and what can be done to encourage greater adoption amongst public sector organisations.

To answer this question, TSC first undertook a literature review to understand why uptake has been low to date and identify the main barriers that need to be overcome to encourage greater uptake.

The literature review suggested three main reasons for low uptake:

- **Long term financial viability** – use of a UCC adds an additional leg into the supply chain and this adds costs. In the past, this extra cost has often been offset by public sector subsidies which has proven to be unsustainable in the long term.
- **Poor selection of location** – the lack of sufficient accessibility to UCCs and the proximity to the area it serves, has led to failures in the past.
- **Controlled environments** – evidence suggests that UCCs often require support from Local Authorities through enforcement of controlled environments such as Clean Air Zones that can help to build the business case for UCCs.

The literature review identified that the most common and largest barrier to the uptake of UCCs was financial viability. TSC's hypothesis was that enhanced visibility of the cost and benefits would stimulate greater interest among potential client organisations.

The main benefits of UCCs for the end user are efficiency improvements and opportunity creation within the user's organisation, but the literature review found no evidence to suggest that these benefits have been successfully monetised. As a result, when the idea of a UCC is proposed to decision makers, they see a large initial investment or increase in costs with little idea of what they will gain in return. Therefore, monetising the efficiency gains and opportunity costs will help support the business case for decision makers and will, hopefully, encourage uptake.

To test this hypothesis, and following initial stakeholder engagement, a case study involving the University Hospital Southampton Foundation Trust (UHS) was identified. Southampton has been identified as a city that needs to identify measures to bring nitrogen dioxide levels within the statutory limits in the shortest time possible. This may include the implementation of a Clean Air Zone (CAZ). As a result, Southampton City Council has committed to a programme of measures to support compliance. Furthermore, the literature review suggested that large public sector organisations such as hospitals would benefit greatly from consolidating their deliveries and, given that UHS is located in a possible CAZ, the project team considered it to make a fitting case study. Finally, Meachers Global Logistics has a multi-user warehousing facility located outside of the potential Southampton CAZ and already has an existing relationship with UHS.

Given the interest from local stakeholders, TSC set about developing an economic model which assessed the costs and benefits of implementing a consolidation model compared to doing nothing. An extensive data collection exercise took place at both Meachers and UHS - where the costs of using the consolidation centre (excluding capital costs to set up the warehouse) were identified and the 'business as usual' activities at UHS were recorded. TSC also obtained the Regional Transport Model for Southampton to understand the impacts this will have on the local environment. The table below provides a summary of the total costs (expressed as negative cash flows) and benefits estimated to accrue across the different categories included for analysis in the economic model. Results suggest that benefits to the UHS from using a UCC could potentially outweigh the additional costs through penalty fee savings and opportunity costs. Results are reported in 2015 prices and expressed in present values discounted for time (using DfT discount factor – 3.5%) to the base year, 2017.

Table 1 – Results from economic impact assessment

Total Present Values (£ p/a)			2017	2030
Additional Costs		Freight Operator (Running Consolidation Model)	-£520,967	-£946,677
Operating Savings		Freight Industry (Operating Costs)	£175,220	£503,960
		Freight Industry (Penalty Fees)	£988,840	£19,662
	NHS	University Hospital Southampton (Opportunity Cost)	£509,548	£958,074
Wider Benefits		Other 'Soft' Social Benefits (Reduction Sick days incl. stress)	£41,490	£69,103
		Improved Journey Times – Decongestion Benefits (*)	£245,327	£201,354
		Environmental Benefits (**)	£5,017	£6,239
		Accidents Reduction (*)	£2,497,534	£1,400,328

(*) Southampton Wide Area covered by Sub Regional Transport Model (SRTM)
(**) Include CO_2, NOx and Noise quantification

These results were presented at a workshop held at the Department for Transport where attendees from industry, Local Authorities, academia and other public sector bodies provided feedback and suggested the next steps for the project.

Based on this feedback and learnings throughout the project, TSC propose the following next steps for the DfT:

Communication

- DfT should disseminate and promote the project to other Departments that could benefit from this work such as DEFRA[1] (JAQU[2]) and the Department for Health as well as Local Authorities. It should also disseminate and promote to any other industry organisations / bodies the DfT has relationships with, such as trade associations and those involved in reducing externalities from freight i.e. LoCity[3].
- The project and its results should be communicated to industry through articles in the trade press and speaking opportunities at conferences and events.

Further Case Studies

- TSC has been approached by other Local Authorities interested in similar work being undertaken within their respective cities. We recommend that a round table discussion, involving the cities required to come up with plans to bring compliance with nitrogen dioxide limits, JAQU, DfT and TSC, should take place to decide how this can be taken forward to support these cities and towns. Undertaking further case studies would test the model under different circumstances and for different organisations.

Include in Package of Measures

- DfT should develop a package of measures to reduce congestion and emissions by supporting more efficient last mile deliveries. This could also include other measures that have been created to achieve similar objectives, such as re-timing deliveries.

Further Work

- DfT could commission further work in this area to identify measures to overcome some of the barriers identified in the workshop such as land availability, framework and procurement agreements.
- Collaborative procurement amongst public sector organisations could also be explored so the benefits of UCCs can be scaled up further. However, delegates at the workshop noted that this could be a difficult and lengthy task.

This research has been unique in that monetising the impacts of urban freight on wider economics and society, to our knowledge, has not been comprehensively addressed before. The use of WebTAG[4] (DfT transport appraisal guidance and toolkit) assessment and operational cost models, combined with the operational savings for the end user, represents a novel approach to measure the impacts of urban logistics solutions. This model now opens the door for future research in this area and testing for different logistics business models.

[1] Department for Environment, Food and Rural Affairs
[2] Joint Air Quality Unit
[3] The LoCITY programme works with freight and fleet operators, vehicle manufacturers, infrastructure providers, procurers and other key stakeholders to increase the availability and uptake of low emission commercial vehicles. LoCITY aims to accelerate the adoption of low emission commercial vehicles in London. This will include the demonstration of vehicle and fuelling solutions, followed by mass rollout as their real-world applicability is proven. (https://locity.org.uk/)
[4] A transport appraisal guidance and toolkit developed by the Department for Transport

1 INTRODUCTION

1.1 BACKGROUND

The road freight sector is vital to the success of the UK economy, both as an enabler of growth and as a major source of employment. In 2016, it contributed £13.1bn to the UK economy and employed around 248,000 people (DfT, 2017). However, Heavy Goods Vehicles (HGVs) account for a significant proportion of UK road transport emissions. In 2016, HGVs accounted for around 18% of Greenhouse Gas (GHG), 16% of the NOx emissions in 2015 from road transport, while comprising just 5% of vehicle miles (DfT, 2017).

The 2008 Climate Change Act set a legally binding target to reduce the UK's GHG emissions by at least 80% by 2050, relative to the emission levels in 1990. Meeting this target will require action across all parts of the economy, including the road freight sector (DfT, 2017). The 2017 Clean Growth Strategy set out proposals for decarbonising all sectors of the UK economy. It confirmed that HGV emissions will need to reduce significantly in order to meet UK climate change commitments.

In 2017, the Government published a UK plan for tackling roadside nitrogen dioxide concentrations. This document outlined proposals for local authorities to come up with plans to bring compliance in the local areas where the UK is exceeding NO2 limit values. Where air quality has been identified as exceeding the legal limits in relation to NO2 levels, the establishment of Clean Air Zones (CAZs) may be required. If they are required, not all CAZs will impose an access charge on vehicles operating below the required emissions standards wishing to enter into a CAZ; nevertheless, it is not unreasonable to assume that those cities where the problems of air quality tend to be most acute may implement a charging CAZ.

The Department for Transport's (DfT) Freight Carbon Review was published in 2017. It assessed the evidence on the key barriers and opportunities for reducing road freight GHG emissions, identified key evidence gaps, and outlined potential emission reduction measures (DfT, 2017). The report identified five key areas on which to focus attention: one of which was a reduction in commercial vehicle road miles. The Review identified considerable potential for reducing emissions through more effective collaboration within the road freight sector, including through the use of Urban Consolidation Centres.

Urban Consolidation Centres

Urban Consolidation Centres (UCCs) represent an opportunity for reducing freight vehicle journeys in urban areas. Nevertheless, as cited in the TRL's Freight Industry Collaboration Study (White, et al., 2017), the cost benefits of UCCs are poorly understood and this may present a barrier to their uptake.

Building on the Freight Carbon Review, the DfT commissioned the Transport Systems Catapult (TSC) to investigate how the public sector[5] could be encouraged to explore the opportunities for, and adopt, consolidation schemes, using UCC services. This study aimed to provide greater insights into the costs and benefits of using UCCs with a view to stimulating increased interest in their use within the public sector.

A UCC is best described as a logistics facility that is situated in relatively close proximity to the geographic area that it serves (Browne, et al., 2005). It allows multiple deliveries, destined for various customers within an urban area, to be combined together into fewer and more efficient vehicles for the final leg of their journey (Cherrett, et al., 2017). A key benefit of UCCs is a potential reduction in freight vehicles operating within urban areas, which in turn can deliver efficiency and environmental benefits.

The existing literature suggests that logistics consolidation models implemented using UCCs deliver localised improvements in transport activity and associated environmental benefits (Browne, et al., 2005). However, UCCs add an additional 'leg' to the supply chain and there has been limited research to quantify the additional operational costs and understand whether those costs can be offset through efficiency gains.

[5] The public sector is the part of a country's economy which is controlled or supported financially by the government (Source: https://www.collinsdictionary.com/dictionary/english/public-sector). Given that this project hoped to understand how better to encourage enterprises to adopt measures that address aspects of Government policy, it seemed appropriate to the project sponsor to target this project towards government financed and supported enterprises and lead, by example, the private sector.

1.2 PROJECT AIMS AND OBJECTIVES

TSC was commissioned by the Department for Transport to examine the costs and benefits of UCCs with a view to stimulating greater interest in urban freight consolidation services. This project's principal objective was to develop a means of more accurately calculating the costs and benefits of urban freight consolidation to a local community, the wider economy and to users (in this project, public sector organisations) of urban freight consolidation services. The project would seek to provide a better understanding of the additional costs imposed by the extra supply chain leg arising from UCCs, and quantify the scale of benefits that might offset these additional costs.

The project team based the cost benefit analysis around a specific case study.

1.3 PROJECT SCOPE

The scope of this project was outlined in five different work packages (WPs) together with one stage gate review conducted at the end of WP2. Each of the work packages are described below as follows:

1.3.1. Developing the Methodology (WP1)

This work package provided a comprehensive description of the methodology and steps followed throughout the project from inception to completion.

Firstly, an extensive literature review of previous national and international experience of implementing UCCs was undertaken. This helped to understand the benefits derived from UCCs and previous limitations encountered. It also identified gaps in current knowledge on how some of the limitations could be overcome within the public sector and by commercial organisations.

The literature review exercise was followed by a stakeholder engagement process to select the most appropriate case study to analyse the logistical implications of the consolidation model.

When selecting a case study, the following selection criteria[6] were considered:

- The user to be within an existing or potential CAZ or Low Emission Zone (LEZ).
- The users to be a public-sector organisation as the literature review suggested their operations are most suited to urban consolidation.
- The ability to demonstrate a reduction in freight movements within a selected LEZ or CAZ.

Based on the above criteria and feedback from the stakeholder engagement process, the University Hospital Southampton Foundation Trust (UHS) was selected as the project case study.

A data identification and collection process then took place to gather and analyse the different datasets and information required to undertake the quantitative assessment of the consolidation model for UHS. Finally, the Freight Economic Model (FEM) was built and calibrated following the work described in Section 4 – The Business Case.

1.3.2. Data Identification and Collection (WP2)

This work package focused on the identification and collection of the datasets required for the correct calibration of the economic model.

The main sources were as follows:

- **Literature review:** To understand average costs associated with the freight industry and to establish a cost benchmark. This was used to validate data collected in the UHS case study.
- **Meachers Global Logistics (MGL):** A UK logistics service provider currently operating a multi-user warehouse in Southampton. MGL provided operating cost data to inform and calibrate the economic assessment model.

[6] Rationale for inclusion of the criteria and case study selection is further described in Section 2.2

- **Delivery and Servicing Plan (DSP) for the UHS:** To provide a comprehensive assessment of the traffic generated by the Hospital which affects the urban road network within the city of Southampton.
- **Interviews with the UHS Supply Chain team:** To understand Hospital 'business as usual', costs – i.e. those related to everyday handling and management of supply chain operations.
- **ANPR[7] data:** Necessary to understand the number and type of vehicles currently delivering to the main Hospital loading bay to assess the potential for penalty fees that may be incurred by entering the CAZ.
- **Sub-Regional Transport Model (SRTM):** To understand traffic flows and travel times on the roads surrounding the University Hospital Southampton, and to simulate what the impact would be in the network after reducing the number of LGVs and HGVs.

Stage Gate review: The purpose of the stage gate was to provide a comprehensive summary of the status of the project after completion of WP1 and WP2 and to highlight any potential risks arising. This was required to help allow the DfT project sponsor to make an informed decision as to whether the project scope required any revision.

1.3.3. The Business Case – Freight Economic Model (WP3)

This section involved the development of an economic assessment model to quantify in monetary terms the costs and benefits of implementing a logistics consolidation model.

The economic model considers the trade-offs between additional costs arising because of the extra supply chain leg and the potential operating cost savings which could be achieved through reduced operational activities for both the receiver and the logistics providers.

Furthermore, it quantifies in monetary terms the wider benefits derived from reduced congestion, improved air quality and other social benefits that arise from the implementation of logistics consolidation models.

1.3.4. Dissemination and Feedback (WP4)

Regular brainstorm sessions and other meetings have been conducted with relevant stakeholders to validate any initial assumptions and communicate the provisional results from the economic model. Moreover, additional external feedback from Local Authorities, other public sector bodies, freight operators, freight specialists and leading academics was gathered during the project workshop held on the 23rd February at the DfT.

Avenues for further research and next steps were identified following these sessions and the findings have been summarised in Section 6 – Workshop Learnings and Next steps of this report.

1.3.5. Final Report (WP5)

The key deliverable of this work package was a strategic report on future public sector logistics consolidation opportunities and the strategies required to encourage their greater adoption, including the following:

- Clear methodology statement and identification of at least one case study.
- A model developed to quantify any potential operational savings and the wider environmental, social and economic benefits.
- A summary of findings from the analysis in WP3 and the dissemination activities in WP4.

[7] Automatic Number Plate Recognition technology enables vehicle registration plates to be read and matched to vehicle registration data bases for identification purposes

1.4 PROJECT IMPACT AND ADDED VALUE

The project has identified some key barriers precluding the adoption of urban consolidation centres by public sector organisations. It has also highlighted some approaches that might help overcome these barriers and suggested further topic areas for research and development.

The project has helped to provide clarity for public sector organisations and others by setting out existing and planned activity in this area. It has further helped to galvanise collaboration between several stakeholders and accelerate the development of opportunities to reduce road freight journeys in the urban area through the use of UCCs.

1.5 STRUCTURE OF THE REPORT

This report has been structured in sections as follows:

Section 1 provides the background to the project, its scope, aims and objectives as well as describing the project approach.

Section 2 presents the main findings from the literature review and describes the stakeholder engagement process that was followed to select the most suitable case study.

Section 3 outlines the data collection process, describing the different datasets and sources that were employed to calibrate the economic model.

Section 4 describes the business case and approach in building the Freight Economic Model.

Section 5 summarises the main findings and the results from the Economic Impact Assessment.

Section 6 outlines the main conclusions from the study and identifies avenues for further research.

2 SETTING THE SCENE - LOGISTICS CONSOLIDATION

This section describes the purpose of this feasibility study and the grounds for adopting the proposed consolidation model. It (a) outlines the results of the literature review, (b) describes the stakeholder engagement process that led to the selection of the identified case study and (c) describes the logistics consolidation model in detail.

2.1 LITERATURE REVIEW

The literature review included desktop research of relevant papers and publications with the goal of assessing the existing evidence on the economic and wider impacts of Urban Consolidation Centres (UCCs). The review focussed on examples in the UK and other European countries and summarised the main advantages, disadvantages and limitations in using UCCs. The literature review identified a gap in the existing analyses of the costs and benefits of UCCs. This finding supported the case for developing a model to calculate the potential operational savings, and wider economic benefits, against the additional costs of implementing a logistics consolidation model.

2.1.1. Logistics and Freight Consolidation

It has been widely discussed in the literature that freight and logistics drives and enables economic growth as well as representing a major source of employment (Gonzalez-Feliu, et al., 2013). A key factor in the growth of goods vehicles activity in Great Britain is the increase in online shopping and the last-mile movement of these purchases (Allen, et al., 2017). According to the Office for National Statistics (2017), online shopping in Great Britain continues to grow and increased 24% in the period 2008 to 2017[8]. The Light Goods Vehicles (LGV) statistics also support this statement, whereby the number of LGVs registered in Great Britain increased 18.5% between 2008 and 2016[9].

However, it is also widely recognised in the literature that logistics and supply chains impose important external costs to society (Schoemaker, et al., 2006). These cross-sectoral costs range from environmental issues related to urban pollution from freight transport emissions - which is associated with lung cancer conditions (Raaschou-Nielsen, et al., 2013) and contributes to the risk of cardiovascular disease and associated mortality (Newby, et al., 2015) - to increased traffic congestion and journey delays borne by road users. In addition, freight operations also cause wider nuisance to local residents from increased levels of noise.

Therefore, it is important to explore measures to reduce freight movements without jeopardising the current growth of the freight industry and its impact on the UK economy.

Some Local Authorities have instigated the use of secure warehouses which allow multiple deliveries of consignments that are destined for various customers within an urban area to be consolidated together into fewer vehicles for the final leg of their journey - these are known as Urban Consolidation Centres (UCCs) (Browne, et al., 2005).

2.1.2. Urban Consolidation Centres

A UCC is a logistics facility that is situated relatively close to the area that it serves. Goods destined for the area served are dropped off at the UCC and are sorted and consolidated onto suitable commercial vehicles, for delivery to their final destinations. In some cases, cleaner vehicles may be used, such as electric vans and electrically assisted cycles (Allen, et al., 2012). UCCs are the last stop in the supply chain before the goods are delivered to the final user and are a key component of urban freight distribution. Many offer a range of 'value added' services such as storage and cross-docking (Choongh-Campbell & Browning, 2017). A UCC includes a diverse stakeholder group, namely: the local authorities, the shippers[10], the carrier, the retailers, the consumers and the local area inhabitants. Each of these stakeholder groups have different interests in the UCC (Van Duin, et al., 2016).

Three different categories of UCC exist (Paddeu, 2017):

1) UCCs serving all or part of an urban area, usually associated with supply of retail products, office products and, food supplies for restaurant and cafes. This type of scheme is used to serve historic urban areas with narrow streets. This type of UCC is usually proposed by local authorities seeking to benefit from the anticipated traffic and environmental improvements. Examples of (a) are: La Rochelle (France) and Bristol (UK).

[8] https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/bulletins/internetaccesshouseholdsandindividuals/2017#online-shopping-continues-to-grow
[9] https://www.gov.uk/government/statistical-data-sets/tsgb09-vehicles
[10] i.e. Consignors of freight

2) UCCs serving large sites with a single landlord, which include airports, shopping centres and hospitals. Examples of (b) are London Heathrow airport retail, Meadowhall shopping centre in Sheffield and the Hospital Logistics centre in London.

3) Construction project UCCs, which are used to serve the areas dedicated to major building projects, to consolidate construction materials; these types typically exist only for the lifetime of a building project. An example of (c) is London Heathrow airport during major development work.

2.1.3. Benefits of using UCCs

Previous experience of UCCs has clearly demonstrated that they can effectively reduce the number of freight vehicles operating within an urban area (Browne, et al., 2005) and optimise the 'last mile delivery' of the supply chain (Allen, et al., 2017; Park, et al., 2016). Some further benefits resulting from minimising the number of freight movements, vehicle trips and kilometres travelled are listed in table 1 and a classification of benefits is proposed accordingly, in four different categories, namely: Environmental, Traffic, Operational and Economic.

Table 2 – Benefits Classification of UCC

Benefits Classification	Benefits of UCCs	Authors, Year							
		Allen, et al., 2012	Boudouin, 2006	Browne, et al., 2005	Choongh-Campbell, S, 2017	Gonzalez-Feliu, et al., 2013	Van Rooijen & Quak, 2010	Transport and Travel Research, 2010	TRL (2017)
Environmental	Reduction of greenhouse gas emissions	✘	✘						✘
	Improved air quality		✘					✘	
	Reduction in noise levels		✘					✘	
	Use of electric vehicles for the last mile delivery						✘		
Traffic	Reduction in goods vehicle traffic	✘		✘					✘
	Improved safety, i.e. fewer collisions, injuries (KSIs), reduced threat and intrusion			✘	✘	✘	✘	✘	
	Opportunity to disconnect trunking from urban delivery, allowing trunking operations to be conducted at night							✘	
	Decreasing the demand for kerbside loading space				✘				
Operational	Shared reverse logistics and home delivery facilities								
	Reduced and better managed local HGV journeys serving the retail environment							✘	
	Improved delivery service level							✘	
	Shared reverse logistics and home delivery facilities							✘	
	Opportunities for stock buffering							✘	
	Encourage and support clients' recycling commitments (WRAP)							✘	
Economical	Overall reduction of operational costs for haulier and retailer							✘	✘
	Reduce loss of goods (shrinkage) within the supply chain							✘	
	Potential for reduced delivery bay requirements and associated costs in new-build shopping centres							✘	

Source: TSC, based on literature review (Allen, et al., 2012; Boudouin, 2006; Browne, et al., 2005; Choongh-Campbell & Browning, 2017; Van Rooijen & Quak, 2010; Transport & Travel Research, 2007; TRL, 2017)

There are a range of initiatives that carriers and city authorities can implement to reduce the costs of last-mile delivery, without negatively impacting on customer service levels (Allen, et al., 2017), by implementing UCCs.

These include:

- Improving the efficiency of unloading at the kerbside in busy urban areas.
- Reducing product return rates.
- Encouraging local organisations to collaborate in their procurement to share suppliers and hence reduce demand for delivery vehicles.
- Fostering greater operational collaboration between freight operators to share work in given geographical locations, increasing vehicle loads, improving drop densities, and reducing the number of vehicles entering that location to make deliveries.

Using a UCC allows the end user to be more responsive to changes in demand by having stock located closer to the facility. Deliveries can be made daily or on request (depending on the agreed operating model) which is important to pharmaceutical firms or hospitals, for example, where trends in demand are difficult to forecast.

The use of UCCs has been proven to free up time and boost the morale of staff at the receiver's end because smaller more manageable deliveries allow them to spend more time on key tasks. Furthermore, deliveries can be arranged for a time that best suits the receiver rather than having to organise a time that suits both the supplier and the receiver (Scott Wilson Ltd, 2010).

UCCs also have the potential to provide added value services that can benefit the end user. Tasks such as unpacking, hanging, security tagging and re-labelling allow staff at the receiver end to spend more time on key tasks rather than sorting out deliveries. Another added value option that can be provided by UCCs is the collection of waste and /or damaged goods that can be taken back to the UCC and recycled, thereby reducing empty running.

The Department for Transport (2017) "Freight Carbon Review" emphasises the importance of collaboration in the freight industry, citing UCCs as one example of the different strategies for collaboration in this industry (TRL, 2017). This report asserts that there is scope to improve the efficiency of freight operations and reduce emissions through wider industry collaboration in overcoming existing barriers. Nevertheless, further work is needed to understand the costs and benefits of implementing these measures (DfT, 2017).

2.1.4. Barriers to the use of UCCs

The literature review evidences that one major constraint that prevents UCCs from delivering these potential benefits has been their long-term financial viability.

The extra 'leg' added to the supply chain imposed by the UCC is viewed as an additional, cost which is often borne by the public sector through large subsidies (Browne, et al., 2005; Verlinde, et al., 2012; Choongh-Campbell & Browning, 2017). Indeed, the literature suggests that UCCs require large subsidies to support their long-term operation (Browne, et al., 2005) in order to afford the set-up cost (Estrada & Roca-Riu, 2017). In this regard, it is important to determine under which scenarios, conditions and freight volumes, UCCs can be operated without the requirement of public subsidies.

The evidence further suggests that the enforcement of controlled environments such as Clean Air Zones – where freight suppliers are restricted or penalised for accessing particular areas – can increase the attractiveness of UCCs to freight operators as they try to avoid any restrictions and charges (Van Rooijen & Quak, 2010). In this regard, London already has the world's largest Low Emissions Zone (LEZ).

Further to this, the geographical location of some UCCs has proven to be a barrier to use. Adequate transport infrastructure is required to access / egress the warehouse facilities and the lack of sufficient accessibility to UCCs has led to failures in the past. Finally, a reluctance to tranship valuable goods through UCCs and a lack of sufficient volumes have also created issues in previous attempts to successfully establish UCCs. It is suggested that high frequency, low volume consignments, that contain simple products and do not have an optimised delivery scheme (such as for Local Authorities) would benefit the most from UCC initiatives (Verlinde, et al., 2012).

However, there is little research and evidence as to how the additional costs incurred by UCCs can be directly offset by a more efficient delivery service.

2.1.5. UK Urban Consolidation Centres' experiences

Four successful implementations of UCCs in the UK are reported below in Table 2 and Table 3. These are the Heathrow Retail Consolidation Centre (HRCC), Regent St Consolidation Centre (RSCC), Bristol Broadmead Consolidation Centre (BBCC) and Bristol-Bath Freight Consolidation Centre (BBFCC).

HRCC and RSCC are operated for a single landlord, which means that the long-term financial sustainability of the UCC is easier to achieve, because a single party is responsible for financing the UCC. The single party then attempts to recover some of the costs from other parties that also obtain operational and financial benefits from the scheme (Triantafyllou, et al., 2015).

Table 3 – Successful UCC implementations in Britain – Part 1

UCC Name	Heathrow Retail Consolidation Centre (HRCC)	Regent St. Consolidation Centre (RSCC)
City	London	London
Organisations involved	BAA, Heathrow's operator and retailers	Crown Estate, retailers and Clipper
UCC Category	UCCs serving large sites with a single landlord	UCCs serving large sites with a single landlord
Year Trial	2000	2007
Year implementation	2001	2008
Reason for implementation	Vehicles delivering goods to be sold in the Airport's retail outlets had difficulty in making deliveries due to insufficient space being allocated to delivery bays. It was becoming ever more difficult to find additional space at a very constrained site. The result was lengthy queuing of goods vehicles waiting to access the delivery bays. This was compounded by vehicles that had already completed their deliveries being blocked in by other vehicles that were still completing their deliveries. This led to lengthy delays at the delivery bays, an unpredictable delivery service for the retail outlets and congestion among the general traffic entering the terminal areas, with consequential impacts on local air quality.	Regent St. represents the largest concentration of value in The Crown Estate's portfolio. The area attracts over 7.5 million tourist visits each year. The area. experiences heavy road congestion which can impair the shopping experience for visitors. Therefore, the Crown Estate initiated efforts to improve the visitor and shopper experience, which would increase a retailer's turnover and ultimately result in a higher rental value for the property. Regent St. is within London's congestion charge area, thus city distribution for receivers that operate their own distribution can be considered expensive.
Operation scheme	Off-site consolidation was facilitated through the construction of 2,325 sq m. of warehousing at the south-east perimeter of the site, providing multi-temperature storage, eight delivery areas and a shuttle-based delivery schedule with a fixed timetable which delivered directly to the stores. The site operates 24 hours a day, 365 days a year and incorporates an innovative recycling scheme. The consolidation centre is overseen by a central delivery planning team, supplier and warehouse management team working in constant liaison with stores on the retail site. In total, 45,000 deliveries are made per annum and 190 stores are serviced.	Deliveries to the Regent St. stores are consolidated with those of other retailers and dispatched from a distribution centre. Two electric vehicles (EV) make two delivery rounds to London per day in the morning and afternoon. The capacity of the vehicles is the limiting factor as the load factor is often 100% and hardly less than 75%: this means that the utilisation of the EVs is very high proving the RSCC's efficiency. The morning and afternoon rounds both take about 5-7 hours to complete. The RSCC serves 21 retail customers, of which some have multiple outlets. This results in savings of an average 40.5 trips/month.

UCC Name	Heathrow Retail Consolidation Centre (HRCC)	Regent St. Consolidation Centre (RSCC)
Quantitative results	The number of delivery journeys being made to the terminal delivery bays because of the Heathrow consolidation centre was reduced by 60-65% by 2006. This resulted in: • Savings of 22 tonnes of CO_2 per year • Savings of 70 kg of carbon monoxide per year • Savings of 197kg of NO2 per year • Savings 14.5kg of particulates per year	• Reduction in logistical nuisance and increased level of safety: [10000:15000] reduction in urban area vehicle km/month • Reduction in congestion: [6000 : 30000] reduction in total vehicle km during peak hour/month • Reduction in emission: NOx [33 :193] kg/month PM10 [2 :6.5] kg/month • Reduction in fossil fuels usage: [11000 : 31000] reduction of fossil fuel vehicle km/month • Reduction in emission CO_2 [1000:55000] kg/month
Qualitative results	There was reluctance on the part of some retailers to participate in the scheme because of the additional charges made for the use of the consolidation centre facility. Therefore, the use of the Heathrow consolidation centre became compulsory with the completion of Terminal 5.	• Vehicle movements to participating stores were reduced by up to 85% • In-store staff could focus more on selling than managing deliveries • More in-store floor space was made available for retail selling

Table 4 – Successful UCC implementations in Britain – Part 2

UCC Name	Bristol Broadmead Consolidation Centre (BBCC)	Bath-Bristol Freight Consolidation Centre (BBFCC)
City	Bristol	Bath-Bristol
Organisations involved	Bristol City Council and owners of Broadmead.	Bath & North East Somerset Council, Bristol City Council and DHL
UCC Category	UCCs serving all or part of an urban area	UCCs serving all or part of an urban area
Year Trial	2002	2011
Year implementation	2004	2012
Reason for implementation	The initiation of the scheme was driven particularly by the problems experienced in delivery vehicles accessing the service bays at the Broadmead shopping centre in the city centre, which lead to retailer dissatisfaction and congestion as trucks and vans struggled to enter, complete their deliveries and clear the centre effectively. The result was a collaborative approach between the City Council (BCC) and the owners of Broadmead. Bristol City Council could use funding from the European Commission within the 'VIVALDI' project to part-fund the cost of contracting Exel Logistics (now DHL Exel Supply Chain) to set up and run a freight consolidation centre trial during the fixed life of the VIVALDI project and then to assess whether to keep the centre running.	Both Bath and Bristol city councils have found it challenging to meet the European policies on air quality in the city centres. The city centre of Bath is classified as a world heritage site. The city council is keen to protect against damage caused by transport (blockages, collision with historical buildings, wear of the roads). Both cities decided to collaborate under the CIVITAS RENAISSANCE European project that funded the initial operation of the BBFCC. This project basically extended the already successful BBCC to the city of Bath aiming to reduce the number of large delivery vehicles entering the city centre by providing a facility, conveniently situated for access from the highway network, where goods can be consolidated for onwards dispatch at prearranged times using electric vehicles.

UCC Name	Bristol Broadmead Consolidation Centre (BBCC)	Bath-Bristol Freight Consolidation Centre (BBFCC)
Operation scheme	BBCC is located on an established industrial estate on the north western edge of Bristol, close to both the M4 and M5 motorways. It is approximately 10 miles from Broadmead, with a typical journey time of 25 minutes. The BBCC serves the Broadmead area of Bristol city centre, which forms the core retail district of the city, and there are over 300 retailers there. The BBCC has been operated by DHL Exel since it opened in May 2004, having secured the support of major stakeholders in the Broadmead area. The BBCC covers approximately 500 sq. m. and uses two vehicles for deliveries; a 7.5 tonne and a 17.5 tonne vehicle. A 9-tonne electric vehicle is being trialled.	The Bristol-Bath city councils are involved in the BBFCC operating entity through a public-private partnership. The urban freight centre is operated by subcontractor DHL Supply Chain, and was offered to Bath business at no charge for the first 15 months of operation. Following this initial period, charges of £9 per cage and £12 per pallet were applied. Goods are dispatched in pre-arranged time slots into central Bath and Bristol using two low emission/low carbon Smith Newton nine tonne electric delivery vehicles.
Quantitative results	• A reduction in vehicle movements to the participating of over 50% - 75% has been achieved • CO_2 emissions have been reduced by up to 600kg per month • NOX emissions have been reduced by up to 100g per month • Particulates emissions have been reduced by up to 1.2kg per month	• Reduction in logistical nuisance and traffic unsafety: [1000 : 8000] reduction in urban area vehicle kms/month • Reduction in congestion: [2000 : 12000] reduction in total vehicle kms during peak hour/month • Reduction in emission: NOx [43 :150] kg/ month PM10 [2:5] kg/month • Reduction in fossil fuels usage: [6000 : 14000] reduction of fossil fuel vehicle kms/ month • Reduction in emission CO_2 [1400 : 3000] kg/ month
Qualitative results	• 38% of retailers have said they can spend more time with customers • 45% of retailers reported improved staff morale • Retailers reduced the average time spent on managing deliveries by more than 20 minutes	• The BBFCC provides value added logistical activities relevant to shippers: Return logistics (waste, returns): Pre-retailing services • Deliveries are 100% on time and only two stock losses (thefts from vehicles) in 10 years. Therefore, it is concluded that the BBFCC offers a high level of service reliability

Source: TSC, based on literature review (Scott Wilson Ltd, 2010; Transport & Travel Research, 2007; Independent Transport Commission, 2017; Van Duin, et al., 2016; Paddeu, 2017; CIVITAS-RENAISSANCE, 2011)

Both BBCC and BBFCC were funded by the European Commission. In these cases, the funding was critical because multiple small businesses are not usually willing to pay for an extra 'leg' in the supply chain, citing that the responsibility for reducing congestion does not lie with them but with the highways authority. Therefore, to embed the idea of consolidating deliveries it is necessary to obtain funding for these projects to begin with (Choongh-Campbell & Browning, 2017). The BBFCC represents a step further for the already successful BBCC, involving the city of Bath and therefore becoming in the first consolidation centre in UK to serve two cities (CIVITAS-RENAISSANCE, 2011).

In the UK, over the last 40 years, public funding has been made available on many occasions to study the UCC concept, but relatively little public funding has been available for trials and fully operational schemes (Allen, et al., 2012).

In 2010, Scott Wilson Ltd carried out a Freight Consolidation Centre Study on behalf of South East Scotland Transport Partnership. This study included a review of six case studies – four from the UK, one from France and one from Sweden. The review found that UCCs which operate on a voluntary basis and are not controlled by a single landlord all appear to require public funding, despite the promotion of value-added services as part of the operating arrangements. Only Meadowhall in Sheffield claims to break-even financially. They found that consolidation centre schemes are more likely to break-even if participation can be made compulsory through planning or lease agreements, but this can be difficult to achieve in most cases. Attention is required to ensure that private sector contributions are maximised, and that those who benefit from the consolidation centre pay for its operation (Scott Wilson Ltd, 2010).

2.1.6. International urban consolidation centre experiences

Research has shown that since the 1970s there has been significant worldwide interest in the use of UCCs particularly from France, Germany, Italy, Netherlands and the UK (Allen, et al., 2012). Table 4, shows three cases of successful UCC implementations in Monaco, Sweden and Netherlands.

These cases are very different in terms of financial viability, operation scheme and UCC category. However, all of them have been government funded at some point of their life cycle. It is clear that without some form of public financial support, UCCs implementation will continue to be slow and insufficiently widespread to have a substantial impact. Local Authorities seem unlikely to fund such initiatives unless compelled to do so by central policies like the implementation of Clear Air Zones, however this sometimes clashes with the devolution agenda. The main difficulty for the private sector is its competitive model, which inhibits the sharing of loads or setting up a system that is more expensive than competition itself. The Independent Transport Commission (2017) recommends piloting a scheme that provides an incentive (or penalty for non-cooperation) for private sector freight distributors to encourage them to work together to make large scale UCCs a reality (Independent Transport Commission, 2017).

Table 5 – Successful international UCC implementations

UCC Name	Monaco Consolidation Centre (MoCC)	Stockholm (Hammarby) Consolidation Centre (SHCC)	Binnenstadservice.nl (BSS)
Country	Principality of Monaco	Sweden	Netherlands
City	Monaco	Stockholm	Nijmegen
Organisations involved	Principality of Monaco, The Chamber of Commerce and Industry and ADEME (the French Energy Agency)	City of Stockholm authorities	Binnenstadservice
UCC Category	UCC serving large sites with a single landlord	Construction project UCC	UCC serving all or part of an urban area
Year Trial	NA	NA	2007
Year full implementation	1989	2001	2008
Reason for implementation	The Monaco Consolidation Centre (MoCC) was established in 1989. It is owned by the Principality of Monaco, which manages it as a public service. The MoCC is operated by a private company on a day-to-day basis. The Chamber of Commerce and Industry and ADEME (the French Environment and Energy Agency) are also partners of the consolidation centre scheme. The costs of the MoCC are shared between the Principality of Monaco which provides financial aid and free warehouse space to the MoCC operator, the MoCC operator which provides drivers and handling staff as well as the MoCC vehicles, and the receivers and deliverers of goods who pay for deliveries, which contributes towards the cost of operating the MoCC.	Stockholm (Hammarby) Consolidation Centre (SHCC) was active from 2001 to 2004, for the duration of a redevelopment project in the former docklands and industrial area of Stockholm. While the redevelopment did not complete until 2010, the main materials movements were concentrated in the three years in which the site was open. When complete, there were 8,000 new apartments as well as other facilities (e.g. schools, commercial premises) and an estimated 30,000 people living and working in the redeveloped area.	The municipality of Nijmegen is considering options to improve the air quality in the inner-city. The political atmosphere in Nijmegen contributes to a positive attitude of the local retailers and shopkeepers. They are open and willing to make logistical adaptations if the environmental conditions will improve. The general opinion is that the bundling of the deliveries by Binnenstad service will result in a decrease of nuisance for residents in the city centre of Nijmegen. In addition, fewer truck kilometres (and certainly less heavy truck kilometres) will lead to an improvement of road safety in the city centre.

UCC Name	Monaco Consolidation Centre (MoCC)	Stockholm (Hammarby) Consolidation Centre (SHCC)	Binnenstadservice.nl (BSS)
Operation scheme	The company operating the MoCC has been given a monopoly over the municipal freight depot and a partial monopoly over the delivery of goods. G oods vehicles over 8.5 tonnes gross weight are banned from entering Monaco (with some exceptions). If vehicles over 8.5 tonnes have goods that need to be delivered, they have to deliver these goods to the MoCC platform and unload them. The MoCC operator then loads these goods onto their vehicles and makes the final distribution. Vehicles less than 8.5 tonnes can enter and deliver goods in the principality during specified time periods. At times when these lighter vehicles are not allowed to enter the principality, they can instead be parked in loading/unloading areas, while the drivers make deliveries and collections on foot.	With the SHCC, flows of materials were consolidated for 22 different delivery areas within the site, with two trips per day being made to each delivery area. A sub-contractor was employed to run the SHCC and the delivery vehicles, and to take care of the administrative issues. Ten people were employed, and five goods vehicles and three fork lift trucks were used.	The mission of Binnenstadservice.nl (BSS) is to provide logistical services to local inner-city stores, regional consumers, carriers and local government. BSS has a location outside the city centre where 18 hours a day goods can be received and picked up. The objective is to minimise the number of trips through the city centre. BSS started with only twenty clients in April 2008. The number of connected stores increased to 98 after one year.
Quantitative results	• 38% reduction in traffic congestion • 42% reduction in space used by vehicles for deliveries • Reductions for deliveries from consolidation centreto site of: 26% in fuel, consumption, 25% in NOX, 35% in CO, 26% in SO2, 26% in CO_2, 30% in local atmospheric pollution and 30% in vehicle noise pollution	• Vehicle load factor improved from approx. 50% to 85% • Vehicle kilometres per day reduced from 64 km to 26 km • Vehicle delivery time reduced from approx. 60 minutes to 6 minutes • The 80% reduction in small volume for direct deliveries was achieved only at peak times • Reductions of deliveries from consolidation centre to site of: 90% in energy use, 90% in CO_2 emissions, 90% in NOx, 90% in PM	• Reduction in logistical nuisance and traffic unsafety: A reduction of 85 vehicles per week. The new vehicles are CNG trucks and electric cargo bikes leading to less nuisance and improvement of the safety • Reduction in congestion: 5% decrease in the number of truck-kilometres and the truck travel time • Reduction in emission CO_2 50 kgs/week
Qualitative results	The Monaco scheme has resulted in a more efficient urban delivery system for the Principality of Monaco.	Analysis of the construction process suggests that the SHCC was instrumental in achieving on-time completion of new buildings, and there were fewer problems than normal with regards to damaged or stolen goods.	The positive results of BSS in Nijmegen give rise to BSS franchise initiatives in other Dutch cities, i.e. BSS already started business in Den Bosch (without subsidy).

Source: TSC, based on literature review (Scott Wilson Ltd, 2010; Van Duin, et al., 2016; Paddeu, 2017; Van Rooijen & Quak, 2009)

2.2 STAKEHOLDER ENGAGEMENT

2.2.1. Finding a Public Sector Case Study

Building on insights from the literature review, TSC looked for examples of public sector organisations generating significant goods vehicle traffic, focussing on densely populated and congested urban areas. In addition, the literature review suggested that large public sector organisations such as general hospitals and universities would benefit greatly from consolidating their deliveries (Allen, et al., 2012; Choongh-Campbell & Browning, 2017).

Given the immediate need to achieve legal compliance on NO2 emission limits, including through the implementation of Clean Air Zones in a number of UK cities, the focus of attention was directed towards those cities. In view of the relatively short project timescales (i.e. 12 months, from project initiation to completion), the project team needed also to identify a city that already displayed some understanding of the role UCCs might be able to play in delivering their clean air strategy: the project team were fortunate to quickly identify the city of Southampton as a viable study area.

The project team established early engagement with experts at the University of Southampton, who had a good track record of research into freight consolidation models and strong links with the local freight logistics industry. As a result, links were made with Southampton City Council (SCC) and the University Hospital Southampton Foundation Trust (UHS).

Southampton is one of 28 local authorities (at the time of writing) identified in the 2017 national Air Quality Plan as requiring to produce plans to bring compliance with NO2 levels in the shortest time possible (DEFRA, 2017). As a result, SCC underlined its commitment to improving air quality in the city with the recent approval of a SCC clean air strategy by the Council's cabinet. The strategy includes a commitment to introduce a programme of measures to support the possible implementation of the Southampton CAZ.

The SCC strategy currently being envisaged will consist of a programme of local measures to deliver immediate action to improve air quality and health while delivering sustained reductions in pollution and a transition to a low emission economy. All this, highlights how seriously SCC is taking the issue and the associated health[11] implications from road traffic pollution[12].

2.2.2. The University Hospital Southampton Case Study

The specific case study identified by the project team was that of the University Hospital in Southampton. UHS was an ideal case study because it serves more than 3.7 million people in the South of England (University Hospital Southampton, 2017) and generates a considerable amount of delivery traffic as a result. Furthermore, UHS has a contract with MGL who operate a multi-user warehousing facility to consolidate its pharmacy supplies. The Meachers facility is ideally located on the fringe of the city, bordering the Clean Air Zone and therefore providing an ideal case study for testing the consolidation model. (Meachers Global Logistics, 2017).

2.3 THE LOGISTICS CONSOLIDATION BUSINESS MODEL – UHS CASE STUDY

This section describes the logistics consolidation business model assessed as part of this project, identifying the logistics operations and resources currently required to supply the Southampton General Hospital (SGH) and comparing them to what would be required under the consolidation model.

The SGH is the UHS Foundation Trust's major centre, with a great number of specialist services, ranging from neurosciences and oncology to pathology and cardiology providing care to more than 3.7 million people in central southern England and the Channel Islands. Emergency and critical care is provided in the hospital's special intensive care units, operating theatres, acute medicine unit and emergency department (A&E), as well as the dedicated eye facility.

[11] In particular, assessments undertaken by Public Health England have indicated that up to 6% of all mortalities in urban centres may be attributable to poor air quality, recognising freight vehicles to be a major contributor.
[12] According to Southampton City Council, heavy vehicles contribute to 34% of the city's air pollution (MGL, 2017).

Figure 1 shows the hospital's location within the Southampton city. It is situated within the M271 ring road, conveniently located with good transport connections to the city centre. It is embedded within residential areas, and close to various arts, sport, and leisure facilities. The UHS central location and large services associated by the Trust contributes to high traffic congestion and emissions, which affect the urban road network within the city of Southampton.

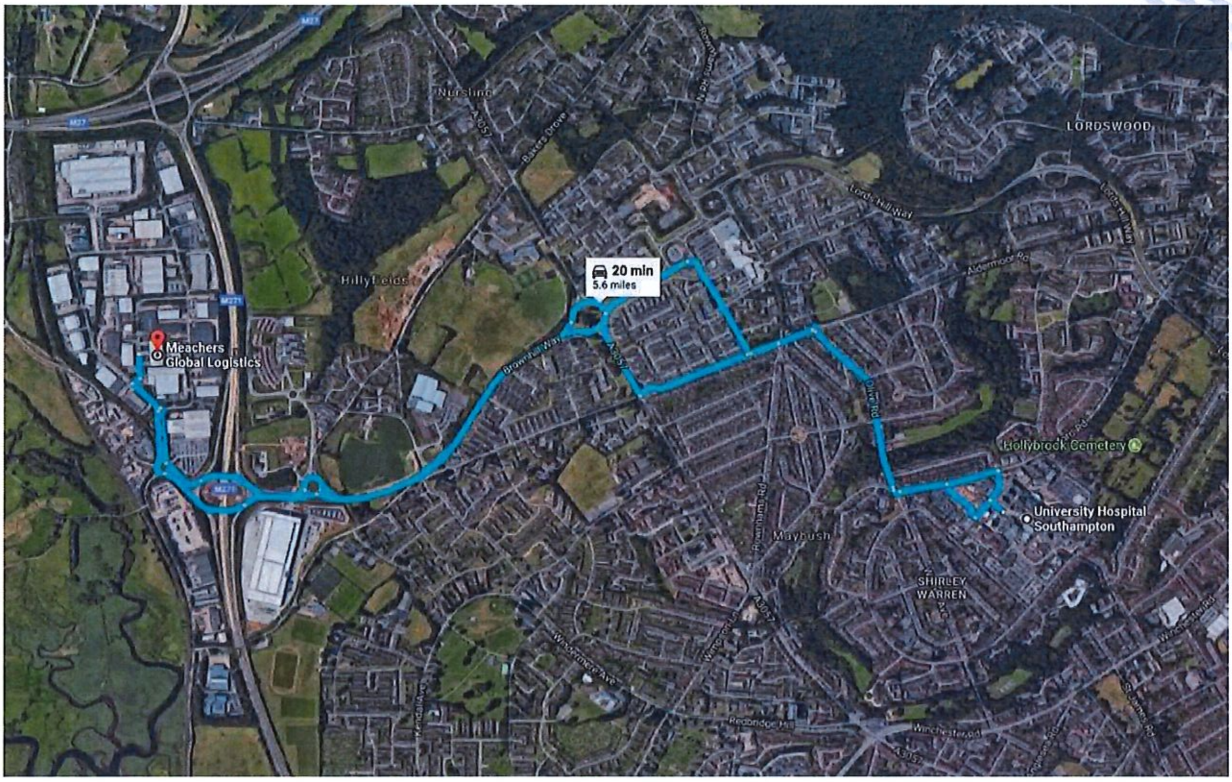


Figure 1 – Location of Southampton General Hospital and MGL warehouse within the Southampton City

Frequent and unscheduled courier deliveries at the main UHS loading bay creates high levels of congestion as well as environmental impacts in the surrounding areas, leading to increased delivery times, pollution and air quality impacts. This increases the risk to local residents[13] to suffer from respiratory conditions as it can exacerbate the effects of these. Furthermore, long-term exposure to air pollution reduces life expectancy by increasing deaths from lung, heart and circulatory conditions (DEFRA, 2017).

In addition, the current logistics model adopted by UHS requires a large amount of resources, including both labour and space requirements that could be better utilised and re-allocated to serve more productive tasks. Adoption of a freight consolidation model would improve efficiency by enabling the scheduling and pre-sorting of a set number of deliveries per day (Cherrett, et al., 2017).

The logistics consolidation model investigated as part of this project seeks to divert supplier deliveries into an existing multi-user consolidation centre (warehousing facility), managed and operated by MGL. Items would then be handled and combined on the minimum number of appropriate, efficient and clean vehicles to ship to one end user i.e. the UHS.

Figure 2 provides a schematic representation of both the baseline and consolidated logistics models for the UHS supply case study. The short dash arrows represent supplier deliveries at the hospital under the current model; these are re-directed to the UCC following the implementation of the consolidation model, as depicted by the continuous arrows. This would effectively reduce vehicle movements within the illustrative Clean Air Zone which is depicted by the shaded area surrounding the Hospital. The additional supply chain leg is represented by both the UCC and the thicker – consolidated delivery – arrow to the Hospital.

[13] Evidence from the World Health Organisation (WHO) shows that older people, children, people with pre-existing lung and heart conditions, and people on lower incomes may be most at risk.

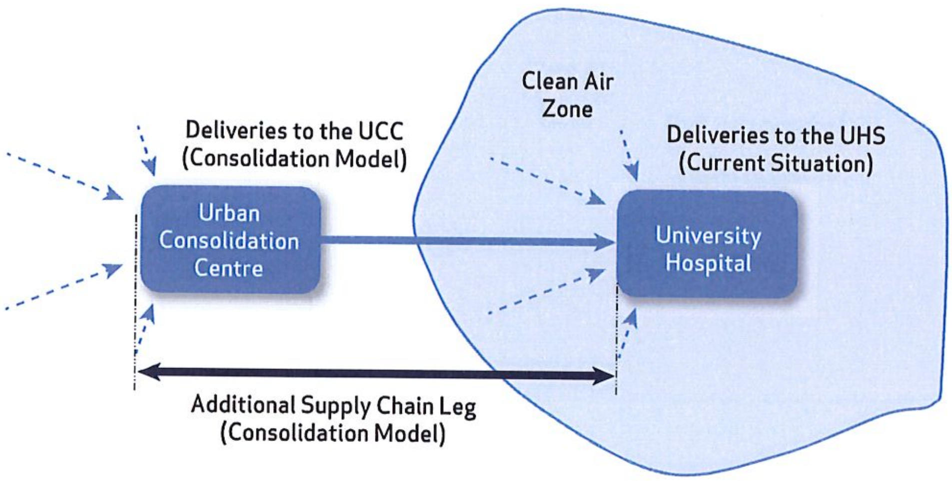


Figure 2 - Representation of the logistic consolidation model

2.3.1. Financial Viability and Benefits to the Local Community

The ultimate goal behind the economic modelling was to assess how the implementation of the logistics consolidation model could be of benefit to the local community as well as demonstrate its financial viability. It was considered paramount to both understand the economic implications to all parties derived from the consolidation model and to monetise the additional social and environmental benefits that could be derived from the consolidation logistics model itself.

The logistics consolidation model could potentially bring benefits to the environment through effectively reducing the number of vehicles circulating in, out or around Southampton City Centre, thus reducing traffic congestion and vehicle emissions.

The model has highlighted, in this particular case study, the potential trade-offs between the business-as-usual operational model at the Hospital compared to the use of a UCC model for all the parties involved. It has considered the positive implications of the UCC, but also taken account of the additional costs associated with the extra supply chain 'leg' being introduced. This work has shown that the economic and wider benefits of using UCCs for Public Sector organisations can off-set additional costs imposed by the UCC.

However, it is important to note that this case study provided the ideal factors and conditions for a UCC model to financially succeed as well as delivering additional wider benefits. The outcome of implementing a UCC model would, however, differ on a case by case basis thus the result of this feasibility study should not be considered directly applicable to other examples.

3 DATA IDENTIFICATION & COLLECTION

The data identification and collection process were undertaken as part of WP2. It involved gaining access to and collecting the necessary data to understand the current situation at UHS and quantifying its related costs to establish the baseline scenario for comparison with the logistics consolidation model.

This section describes the main datasets used to build and calibrate the economic assessment model developed as part of WP3.

3.1 FREIGHT OPERATING COST DATA

This includes both vehicle and warehouse operating costs. Data was obtained from MGL and further cross-validated with overall industry data obtained through the literature review.

3.1.1. Meachers Global Logistics

MGL is one of the UK's leading independent providers of international freight and transport logistics services and provides a broad range of UK warehousing facilities in the South of England and the West Midlands.

MGL provided operating cost data obtained from the real-world experience of both Steve Porter Transport[14] (an operation carried out as part of an alliance with Meachers and Red Funnel for consolidated deliveries to the Isle of Wight) and Carnival[15] consolidation models currently in operation. Operating cost data included monthly average fleet running costs, rental space costs at the Southampton warehouse and other labour and administrative costs.

Although the data provided does not particularly involve consolidation for a public sector organisation, we believe that it can be extrapolated to inform the UHS case study and it is therefore used to calibrate the economic assessment model.

3.1.2. Literature Review

Data obtained from the literature review and other publications provided generic industry operating costs that were employed as a benchmark to assess the costs of other logistics providers involved within the wider UHS supply chain.

Amongst the array of papers consulted and outlined in Section 2, Cherrett, et al., 2017 and RHA, 2014 were found to be of particular interest and widely used to populate and calibrate the overall freight industry costs within the economic assessment model.

3.2 UHS 'BUSINESS AS USUAL' DATA

This data relates to the current situation at UHS and considers both the external and internal logistics operations. This includes the number and type of delivery vehicles as well as the resource and processes required for internal movements of goods at UHS.

3.2.1. The Delivery and Servicing Plan (DSP) Data

The DSP hospital-wide audit data provided a comprehensive assessment of the traffic associated with all logistics activities to and from Southampton General Hospital (SGH).

The DSP data helped to: (a) gain a better overview of purchasing behaviour and the options for consolidating the Hospital's ordering process and (b) understand the current delivery patterns and service vehicles to optimise the use of delivery bays.

The DSP data came from a Delivery and Servicing survey, conducted by the University of Southampton in May 2015, over a 5-day period from Monday 11th to Friday 15th between the hours of 7:00 and 18:00.

[14] Steve Porter Transport provides express transport services to businesses in central Southern England, the Isle of Wight, the Channel Islands and throughout the UK
[15] Carnival UK is part of the larger Anglo-US Carnival Corporation. Carnival UK comprises P&O Cruises and Cunard Line, headquartered in Southampton. Meachers provide a freight consolidation and logistics service for cruise ships calling in Southampton

The survey covered:

- Date and time of arrival and departure of each vehicle
- Supplier and courier details for each item delivered
- Recipient department(s) and receiver details
- Consignment sizes and contents
- Packaging / containment type (e.g. box, cage, loose, envelope)
- Trip purpose, i.e. drop, collection, servicing
- Vehicle fill-rate and registration
- Details of any returns
- Vehicle origin, previous drop, next drop and final destination

3.2.2. UHS Internal Supply Chain Data Audit

An overall understanding of internal supply chain activities was gained through on-site visits and interviews with the Procurement & Supply Chain team at the UHS.

This information provided an invaluable insight into the business as usual activities required from the time an item is dropped off at the loading bay to when it reaches the Point of Use. A high-level analysis was undertaken to understand what resources were involved, both in terms of labour and space, to identify where inefficiencies and existing issues lay. This helped the economic assessment to quantify the opportunity costs of moving towards a logistics consolidation model.

3.2.3. Automatic Number Plate Recognition (ANPR) based traffic data

ANPR is a technology that uses optical character recognition on images to read vehicle registration plates. This data can then be matched with the Driver and Vehicle Licensing Agency (DVLA) database to identify specific vehicles coming in and out of a particular location – in this case, the hospital loading bay.

Re-using ANPR data already collected and available for the Southampton city-wide area was first considered. However, since the ANPR camera locations did not properly capture vehicle flows at the entrance of the hospital loading bay, TSC employed the ANPR camera provider, TRACSIS[16], to undertake a data collection exercise specifically for the purpose of this study.

ANPR data collection took place from Monday 9th October to Friday 13th October 2017 between the hours of 07:00 and 19:00. The registration details of vehicle movements to the loading bay were captured and subsequently run through the DVLA database. The outputs from the DVLA database allowed us to understand the number and type of vehicles going in and out of the Hospital including vehicle types (LGV and HGV), engine type (Euro classification) and delivery times.

This data was used to: (a) estimate the number of goods vehicles that would potentially be required to pay a charge to access any potential charging CAZ. (b) analyse average delivery times for vehicles at the hospital loading bay and, (c) understand the type of deliveries and utilisation rates of vehicles approaching the loading bay. This data was fed into the economic assessment model to quantify operating costs savings.

[16] The Tracsis plc Group specialises in solving a variety of data capture, reporting and resource optimisation problems along with the provision of a range of associated professional services. (https://www.tracsis.com/about-us

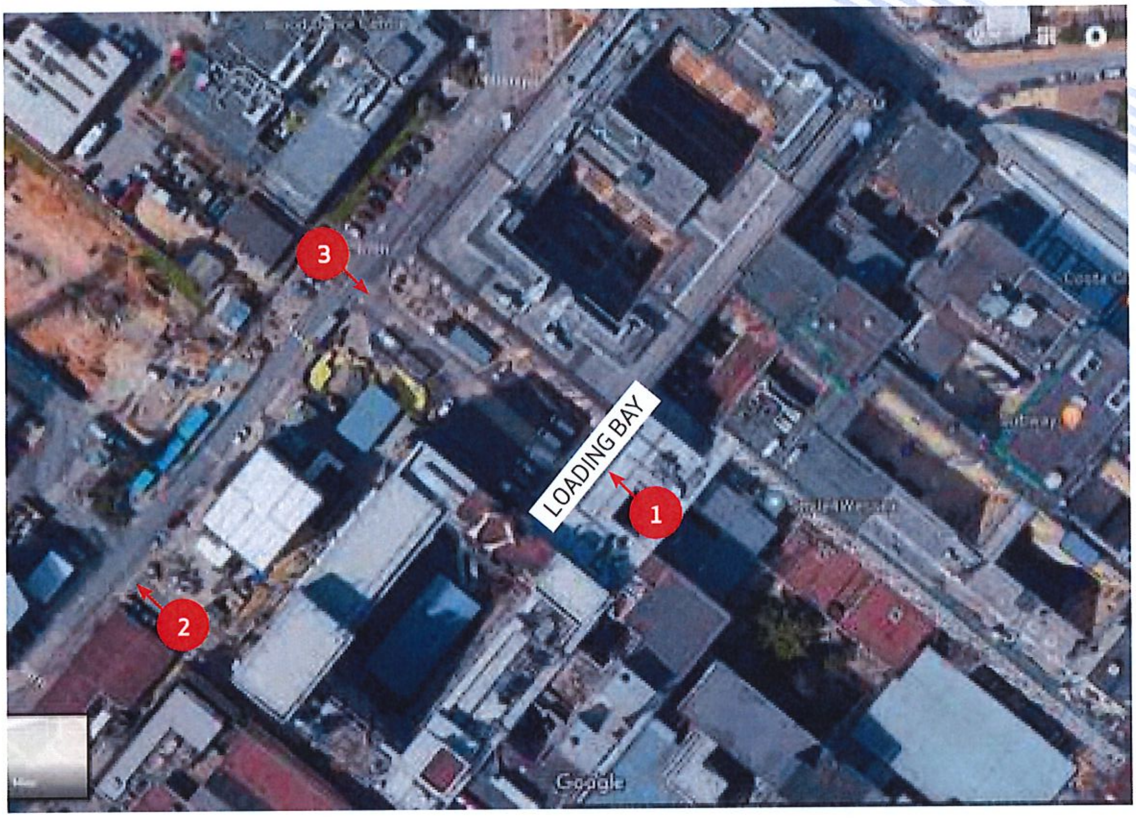


Figure 3 - Camera location in the University Hospital Southampton

Figure 3 shows the camera locations around the hospital loading bay and access roads chosen as well as the nature and rationale for their inclusion:

Camera 1 - Footage only camera within the loading bay to capture arrival and departure times, company logo if applicable and an estimation of vehicle utilisation.

Camera 2 - Footage only camera at the junction to capture vehicle type and direction of travel.

Camera 3 - ANPR camera capturing number plates of vehicles going into the loading bay which will then be run through the DVLA database to provide vehicle details.

(TRACSIS was instructed to exclude traffic involved with construction works at the loading bay and to discount vehicles that related to this).

3.3 WIDER TRAFFIC IMPACTS: SUB-REGIONAL TRANSPORT MODEL (SRTM)

3.3.1.Rationale for Inclusion

Traffic models are tools that simulate current traffic conditions based on real traffic flows and travel times amongst other relevant traffic datasets. They are useful tools to model so-called 'what if scenarios' to understand how the traffic patterns would respond if certain traffic conditions were to be changed in the future.

For example, traffic models can be used to analyse future network disruption impacts under increased transport demand scenarios, or to understand the impact of mitigation measures, such as improved roundabout layouts or enhanced network capacity.

3.3.2. Introduction to SRTM

It was important to access an existing transport model covering the Southampton area to understand traffic flows and travel times around the University Hospital Southampton.

Stakeholder engagement identified the Sub-Regional Transport Model (SRTM), developed by the Transport consultancy SYSTRA on behalf of Hampshire County Council, as a potential tool that could meet the requirements for this task. Following consultation with SYSTRA[17], it was determined that the model provided a good fit to understand the traffic conditions for the study area and the TSC subsequently commissioned SYSTRA to undertake the analysis.

SRTM was developed as per WebTAG guidance in 2009/10 with a base year of 2010 to support a wide-ranging set of interventions across the Solent Transport sub-region. It has since been updated for a 2015 base year and it is specifically required to be capable of:

- Forecasting changes in travel demand, road traffic, public transport patronage and active mode use over time because of changing economic conditions, land-use policies and development, and transport improvement and interventions;
- Testing the impacts of land use and transport policies and strategies within a relatively short model run time; and
- Testing the impacts of individual transport interventions in the detail necessary for preparing submissions for inclusion in funding programmes.

The SRTM model was employed to simulate the traffic impact on the road network associated with the two scenarios described below:

- **Baseline:** This scenario considers the impact of traffic on the transport network under typical daily conditions.
- **Consolidation:** This scenario considers the impact of traffic on the transport network following the implementation of the UCC model. Under this scenario, a proportion of goods vehicles travelling to Southampton University Hospital are redirected to the MGL warehousing facility located on the outskirts of Southampton. A reduced number of consolidated HGV vehicles are assigned from the warehouse to the UHS to deliver the goods to the hospital outside peak times, reducing the overall number of LGVs and HGVs travelling in/out Southampton.

The difference between traffic modelling outputs obtained from the baseline and consolidated runs were used to quantify and assess the economic, environmental and social benefits that could be derived from implementing freight consolidation models in the last mile of delivery in terms of reduced congestion and travel times.

3.3.3. Land Use Assumptions

This section summarises the land use assumptions that were used in the Traffic Modelling. Figure 4 shows the zone system around the hospital area. Zone 117 from SRTM was chosen to represent the hospital, as it closely matches the hospital footprint.

Table 5 shows the floor space quantum (alongside the %) for each category modelled in 2015, for the zones around Southampton Hospital.

[17] A recognised world leader in mobility and mass transit, and with a 60-year history, SYSTRA is an international company, present in more than 80 countries. Engineering News-Record ranks SYSTRA in the top two mass transit and rail international design firms and among the 50 largest engineering firms in the world. (https://www.systra.co.uk/index.php/about-systra/systra-uk)

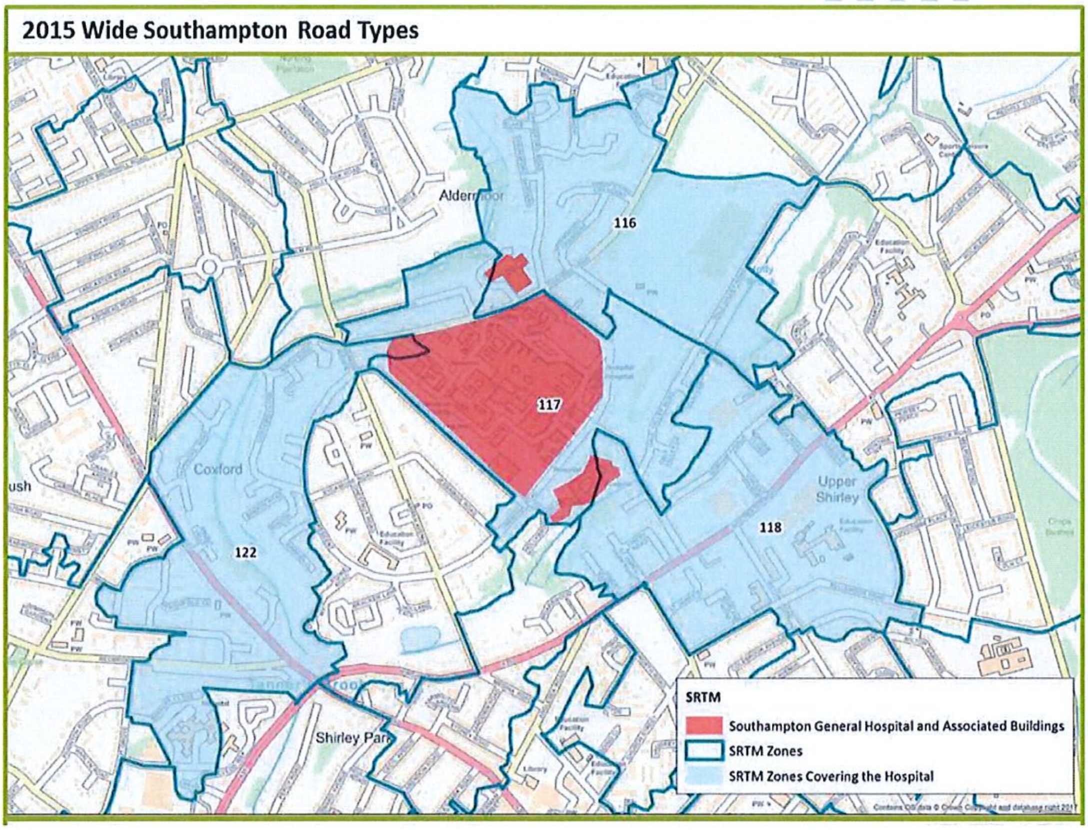


Figure 4 -SRTM Zone System around University Southampton Hospital

	Residential (sqm)	Retail (sqm)	Office (sqm)	Industrial (sqm)	Warehousing (sqm)	Primary and Secondary Education (sqm)	Adult Education (sqm)	Hotel and other Accommodation (sqm)	Healthcare (sqm)	Leisure (sqm)
Southampton City	8,644,959	498,509	936,150	493,774	898,449	128,791	21,289	107,066	301,310	89,161
Hospital Zone (117)	35,413	19m832	28,029	11,550	1,664	10,032	11	4,231	109,804	2,677
Hospital Zone % (117)	7.0%	3.9%	5.5%	2.3%	0.3%	2.0%	0.0%	0.8%	21.7%	0.5%
Surrounding Hospital Zone % (116)	10.0%	0.3%	0.8%	1.1%	0.0%	0.0%	0.3%	0.1%	1.7%	0.1%
Surrounding Hospital Zone % (118)	17.2%	0.8%	1.3%	1.0%	0.5%	0.7%	0.0%	0.2%	0.4%	0.2%
Surrounding Hospital Zone % (112)	15.0%	1.3%	0.9%	0.7%	0.1%	0.2%	0.0%	0.1%	0.8%	0.1%

Table 6 - Southampton and zones of interest - Land Use Assumptions for SRTM

3.3.4. Traffic Flow Variation Due to Consolidation

Figure 5 identifies the change in traffic flow (PCUs[18]) in the morning peak hour[19] around the vicinity of the University Southampton Hospital and MGL warehousing facility, resulting from the implementation of the UCC.

For the flow difference plots, the absolute difference in PCUs is identified adjacent to the appropriate link. Blue lines represent a reduction compared to the 'without consolidation scheme' scenario, and pink/red lines an increase. In addition, the scale of the change is represented graphically with the coloured lines of varying bandwidth.

The redirecting of goods vehicles from the hospital to the warehouse shows a slight decrease in overall traffic flows around the Hospital vicinity in the morning hours, with a very slight increase on Coxford Rd. At the warehouse vicinity, there is an increase in PCU travelling east to west and vice versa at the Junction 1 roundabout on the M271.

Redirecting the goods vehicles in this scenario has pushed more traffic towards the warehouse (see Figure 6), allowing other vehicles to use the less congested roads around the hospital, thus improving traffic conditions (see Figure 5).

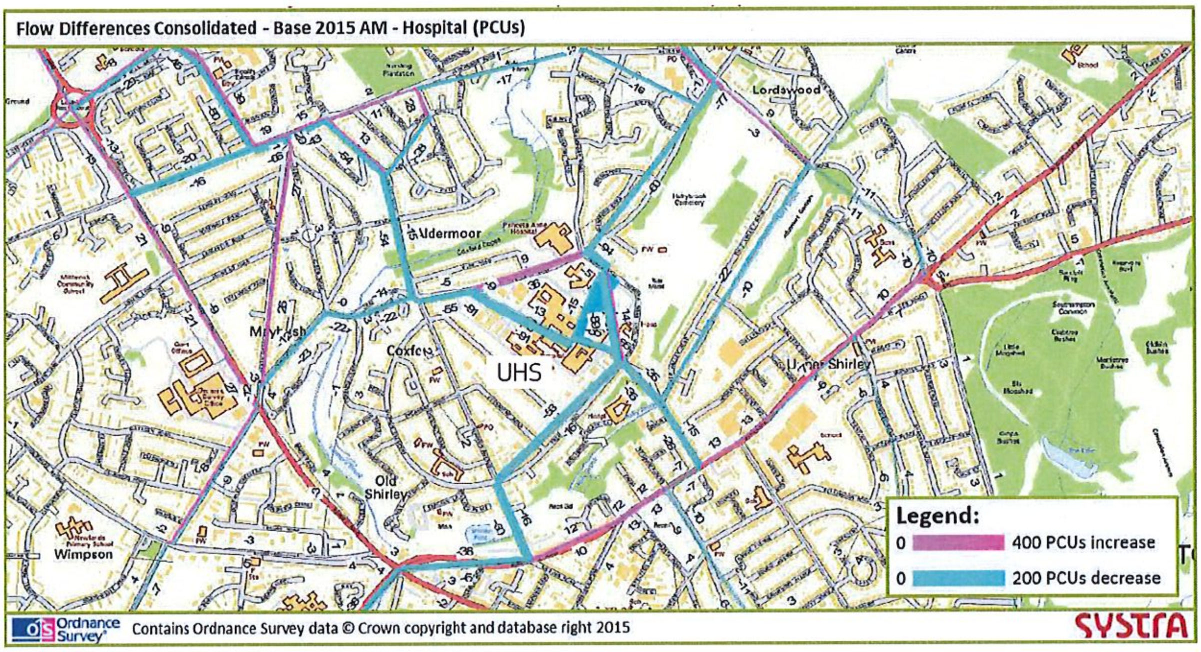


Figure 5 – AM Peak Flow Difference (Consolidated v Base, Hospital), UHS

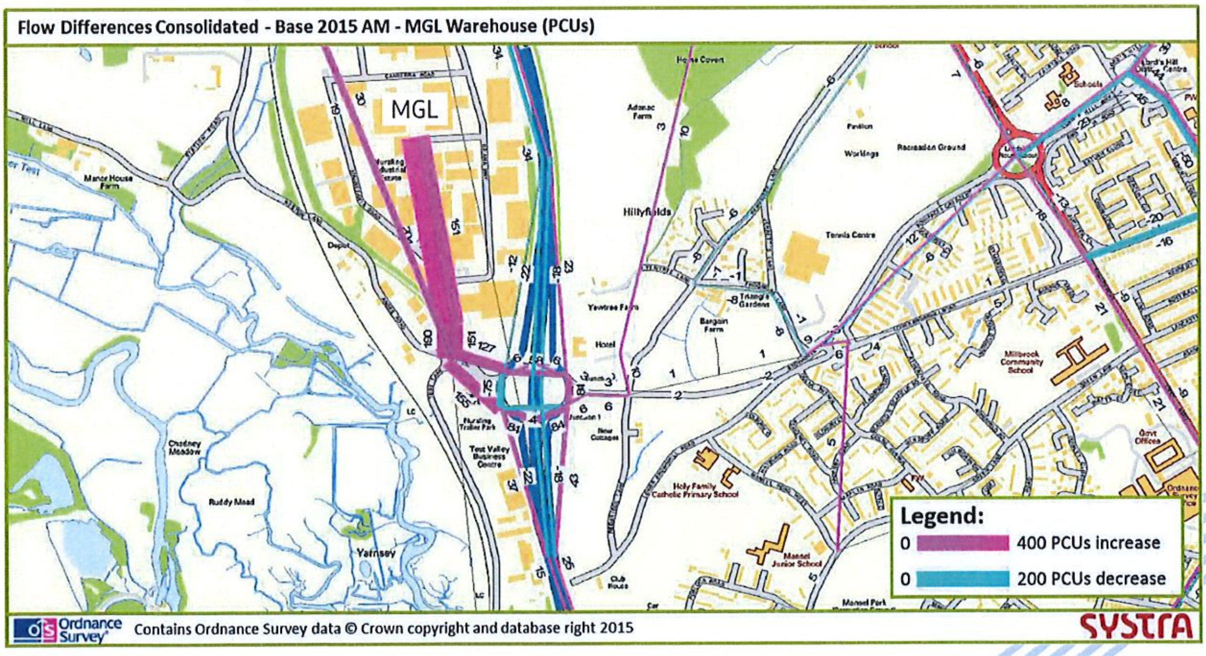


Figure 6 – AM Peak Flow Difference (Consolidated v Base, Hospital), MGL

18 Passenger Car Unit - metric used in Transportation Engineering, to assess traffic-flow rate on a highway. A Passenger Car Equivalent is essentially the impact that a mode of transport has on traffic variables (such as headway, speed, density) compared to a single car.

19 All AM, IP and PM peak periods where modelled and plots are reported in the Appendix A.

3.3.5. Highway Delay Variation Due to Consolidation

Figure 7 identifies the change in link delay (seconds per PCU) in the morning peak hour between the base and the consolidated runs, at the hospital and warehousing vicinities. The absolute difference in delay (expressed in seconds) is identified adjacent to the appropriate link. As previously, blue lines identify a reduction and pink/red lines an increase. All delay differences in excess of 1 second are displayed in the plot.

Differences in delay are generally minor, with average travel time variations under 10 seconds. Slight decreases in delay are seen in the hospital area and increases in the MGL Warehouse area.

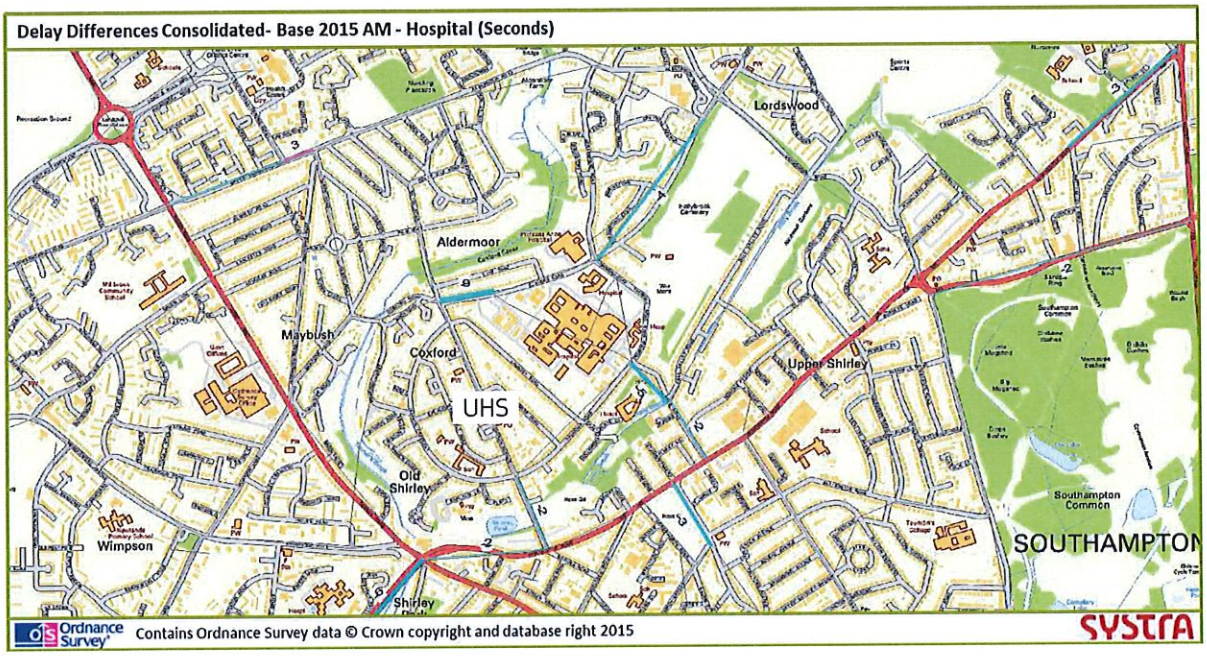


Figure 7 – AM Peak Delay Difference (Consolidated v Base, Hospital), UHS

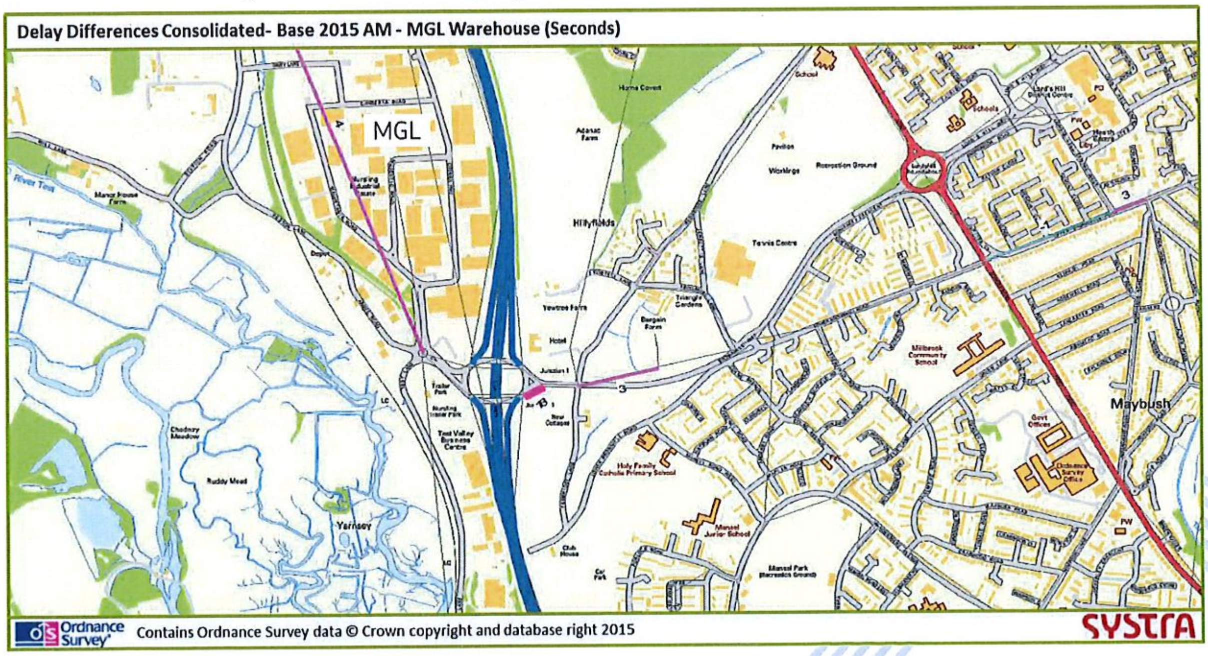


Figure 8 – AM Peak Delay Difference (Consolidated v Base, Hospital), MGL

4 THE BUSINESS CASE

4.1 FREIGHT ECONOMIC MODEL (FEM) SPECIFICATION

The Freight Economic Model (FEM) outlined below provides a detailed impact assessment of the costs and benefits derived from implementing a logistics consolidation model across three main impact categories as described below:

- Additional costs **(C)** arising from the extra supply chain leg.
- Operating cost savings **(S)** which could be achieved through reduced operational activities for both the end-receiver and freight suppliers.
- Wider impacts **(W)** in terms of economic, environmental and social benefits derived to the local community.

Figure 9 provides a graphical representation of where these potential costs and benefits would occur within the supply chain as a result of the implementation of the logistic consolidation model.

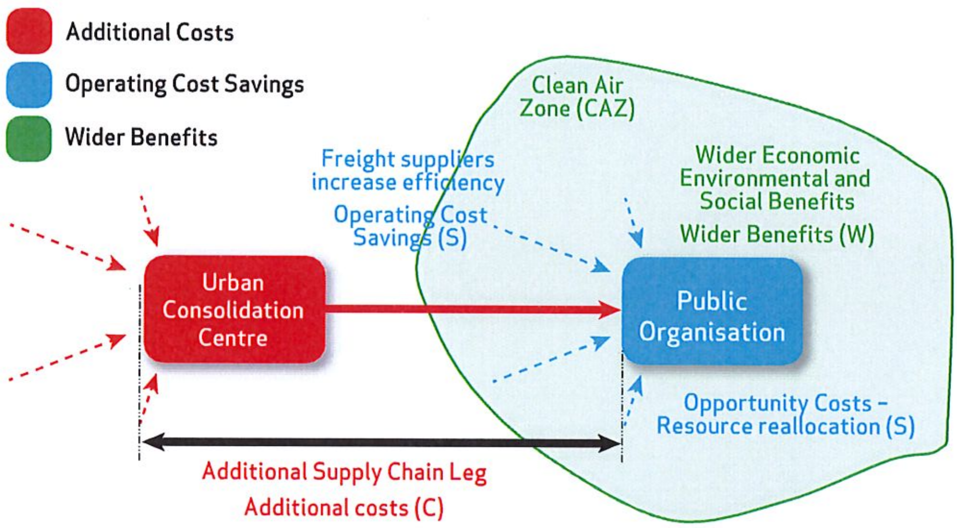


Figure 9 - Impact categories considered within the Freight Economic Model

Arguably, the total value of the three impact categories identified above would depend on the logistic volumes associated within each case study. The FEM tool has been developed to provide a robust economic assessment that can be transferrable to assess different scenarios and cases studies if the necessary input data is made available.

Figure 10 provides a two-dimensional view of the possible outcomes and magnitudes that each of the three impact categories could have depending on the freight volumes.

Each category follows a different function of volume as described below:

- Additional costs **(C)** are depicted by a downwards red curve to account for existing economies of scale in the freight industry with cost per unit reducing inversely proportional to total volumes being shipped.
- Operating cost savings **(S)** are represented by the upwards blue curve as savings that will increase proportionally to the total freight volume.
- Wider impacts **(W)** derived from environmental and decongestion factors are added to the operating costs curve and depicted by the exponential upwards green curve as the consolidated freight volumes increase.

This two-dimensional relationship is of interest because it suggests that the additional costs to implement an UCC with low freight volumes would not be fully offset by minor potential gains in terms of inefficiencies, congestion and pollution reduction. On the other hand, it suggests that since the freight industry enjoys economies of scale, the higher the freight volumes, the higher the benefits compared to costs that would be derived from the implementation of an UCC.

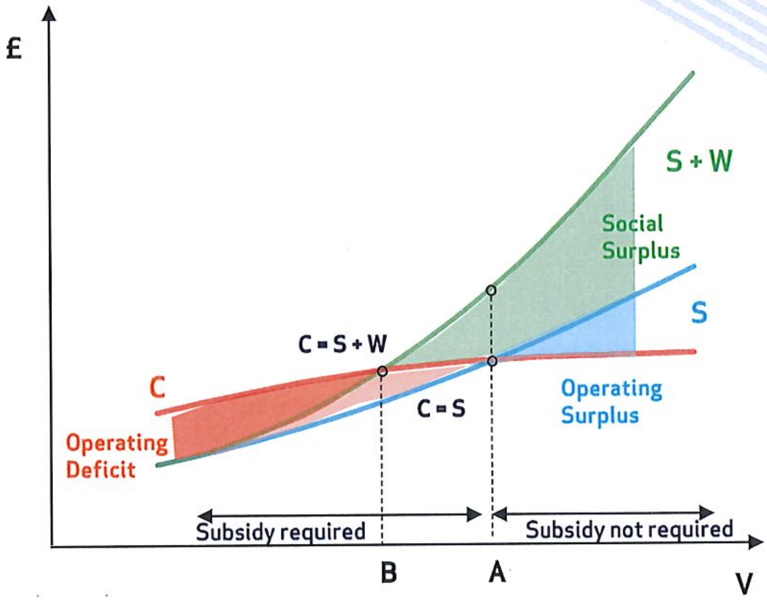


Figure 10 - Impact categories variation with volume

As such, the graph identifies a few critical points, defined where curves intersect each other. These define the key scenarios, to look at during the economic modelling exercise, which are described below:

Scenario A: ***C=S***

Additional costs imposed by the extra supply chain leg are fully offset by operating cost savings only and therefore any subsidy to implement and operate the consolidation model is not needed. This is the operating break-even scenario without any subsidy being required. It is important to note that under this scenario, social surplus[20] is greater than zero and magnitude W, represented by the green shaded area. A further increase of freight volume from this point will generate an operating surplus represented by the blue shaded area.

Scenario B: ***C=S+W***

Additional costs imposed by the extra supply chain leg outweigh operating cost savings by just the amount of benefits that can be fully recovered through additional wider economic, environmental and social benefits. This scenario will require a subsidy of amount W. It is important to note that a further decrease in freight volume from this point would require a subsidy amount higher than that which can be recovered through wider benefits W.

4.2 FEM METHODOLOGY

This section aims to provide further description of each of the impact categories that are considered within the outlined economic model. For each impact category, several indicators to measure and quantify in monetary terms the costs and benefits are defined and presented in Table 6. Indicators are populated using data for each case study and will provide the magnitude for each of the impact categories considered.

Wider economic, environmental and social impacts are quantified in monetary terms and assessed against a range of qualitative and quantitative economic and strategic criteria in accordance with the Department of Transport's Appraisal Guidance (WebTAG). Where information is not available some assumptions are made by drawing upon existing evidence in the literature.

The Costs and Benefits resulting from the FEM assessment are interpolated and extrapolated to cover the full appraisal period as necessary. Monetary values are adjusted by inflation and discounted to the present value year[21]. Finally, results are reported as perceived costs and market prices.

20 The social surplus is the difference between what someone is prepared to pay and the amount of benefit they receive, with the latter being greater than the amount paid.
21 Further guidance on forecasting projections to cover the appraisal period is described in Section 4.3

4.2.1. Additional Costs (C)

The use of an UCC requires additional handling, storage and transportation costs – which creates an additional expense to the overall delivery of goods for the end user.

Additional costs are grouped into two different sub-categories, distinguishing between the costs of running the fleet and the costs related to operating the UCC.

Fleet Operating Costs

This sub-category includes costs related to running the MGL's vehicle fleet from the UCC to the end-user. Fleet to run the UCC model would involve HGV vehicles with euro VI engines. Indicators have been identified to quantify how these costs vary according to the miles/time/fleet operated by the supplier:

- **Distance related costs:** Considers costs that increase proportionally with the total distance travelled by the logistic suppliers. Fuel consumption, tyre wear and fleet maintenance costs are the indicators selected to quantify mileage related costs.
- **Time related costs:** Considers costs that increase proportionally to the number of hours operated by the logistics supplier. Employment costs, including actual weekly wages, bonuses, holiday entitlements, relief drivers, sick leave, NIC and pension costs are the indicators selected to quantify time related costs.
- **Fixed costs:** Considers costs that are incurred regardless of the operational level undertaken by the freight vehicle fleet. Depreciation, insurance, licenses, interest on capital and overhead per vehicle costs are the indicators selected to quantify overhead related costs.

Warehousing Related Costs

This sub-category includes costs related to handling, operating and running an UCC. These would involve mainly the administration and management labour costs to receipt, handle, re-organise and despatch goods and items. Besides, it includes the space requirements to accommodate and store the goods delivered that otherwise would be shipped directly to the end-user. It is important to note that these costs do not include the capital costs necessary to build and set up the warehouse in the first place.

4.2.2. Operating Cost Savings (S)

Operating cost savings are grouped into three different sub-categories depending on the entity that derives the benefits as outlined below:

End-User Opportunity Cost

Opportunity costs are quantified by running a cost comparison between the costs incurred by the end-user under the current logistics model and those that would potentially be involved under the proposed consolidation model.

This section quantifies cost savings arising from the optimisation and consolidation of freight deliveries into the receiver. The logistics consolidation model would reduce the number of deliveries as well as minimising consolidation related activities undertaken at the end user premises which would effectively reduce both the space and labour resources needed to deal with handling and management activities.

Labour and space requirements to operate the current logistics model were identified during on site interviews at the UHS. A reduction of labour and space requirements following the implementation of the consolidation model was then modelled and validated by the UHS. A direct cost comparison was then undertaken using UHS internal labour and space unit rates. It is therefore important to point out that opportunity costs refer to the mere cost comparison between resources needed under the two logistics models rather than the opportunity cost of allocating these human resources to serve more important purposes[22].

[22] Interviews with the UHS Supply Chain team revealed that most of the procurement and Supply Chain staff were currently working over capacity and struggling to deal with urgent, so-called 'To Take Out' orders for in-patients, while constantly dealing with new courier deliveries.

Clean Air Zone Charge

A Clean Air Zone (CAZ) defines an area where targeted action is taken to improve air quality and resources are prioritised and coordinated to shape the urban environment in a way that delivers improved health benefits and supports economic growth[23].

CAZs would bring together local measures to deliver immediate action to improve air quality and health with support for cities to grow, while delivering sustained reductions in pollution and a transition to a low emission economy.

In areas where there are the most persistent pollution problems, restrictions that encourage only the cleanest vehicles to operate in the city are likely to be supported. These are zones where vehicle owners could be required to pay a charge to enter, or move within a defined zone if they are driving a vehicle that does not meet the particular standard set for their vehicle type in that zone.

The implementation of a logistics consolidation model would enable freight carriers to deliver at the UCC (normally located outside a CAZ) thus saving the potential penalty fee charge that would otherwise be imposed to deliver to the end-user typically located inside the CAZ.

Fleet Operating Cost Savings

As was pointed out in the logistics model description, freight carriers would directly deliver goods to the UCC. UCCs are usually strategically located alongside adequate transport infrastructure allowing for a single point of delivery and less time spent making deliveries in urban areas. This leads to reduced operating costs and the potential to use time savings to generate additional revenue[24].

In addition, unlike some towns and city centres, there are no vehicle size restrictions at UCCs (beyond the normal weights and dimensions rules imposed by national regulation) and deliveries can be accepted out of regular peak hours. MGL operates warehousing services 24-hours a day including weekends. The ability to deliver out of hours allows hauliers to travel during off-peak periods where traffic is quieter, and thus operating costs may be reduced by running vehicles more efficiently at consistent speeds. Ultimately, freight suppliers would experience operating cost reductions which - assuming an industry with close to perfect competition - would likely be passed on to the receiver through renegotiating procurement contractual terms between the suppliers and receiver.

Fleet running cost savings are quantified within the FEM following the same sub-categories and indicators outlined in Section 4.2.1.

4.2.3. Wider Impacts (W)

Wider impacts encompass the additional economic, environmental and social benefits offered to the local economy following the implementation of consolidated logistics. The FEM primarily considers impacts across the following categories and the calculation methodology[25] is outlined below:

Direct road user benefits

Logistics consolidation aims to optimise and reduce the number of deliveries coming in and out of sensitive areas located within city centres and potentially surrounded by CAZ. Reduction of traffic congestion would have a positive impact on direct road users and other transport providers.

The FEM analyses the decongestion benefit derived from reduction of travel times across the different user categories described below:

- Car Work: considers users travelling as part of business or during business time.
- Car Non-Work: includes both commuting, leisure and other purposes.
- LGV: Considers Light Goods Vehicles (<3.5 tn).
- HGV: Considers Heavy Goods Vehicles (>3.5tn).

23 As defined by Clean Air Zone Framework - Principles for setting up Clean Air Zones in England (DEFRA 2017)
24 The introduction of an UCC at Heathrow Airport resulted in suppliers reporting a saving of up to £5000 in fuel bills per supplier per annum, due to less time spent running in, around and out of cities and towns (Scot Wilson, 2010).
25 Broadly in accordance and compliance with Department for Transport (DfT) Transport Analysis Guidance (WebTAG).

The FEM incorporates the above traffic data from the Transport model (SRTM) into the model environment described in Section 3.3 along with additional datasets extracted from WebTAG Databook and other data sources necessary to undertake the assessment.

Value of Travel Time Savings (VTTS) are derived from variations of journey times within the network. The journey time variations across the network are obtained through traffic modelling and simulation of the traffic conditions before and after the implementation of the logistics consolidation model. These are quantified into monetary terms using the appropriate Values of Time (VoT) for each vehicle type and user class.

Values of Time are largely drawn based on Stated and Revealed Preference (SP&RP) analysis where survey respondents are forced to trade-off between shorter/expensive journeys and longer/cheaper options. Combinations of survey responses from multi realistic and hypothetical cost/time journey choices reveal the individual willingness-to-pay for travel time saving.

Traffic flows and VoT are employed to quantify in monetary values economic benefits derived from changes in travel times within the network. The assessment for this category is based on the Consumer surplus theory from reduced travel costs known as 'rule of a half' that forms the basis of the Department's Appraisal Software, TUBA.

Environmental benefits

Logistics consolidation would reduce emissions within air quality management areas, helping to bring down the overall exposure to concentrations of nitrogen dioxide (NO_2) as well as reduce emissions of carbon dioxide.

This section undertakes the assessment of local air quality, regional pollution and greenhouse gas emissions (CO_2e) resulting from the logistics consolidation model compared to the baseline situation. The FEM environmental section undertakes the assessment of traffic related environmental impacts following the WebTAG methodology[26]. The assessment covers the following categories:

- **Greenhouse gases:** This sub-section estimates the overall quantity of carbon dioxide equivalent emissions (CO_2e), in tonnes, under each of the modelled scenarios and expresses it as monetary values.
- **Air Quality impacts:** This sub-section includes the appraisal of air quality impacts derived from NOx which is a major source of local air pollution. The FEM undertakes a high-level appraisal of changes in concentration in properties within the vicinity of the transport network as a result of the implementation of consolidated logistics.
- **Noise impacts:** This sub-section quantifies the outcomes of transport-related noise covering a range of impacts on annoyance, sleep disturbance and health impacts, including heart disease, stress and dementia.[27] These are calculated using the marginal external cost method described within TAG unit A5-4.

It is important noting that the environmental evaluation compares emissions between the two scenarios described above for only the delivery vehicles affected by the logistic model. Therefore, it only considers emissions reduction for the stretch of journey removed to the overall freight vehicles and the additional mileage from consolidated vehicles running from the warehouse to the Hospital.

It does not however, quantify the wider impact on traffic emissions derived by improving overall traffic conditions. In this regard, the mileage reduction of delivery goods vehicles would also have a positive impact on traffic (i.e. improving speeds), thus reducing traffic emissions further.

[26] EAM integrates the process described in TAG Workbook Air Quality Valuation.
[27] https://www.gov.uk/guidance/noise-pollution-economic-analysis.

Social benefits

- **Accident Impacts:** The FEM undertakes the analysis of the impact on accidents as part of economic appraisal for a transport scheme following COBA-LT Guidance (COst and Benefit to Accidents – Light Touch), software developed by the DfT. These cover the human experience and benefits derived from reduced road freight congestion under the selected scenarios considering all costs associated with them (e.g. loss of output and medical and ambulance costs).

  The FEM assesses the safety aspects of road schemes using traffic input data of combined links and junctions in the network covered by the transport model. Input traffic data is obtained from the SRTM model runs; which summary results are incorporated into the economic model environment. The assessment is based on a comparison of accidents by severity and associated costs across the network for both 'baseline' and 'consolidation' model runs, using details of link and junction characteristics, relevant accident rates and costs and forecast traffic volumes by link and junction.

  Economic parameters, such as accident rates, costs of accidents and cost growth rates, necessary to undertake the assessment are coded into the FEM. These are consistent to the standard file supplied by the TASM division of DfT on the COBALT section.

- **Other 'Soft' Social Impacts:** This section quantifies in monetary terms, the additional social benefits derived from improved working conditions and social wellbeing at the UHS. Those benefits consider the governmental, individual and employer financial savings from the reduction of work related sick and injury leave. Work injuries relate to handling activities as well as slips, trips or falls. Sick leave includes illnesses such as stress, depression or anxiety.

  Workplace injury and illness rates per employee for transport related activities are obtained from the Health and Safety Executive (HSE) Cost model[28]. Rates are applied to the total number of employees involved within the internal supply chain at the UHS and further quantified using unit costs obtained from HSE.

- **Indicators by Impact Category:** Table 6 provides an overview of the three impact categories and sub-categories derived from them, along with the relevant indicators employed to undertake the economic impact assessment. It also describes the datasets and sources employed to populate the indicators for the UHS Case study.

Freight Economic Model (FEM) – Indicators by impact category					
Impact Category	**Symbology**	**Sub-category**	**Entity**	**Impact Indicators**	**Data Source**
Additional costs	C	Fleet operating costs	Last mile Freight operator	Fuel Consumption	Meachers Global Logistics (MGL) Data
				Tyre Wear	
				Repair & Maintenance	
				Employment	
				Vehicle Finance	
				Overhead Costs	
		Warehousing costs		Staff Benefits	
				Space requirements	
Operating cost savings	S	Fleet operating savings	Freight suppliers	Fuel Consumption	Road Haulage Association (RHA) Data
				Tyre Wear	
				Repair & Maintenance	
				Employment	
				Vehicle Finance	
				Overhead Costs	
		Penalty fares	End user	Penalty Fee	ANPR Data
		End user opportunity cost		Hospital Admin & Management	NHS Data
				Hospital Land	
Wider benefits	W	Direct road users	Local community	Value of Travel Time Savings	Traffic Model (SRTM) & WebTAG Data
		Environmental benefits		CO_2e	
				Air Quality	
				Noise	
		Social benefits – Accidents		Accidents	
		'Soft' social benefits		Other Soft Social Benefits	NHS & HSE Cost model

Table 7 – Impact category indicators

[28] Further information about the HSE Cost model is available in: http://www.hse.gov.uk/economics/eauappraisal.htm

4.3. FORECASTING PROJECTIONS

The FEM provides the capability to undertake an impact assessment over multiple appraisal periods providing the evolution of costs and benefits derived from the implementation of a consolidation business model over time. The following sections detail how the projections and assumptions have been derived and integrated into the FEM.

4.3.1. Forecasting Assumptions

The costs and benefits that are expected to occur in future are accounted by inflation and expressed in Present Values discounted to the base year in 2015 prices to provide a consistent measure across the appraisal period.

Table 7 provides an overview of the proxies and related growth rates employed to simulate the evolution of the indicators coded into the FEM over the appraisal period.

Indicator	Proxy	Annual Rate
Discount factor	*WebTAG*	3.5%
Price adjustment	*WebTAG*	Variable
Fuel consumption	*Fuel forecast*	Variable
Tyre wear	*RHA forecast*	5.2%
Repair & maintenance	*RHA forecast*	4.8%
Employment	*Wage growth*	Variable
Vehicle finance	*RHA forecast*	4.1%
Overhead costs	*RHA forecast*	3.0%
Penalty fee	*CPI*	Variable
Warehouse Admin & management	*Wage growth*	Variable
Warehouse land	-	3.0%
Hospital admin & management	*Wage growth*	Variable
Hospital space (NHS)	*Hospital space data*	7.4%

Table 8 - Forecasting assumptions and growth rates

Discount Factor: The discount factor also refers to the rate used to determine the present value of future cash flows. The FEM uses the DfT's discounting rate for project of lifespan below 30 years (3.5%) and it is applied as expressed in the formula below:

$$\text{discount factor} = (n - 1)_{\text{year}} * (1 + r)$$

Inflation: Inflation is the rate at which the general level of prices for goods and services rise, diminishing the purchase power of a unit of currency in future. FEM employs the DfT's price adjustment formula as expressed below:

$$\text{Price Adjustment} = \frac{\text{Real GDP per Capita}_{\text{n year}}}{\text{Real GDP per Capita}_{\text{PV base year}}} * \frac{\text{GDP deflactor}_{\text{Outputs Price year}}}{\text{GDP deflactor}_{\text{Price base}}}$$

- **Fuel Forecast:** Fuel price projections are obtained from official UK projections published by the Department for Business, Energy and Industrial Strategy (BEIS)[29].
- **Employment Costs:** Employment costs projections are pegged to the United Kingdom Average Weekly Earnings Growth Forecast[30].
- **Fleet Running Costs:** Costs of running the vehicle fleet projections are coded into FEM according to the forecast provided in the Road Haulage Association (RHA) cost tables.
- **Warehouse Space Rates:** Space costs was assumed to continue at constant growth rate as areas surrounding the MGL warehouse.
- **University Hospital Southampton Space Rates:** Space cost growth rate for the UHS is obtained as the constant compound growth rate from 2011 to 2017 – for which cost data was made available – as indicated in the formula below. Constant growth rate is then applied throughout the appraisal period.

$$P_{2017} = P_{2010} + (1 + rate)^{n(years)}$$

4.3.2. UHS Demand Forecast

UHS demand projections are extrapolated based on daily delivery data to the hospital for the past three years (2015 – 2017) and projected forward throughout the appraisal period. Direct delivery items are correlated to the number of courier deliveries and rolling cages handled every day, as the data audit at the UHS found a direct relationship between them.

Figure 11 represents the actual/projected weekly number of direct delivery items (blue line) and its associated courier vehicles (amber line) for the past three years. The maximum capacity of the loading bay (dashed grey line) has been calculated using optimistic assumptions to obtain the best-case scenario. In this regard, typical loading time periods from 7.00am to 4.30pm have been extended to 7.00am to 7.00pm. Furthermore, six loading bays are assumed to be constantly available (this does not correspond with the current situation, where only five of the bays are available due to temporary construction works). Finally, median per vehicle (un)loading times obtained from the ANPR analysis of about 22 mins have been reduced to 18 mins assuming a 15% efficiency optimisation.

The figure projects that, assuming similar seasonally adjusted demand growth as experienced over the past three years, the number of vehicle deliveries would eventually exceed the maximum capacity of the loading bay by around June 2020.

The potential costs and consequences of an insufficient supply and /or poorly timed provision of medical equipment to in-patients due to capacity constraints at the loading bay are not quantified as part of this study. It is believed that these costs may well be above the costs quantified here, as we have only modelled the simple opportunity cost of a better allocation of resources assuming sufficient capacity at the loading bay.

Moreover, it is projected that capacity constraints might eventually be reached before June 2020 during busy periods where total deliveries typically deviate above the mean (i.e. Christmas and Easter). The likelihood of hitting the maximum capacity at any given time is depicted by the progressively red shaded area in Figure 11, which suggests that this situation could occur as early as in May 2019.

[29] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/576542/BEIS_2016_Fossil_Fuel_Price_Assumptions.pdf
[30] https://tradingeconomics.com/united-kingdom/wage-growth/forecast

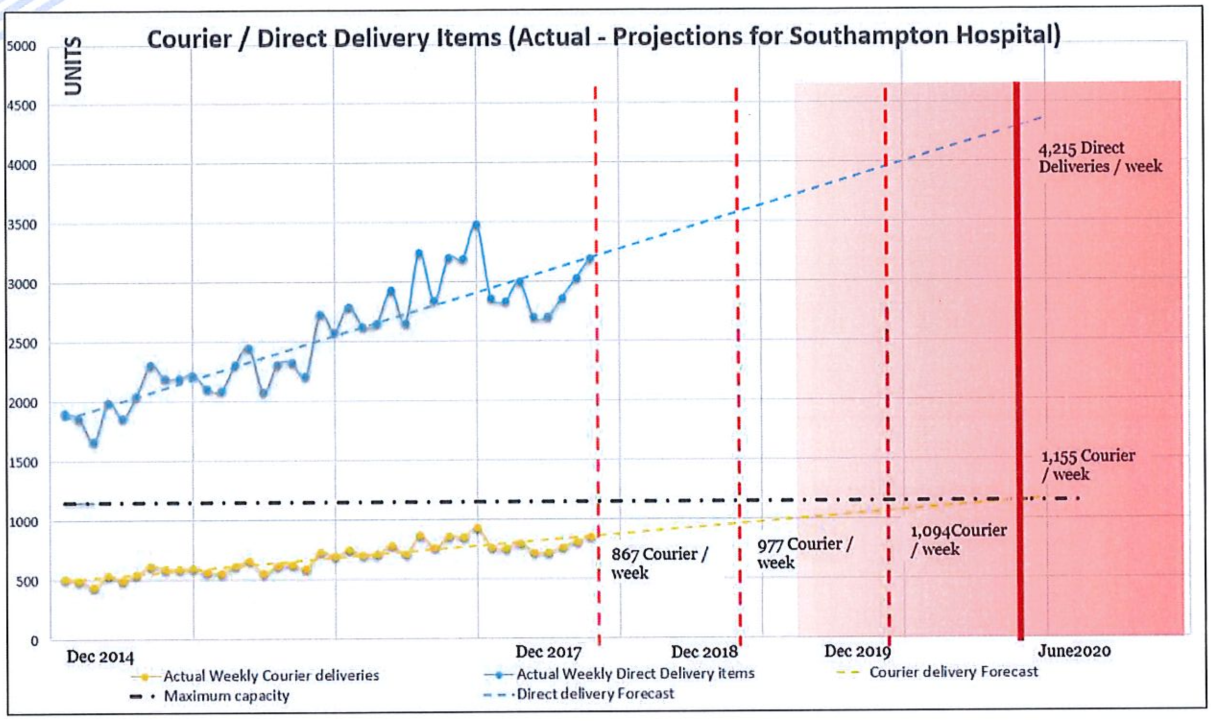


Figure 11 - Source TSC: UHS Forecasting Demand

4.3.3. Traffic Growth Factors - TEMPro

As described in Section 3.3, the transport model (SRTM) has been employed to obtain useful insight into the current traffic conditions surrounding the UHS and wider areas. The SRTM employs 2015 traffic data and outputs from the simulation are used to derive wider benefits through the FEM.

Traffic growth factors are employed to simulate increasing transport demand expected to occur during the area over the appraisal period. Growth factors are obtained from TEMPro[31], which represents what the future demand would be if there were no changes in the relative cost of each mode, and no effects of income (beyond its effects on car ownership, which are included in TEMPro).

TEMPro takes account of local planning data to provide factors which, when used in conjunction with national or regional traffic growth forecasts, can provide very local traffic projection factors.

[31] Trip End Model Presentation Program (TEMPro) software developed by ATKINS for DfT and available https://www.gov.uk/government/publications/tempro-downloads

5 MODELLING RESULTS

The Freight Economic Model (FEM) outlined below provides a detailed impact assessment of the costs and benefits The FEM run provided a detailed Cost-Benefit Analysis (CBA) for the appraisal period (considered to cover from 2017 to 2030). Modelling results are interpolated and extrapolated to cover the full appraisal period as necessary. Monetary values are adjusted by inflation and discounted to the present value year. Finally, results are reported as perceived costs and market prices.

By and large, it is important to note that the analysis undertaken as part of this project has – within reasonable limits – tended to overestimate costs and underestimate benefits, thus the figures provided in this report can be regarded as the low range or conservative side of the total possible outcomes of implementing an UCC. It would not be unreasonable therefore, to believe that real costs and benefits could be respectively lower and higher than that which has been stated in the following sections.

5.1.Additional Costs (C)

Additional costs are expected to increase over time as the volume of deliveries is projected to grow. Thus, more frequent consolidated shipments of vehicles, larger space and more labour requirements to run the logistics consolidation model would be required to handle the increasing volume of demand from the UHS.

Stakeholder engagement suggested that there would be a need to run about 20 trips a week of fully utilised HGV vehicles (Euro VI) to deliver the current amount of goods required by the UHS in the base year. Number of trips were scaled up in correlation to the expected growth of deliveries as per obtained during the data audit at the UHS and reported in Section 4.3.2.

Total additional costs include both the cost of running the fleet from the MGL warehouse to the UHS (about 5.6 miles return) and quantified in monetary terms using unit cost rates provided by MGL and as explained in Section 4.2.1.

Additional costs to run the consolidation scheme are expected to account for up to £520K per annum on the initial year following the model implementation, and to increase over the appraisal period up to £947K p/a by 2030. These figures have been inflated considering an operating margin of 25% to account for unforeseen events and allow an additional small profit margin to the UCC operator. As described above, these additional costs include fleet and multi-user warehouse operating costs. It is worth noting that the latter category accounts for the majority (about £486K p/a or 93%) of the total additional costs as shown in Figure 12.

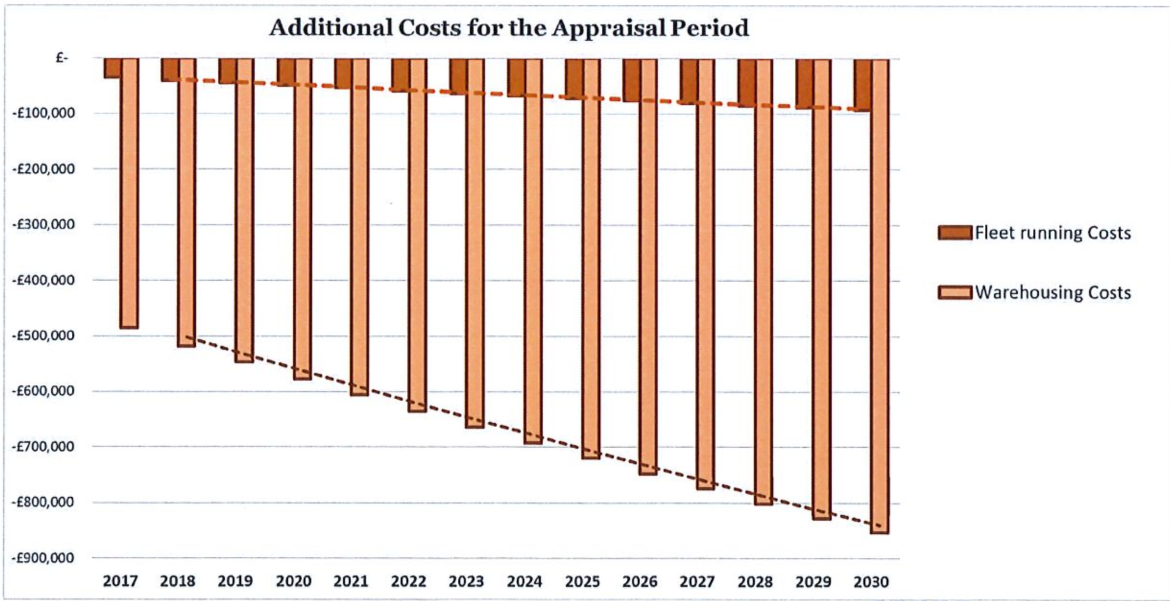


Figure 12 - Quantification of Additional Costs throughout the appraisal period

5.2. Operating Cost Savings (S)

Operating Savings are quantified across three main sub-categories as discussed below:

Penalty Fares

The calculation of the total penalty fee savings followed a two-step process described below. Firstly, the proportion of vehicles that would potentially be paying the penalty fee were identified. It is important to note that not all LGVs and HGVs will be expected to bear this fee – only those unable to meet Euro 6/VI engine emission standards. The number of vehicles with different engine types delivering at the UHS was obtained from the ANPR dataset collected as part of this project and described in Section 3.2.3.

Secondly, an analysis of the video footage at the loading bay was employed to develop an index to determine the vehicle utilisation rates when (un)loading at the UHS. The index represents the proportion of a courier trip that can be fully (and only) attributed to the specific end-user client.

In other words, it would be unreasonable to assume that a given vehicle would only deliver to the UHS during a given day. Thus, the daily penalty fee cannot be fully attributable to the UHS but only the proportion of parcels being dropped/ picked up at the UHS.

In practical terms, the index is constructed as a function depending on the percentage of the total vehicle load that is dropped-off when it arrives at the end-user and the percentage of total vehicle load that is picked-up when it leaves the end-user. Table 8 exemplifies the methodology followed to calculate the penalty fee index attributable to the UHS. In this case, the UHS savings would be 15% of the total access fee that is imposed to the courier.

Category	Formula	Example
Proportion of total goods unloaded when vehicle arriving	*(Pa)*	20%
Proportion of total goods loaded when vehicle departing	*(Pd)*	10%
Index	*(Pa + Pd) /2*	15%

Table 9 – Exemplification of Index construction

The ANPR data analysis identified a total of 817 vehicle deliveries per week amongst which 572 were found not compliant with a potential implementation of a CAZ in Southampton after matching the number plate with the DVLA database.

Although charges to access the proposed CAZ are still not confirmed, stakeholder engagement suggested to undertake the economic modelling assuming a daily £130 fee in line with the TfL[32] charge.

Potential savings from not paying the charge to access a Clean Air Zone (CAZ) are projected to decrease as the proportion of fleet vehicles with a Euro V and below engine type would reduce over time[33]. Penalty fee savings would account for just under £1m in 2017 and are projected to drop to just £20K p/a by 2030.

- **Fleet Operating Cost Savings:** Savings across overall freight providers are calculated as the proportion of the total trip length saved by the courier by dropping the cargo off at the UCC instead of the end-user location.

  Savings are modelled to take account of the actual time of delivery in order to account for higher operating costs incurred at morning and evening peak times due to increased congestion and lower average speeds. Operating cost data is obtained for each vehicle type from the Road Haulage Association (RHA, 2014).

  Based on the DSP data, where vehicles' origins were obtained through individual interviews to the vehicle drivers, it was estimated an average of two miles reduction for each delivery vehicle. Potential savings to the freight industry would account for £175K in the initial year and are projected to increase by just under a factor of three times over the appraisal period reaching £503K p/a by 2030.

- **End User Opportunity Costs:** The quantification of the opportunity cost arising from the implementation of the logistics consolidation model followed a two-step process. Firstly, a high-level representation of the current activities and resources allocated to the internal UHS supply chain was modelled.

  Figure 13 depicts the internal distribution processes followed by direct delivery items from the loading bay until they are placed at the Point of Use. This provided understanding of the potential inefficiencies and the amount of resource, both in terms of labour and space, currently involved in the internal supply chain at the UHS.

  Additionally, a hypothetical situation, considering what the processes would be following the implementation of a consolidation model, was modelled and is represented in Figure 14.

[32] Transport for London emission charge
[33] Projections of fleet composition by vehicle and engine type were drawn from the National Atmospheric Emissions Inventory database

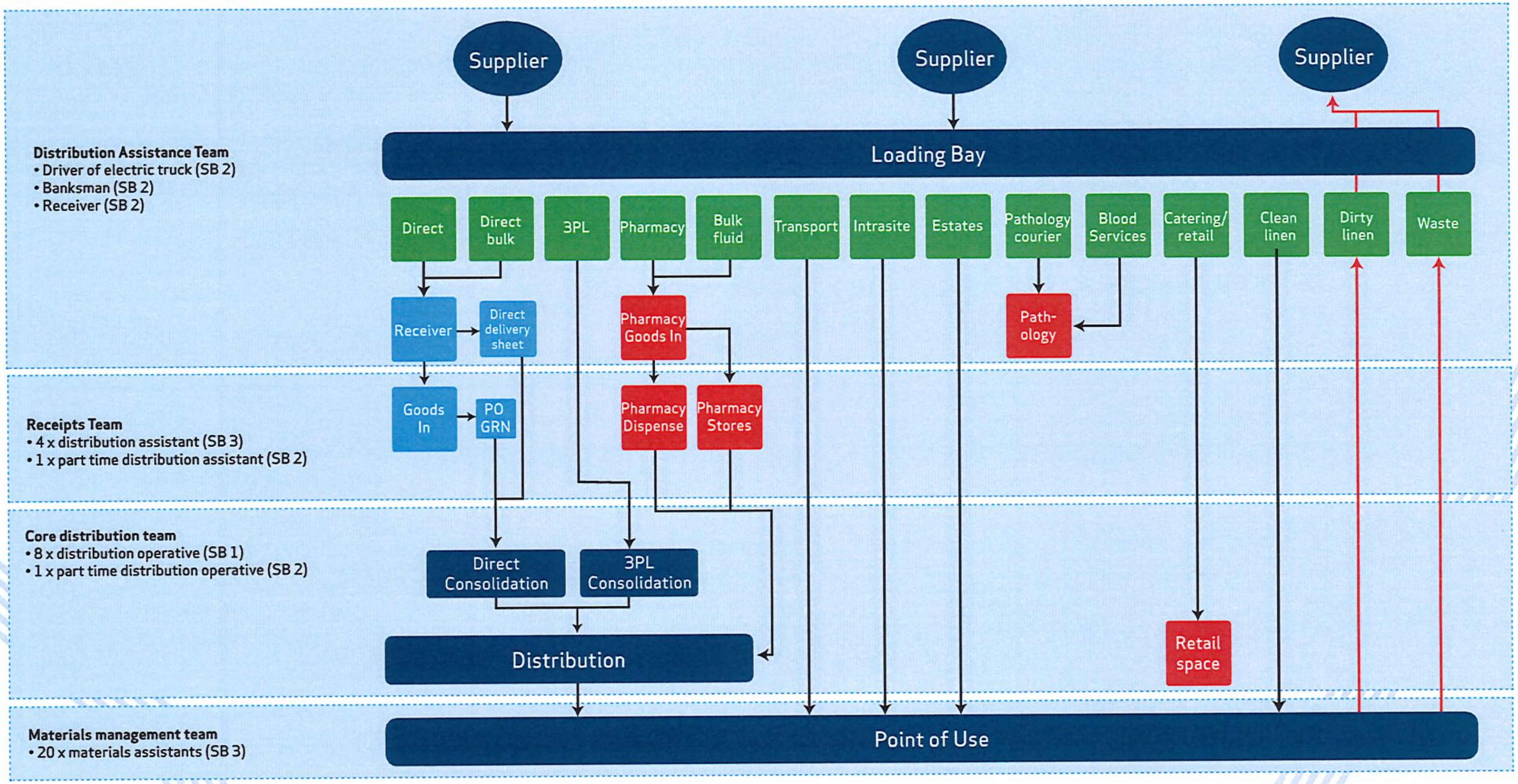


Figure 13 – High-level representation of the current internal UHS Supply Chain

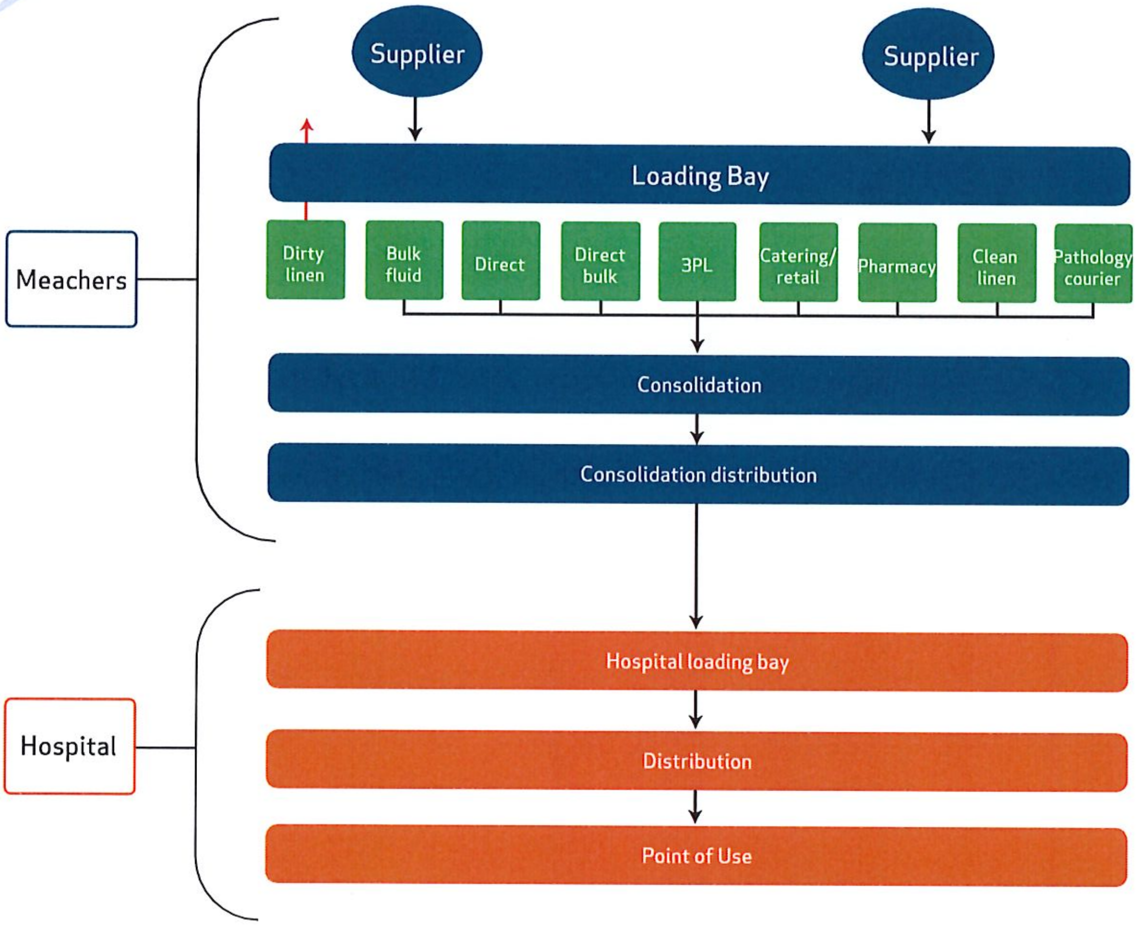


Figure 14 - High-level representation of the UHS internal Supply Chain under consolidated logistics

Resourcing costs to undertake the internal supply chain processes in the baseline year are calibrated by unit of delivery, rolling cages transported and lines processed and projected forward through the appraisal period accounting for the UHS demand growth.

As observed for the previous sub-category, opportunity costs are expected to rise over time as the volume of operations is projected to increase over the appraisal period, from £510K in 2017 to just under £1m p/a by 2030.

It is worth noting that opportunity costs quantified in this study do not consider all the inefficiencies identified within the UHS supply chain. For example, there is insufficient data / evidence to provide a robust quantitative assessment for processes such as waste returns and efficiency improvements for doctors and nurses. As a result, these have been covered by qualitative analysis in conjunction with the Supply Chain Manager at UHS. In this regard, the waste materials team is expected to reduce costs by a conservative 50% due to reduced cardboard being delivered/collected at the UHS following the implementation of a consolidated model. Furthermore, nurses' interaction with the materials management team would reduce as distribution efficiency improves, enabling nurses to allocate the time to attending patients. This shows once again, that the total real benefits might well be above what has been reported and quantified in this study.

Figure 15 provides an overview of the evolution of savings for the above described sub-categories across the appraisal period. It shows that the reduction of savings through penalty fees is eventually offset over the appraisal period with constantly increasing freight and end-user savings.

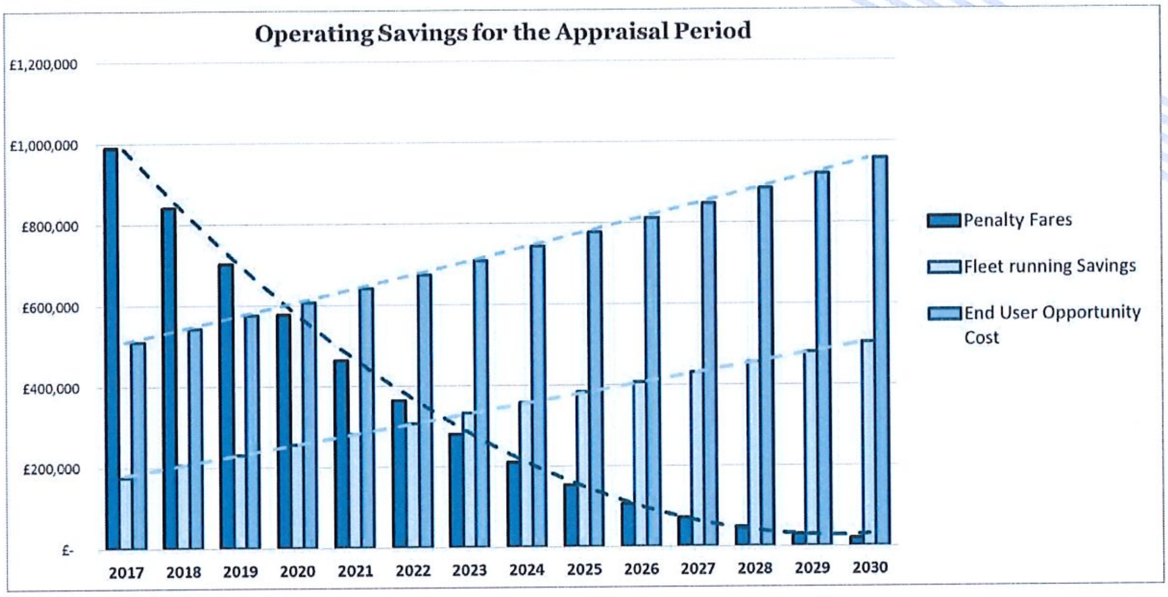


Figure 15 - Quantification of Operating cost savings throughout the appraisal period

5.3 WIDER IMPACTS (W)

Wider benefits are projected to remain constant and thus reduce in real terms when discounted for time over the appraisal period. Wider impacts sum up to about £2.78m in the initial year and are projected to reduce to £1.67m p/a by 2030. Figure 16 provides an overview of the evolution of wider impacts across the appraisal period staking together the combined effect of the economic, environmental and social benefits.

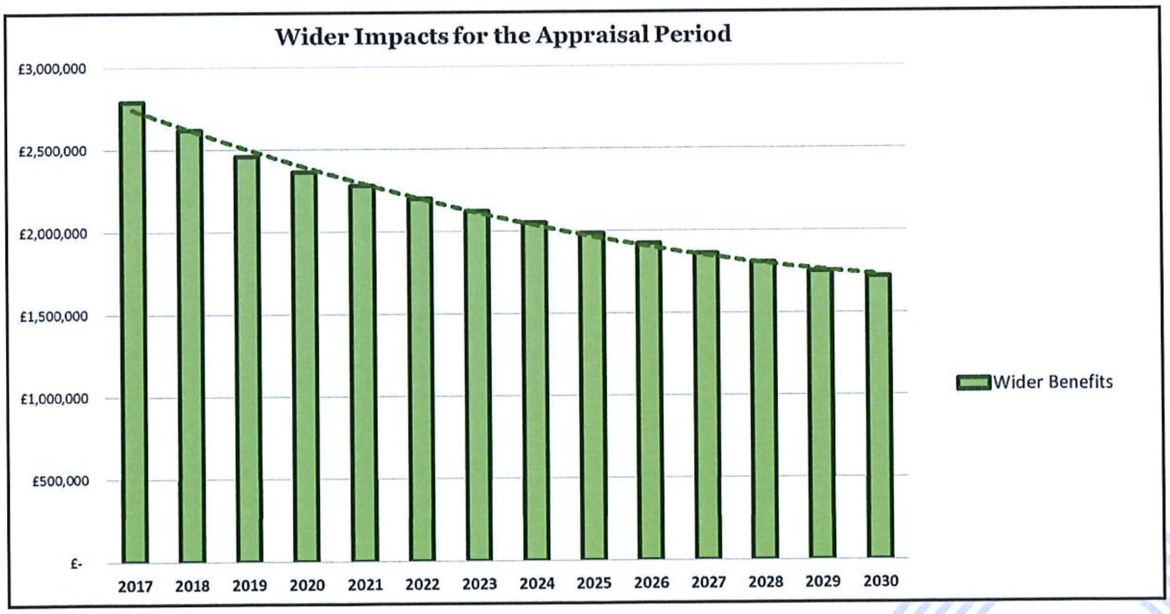


Figure 16 - Quantification of wider impacts throughout the appraisal period

5.4 RESULTS OVERVIEW

Figure 17 displays together the evolution of the three main categories previously discussed over the appraisal period.

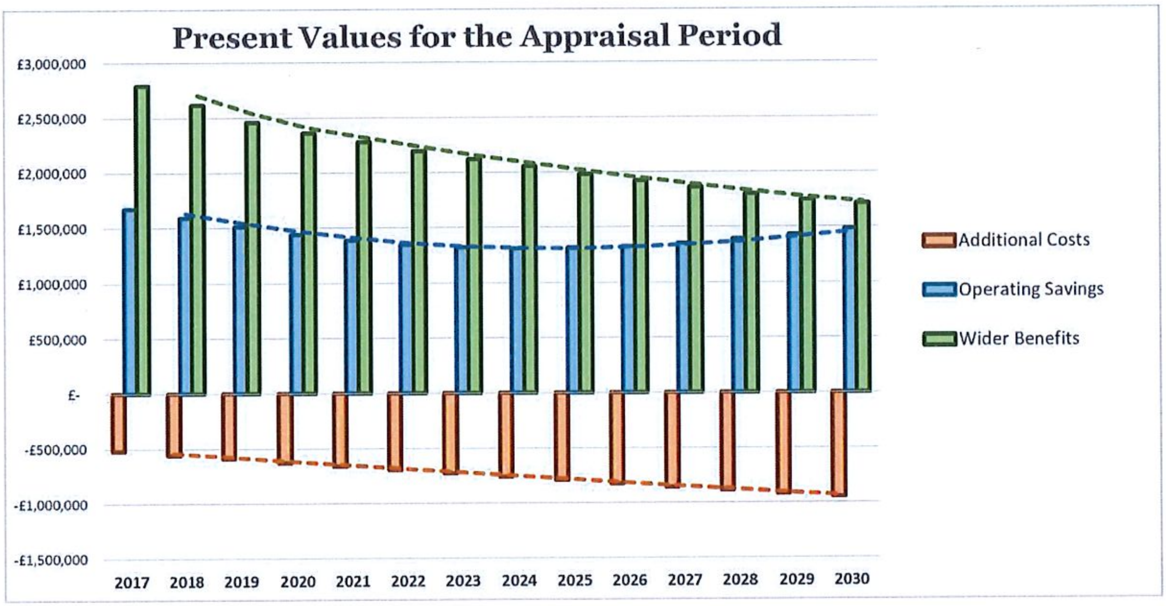


Figure 17 - Costs and Benefits Evolution throughout the appraisal period

Operating savings - depicted with blue bars - show an initial reduction followed by an increase after having bottomed out in 2023. Effectively, the initial reduction of savings through penalty fees is progressively offset by increasing savings for both freight industry and the end-user.

Additional costs seem to increase annually over the appraisal period, whereas wider impacts would reduce in real values. It is worth noticing that both operating savings and wider impacts are consistently larger than the additional cost for each year, thus offsetting the initial layout needed to run the consolidation centre.

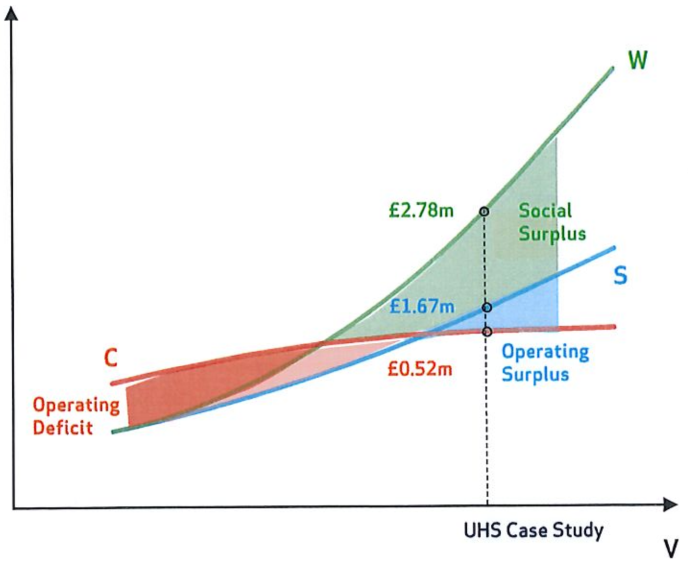


Figure 18 - Magnitude of Impact categories for the initial year within the range of case scenarios

Figure 18 represents the magnitude of costs and benefits following the initial year after the hypothetical implementation of consolidated logistics. The figure suggests that the UHS case study falls within the right-hand side of scenario A described in Section 4.1 where subsidy is not required – i.e. additional costs are fully recovered through operating savings – and social surplus is positive.

Finally, Figure 19 below presents an infographic summary of the cost and benefits across each of the sub-categories defined within the Freight Economic Model for the initial and final (individual) years of the appraisal period. Results are reported in Present Values discounted for time to the base year 2017 and expressed in 2015 prices.

Figure 19 – Total Present Value of Benefits (£ per annum)

Total Present Values (£ p/a)		2017	2030
Additional Costs	Freight Operator (Running Consolidation Model)	**-£520,967**	**-£946,677**
Operating Savings	Freight Industry (Operating Costs)	**£175,220**	**£503,960**
	Freight Industry (Penalty Fees)	**£988,840**	**£19,662**
	University Hospital Southampton (Opportunity Cost)	**£509,548**	**£958,074**
Wider Benefits	Other 'Soft' Social Benefits (Reduction Sick days incl. stress)	**£41,490**	**£69,103**
	Improved Journey Times – Decongestion Benefits (*)	**£245,327**	**£201,354**
	Environmental Benefits (**)	**£5,017**	**£6,239**
	Accidents Reduction (*)	**£2,497,534**	**£1,400,328**

(*) Southampton Wide Area covered by Sub Regional Transport Model (SRTM)
(**) Include CO_2, NOx and Noise quantification

5.5 SENSITIVITY TESTING

A sensitivity analysis was carried out to test the robustness of the results presented above. The Freight Economic Model employs three different scenarios using low, central and high estimates creating a plausible spectrum of assessment values where the real benefit is expected to fall into with a 95% confidence interval.

Table 9 indicates the sensitivity ranges employed for each of the subcategories included within FEM. For those categories using a complex sensitivity range, a link to the appropriate WebTAG document is provided[34].

Category	Low	High
Fuel Consumption	-10%	10%
Tyre Wear	-10%	10%
Repair & Maintenance	-10%	10%
Employment	-10%	10%
Vehicle Finance	-10%	10%
Overhead Costs	-10%	10%
Penalty Fee	-20%	20%
Warehouse Admin & Management	-10%	10%
Warehouse Land	-10%	10%
Fuel Consumption	-10%	10%
Tyre Wear	-10%	10%
Repair & Maintenance	-10%	10%
Employment	-10%	10%
Vehicle Finance	-10%	10%
Overhead Costs	-10%	10%
Penalty Fee	-20%	20%
Hospital Admin & Management	-10%	10%
Hospital Land	-10%	10%
Value of Travel Time Savings	WebTAG	WebTAG
CO_2e	WebTAG	WebTAG
Air Quality	WebTAG	WebTAG
Noise	-10%	10%
Accidents	-10%	10%
Other Soft Social Benefits	-10%	10%

Table 10 - Sensitivity Testing Range values

Higher sensitivity analysis is considered for the penalty fees calculations to acknowledge a higher dispersion and variance around the mean value, obtained from human observations of vehicles utilisation rates from the ANPR camera footage. Besides, it is unclear at this stage what the penalty fee is likely to be. As mentioned in this report, stakeholder engagement suggested that this might potentially be around £130 a day, hence the figure employed as a central estimator in this report. It is however, worth mentioning that the final figure might vary from that estimate; therefore a higher sensitivity was employed during the modelling exercise.

Figure 20 shows the sensitivity range around the mean for each of the categories assessed in the economic assessment.

[34] Department for Transport (DfT) indicates that there is a significant level of uncertainty around some of the estimates provided within WebTAG methodology, thus sensitivity testing of the impact assessment should be undertaken

Figure 20 - Total Present Value of Benefits for 2017 by scenario (£ per annum)

Total Present Values (£ p/a)		Low	Central	High
Additional Costs	Freight Operator (Running Consolidation Model)	-£468,870	-£520,967	-£573,063
Operating Savings	Freight Industry (Operating Costs)	£157,698	£175,220	£192,742
	Freight Industry (Penalty Fees)	£791,072	£988,840	£1,186,608
	University Hospital Southampton (Opportunity Cost)	£458,594	£509,548	£560,503
Wider Benefits	Other 'Soft' Social Benefits (Reduction Sick days incl. stress)	£37,341	£41,490	£45,639
	Improved Journey Times - Decongestion Benefits (*)	£221,081	£245,327	£270,665
	Environmental Benefits (**)	£2,792	£5,017	£7,898
	Accidents Reduction (*)	£2,247,781	£2,497,534	£2,747,288

(*) Southampton Wide Area covered by Sub Regional Transport Model (SRTM)
(**) Include CO_2, NOx and Noise quantification

6 WORKSHOP LEARNINGS AND NEXT STEPS

On 23rd February 2018, TSC and the Department for Transport held a project workshop at the Department for Transport. The objective of this workshop was to explain the project methodology and disseminate the results – and to obtain feedback from delegates. A variety of stakeholders were invited to the workshop including freight operators, academia, local authorities and other public sector bodies such as the NHS. Approximately 35 people attended the workshop with representation from all the aforementioned sectors.

The workshop aimed to, (a) provide the context to this project, (b) describe the methodology and approach to selecting the case study, (c) describe the challenges faced by stakeholders in Southampton, and (d) describe the results of economic modelling. The workshop concluded with an open discussion where delegates provided feedback on the results and identified potential next steps for this work. In addition, delegates were also provided with a feedback form which they completed at the end of the workshop. A copy of the feedback form can be found in appendix B. This section will detail the feedback received at the workshop as well as suggested next steps.

6.1 WORKSHOP FEEDBACK FORM RESULTS

Of the 35 workshop attendees, 18 completed the feedback form. 33% of the responses came from Local Authorities, 22% from consultants and the rest from other public sector organisations, academia and other organisations.

All respondents either agreed or strongly agreed that consolidation models can play a key role in reducing road freight emissions and 97% either agreed or strongly agreed that urban freight consolidation models would support the goal of achieving clean air zone targets. Furthermore, 50% found the project very useful and applicable to their organisation with 33% finding it useful but unsure how to take it forward.

72% of responders strongly agreed that having access to the economic model would be of use to their organisation. 17% agreed that it would be of use, whilst 11% were either unsure or did not respond. However, while the majority agreed that the model would be of use to their organisation, some issues around the availability of data were also identified.

Regarding ANPR data, 40% of respondents said that this data is not available or is hard to obtain while just 17% said this was readily available. Transport models seem slightly easier to obtain with 28% suggesting they are readily available but 28% also noting they are not available or difficult to obtain. A similar response was given with regards to DSP data but with more respondents suggesting this is easier to obtain. Finally, 28% suggested that business-as-usual operational data is readily available and 28% said it is not available but easy to obtain. On average, there was a 30% no response rate to the questions regarding data.

6.2 OPEN DISCUSSION RESULTS

Qualitative responses supplied to support the quantitative answers in the feedback form and key points from the open discussion are captured below.

6.2.1. Can UCCs support policy objectives for implementing CAZs?

There was general agreement amongst delegates that urban freight consolidation models can play a key role in reducing emissions from transport. However, it is felt that there is no "silver bullet" for solving this issue and urban freight consolidation models need to be part of a package of measures. CAZs are considered to be the catalyst that compels the discussion around UCCs and the business case for these is stronger in those areas that introduce CAZs. However, a degree of caution needs to be applied in that an adequate business case may not always exist and will be dependent on local circumstances.

6.2.2. How useful and applicable is this project to your organisation?

Most survey respondents and workshop delegates agreed that this project is useful and applicable to their organisation. It was suggested that the project has provided the data and evidence required to support the argument for UCCs and can encourage further exploration and progression in this area. Respondents from Local Authorities mentioned several organisations within their locality that this model could benefit, thus presenting an opportunity for wider roll-out of this model going forward.

6.2.3. Barriers to further work / implementation

Low availability of the datasets required to feed the economic model[35] was an apparent barrier to taking this work further with many respondents suggesting that these datasets are not readily available and difficult to obtain or collect. Data collection is a time consuming and costly exercise and Local Authorities tasked with implementing CAZs expressed difficulty in obtaining funding for this type of work. Furthermore, given the time constraints associated with implementing CAZ targets, Local Authorities suggested they don't have sufficient human and monetary resources to undertake data collection exercises.

Workshop delegates also identified framework agreements and procurement contracts as another barrier to implementation of UCC strategies, describing these as difficult to unpick. This was not an issue encountered in Southampton and is likely to vary by location but is nonetheless important to consider as a potential barrier going forward.

Unlike Southampton, not all cities have existing and established UCCs operating within or in close proximity to them and delegates voiced concerns over the availability of land for such facilities and distribution centres. This often results in UCCs being located further away from the city centres and therefore having less of an impact in terms of reducing vehicle miles.

Finally, delegates suggested that despite the business case put forward by this project, one of the main challenges that remains is convincing decision makers to support and provide funding for UCC strategies. While the results from this project have monetised the costs and benefits to all stakeholders for this particular case study, it was suggested that not all of these benefits would be returned as direct cash benefits which is what decision makers look for when making an investment. In this regard, some of the benefits refer to the opportunity cost of reallocating existing resources to serve other activities, but not monetary cash savings. However, delegates did feel that if the business case is presented to decision makers via a third party such as TSC rather than a "sales" person, it would likely carry more weight, since TSC is a not-for-profit organisation.

6.3 SUGGESTED NEXT STEPS

During the open discussion, delegates were asked for views on the best way forward beyond the project completion date – and these are captured below:

- TSC to look to provide further clarity to the DfT regarding the data used by the model, as would be allowed by the data providers and any associated data user or sharing agreements.
- Undertake more case studies in different locations and for a variety of public sector organisations to test the model under different circumstances.
- Create a user guide and make the model available free of charge for anyone to use.
- Consider how multiple organisation collaboration and joint procurement approaches might be supported through this model.
- Communicate and promote the project and its results to the freight industry and the public sector to increase awareness and encourage uptake.
- Government and Local Authorities should combine this approach with other measures such as retiming deliveries and collaborative procurement to create a package of measures that might collectively achieve an overall greater impact on emissions and congestion.

6.4 RECOMMENDATIONS TO THE DEPARTMENT FOR TRANSPORT

Communication:

- DfT should disseminate and promote the project to other Departments that could benefit from this work such as the Joint Air Quality Unit (JAQU) and the Department for Health, as well as Local Authorities. It should also disseminate and promote to any other industry organisations / bodies it has relationships with such as trade associations and those involved in reducing the externalities from freight i.e. the LoCity programme.
- The project and its results should be communicated to industry through articles in the trade press and speaking opportunities at conferences and events. TSC has already received several requests to speak at conferences beyond the project completion date.

[35] Datasets required for the economic appraisal is outlined in Appendix B and described within section 3 for the UHS case study

Further Case Studies

- A round table discussion involving the local authorities, JAQU, DfT and TSC should take place to decide how this can be taken forward to support these places. Undertaking more case studies will test the model under different circumstances and for different organisations.

Make the Model Publicly Available

- Make the model available for any organisation to use, and develop a "Best Practice Guide" that outlines the requirements and includes a user guide for how to use the model. The model will be maintained and issued by TSC through user licence agreements.

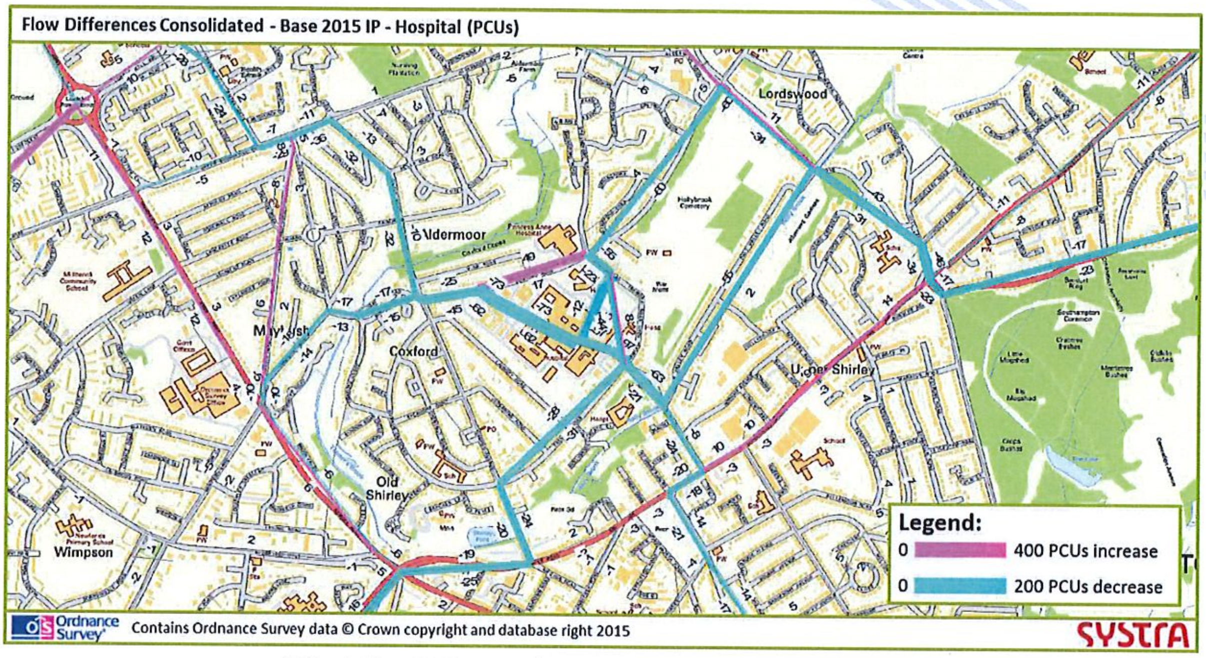
Include in Package of Measures

- The DfT should combine this work with other measures that have been created to achieve a similar objective such as re-timing deliveries. This can be provided to organisations as a package of measures that may achieve a greater impact.

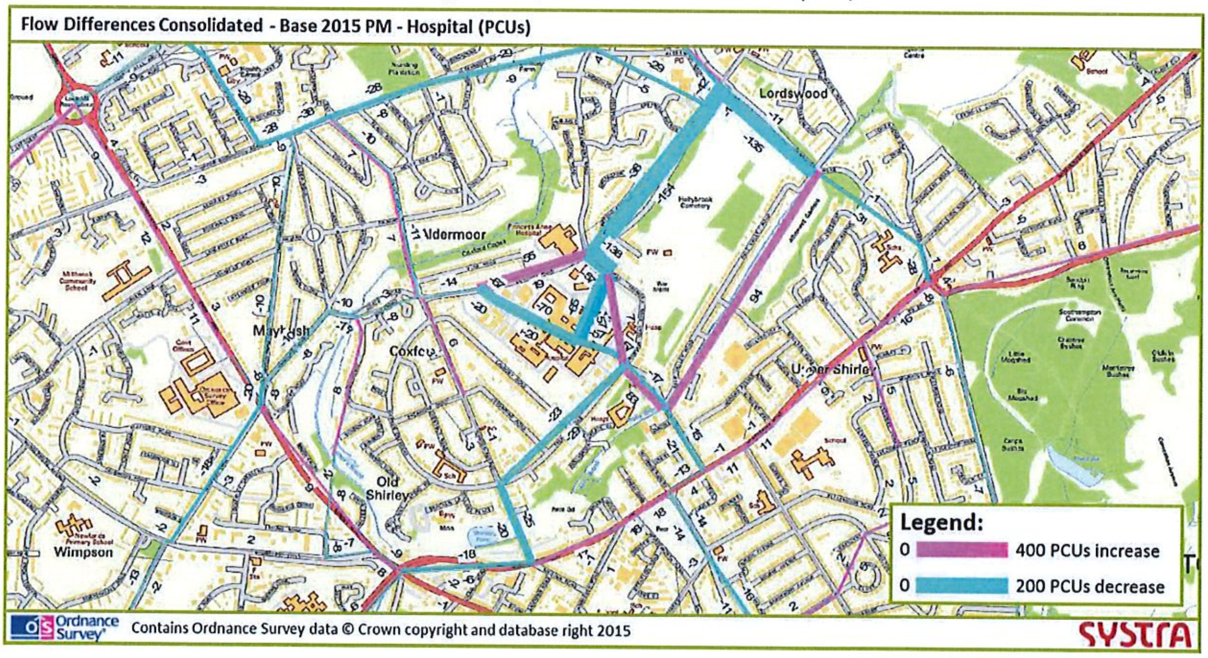
Further Work

- The Department could commission further work in this area which looks to overcome some of the barriers mentioned in the workshop such as land availability and framework procurement agreements.
- Collaborative procurement amongst public sector organisations could also be explored so the benefits of UCCs can be scaled up further. However, delegates at the workshop warned that, in their experience, this could prove to be a difficult and lengthy task.

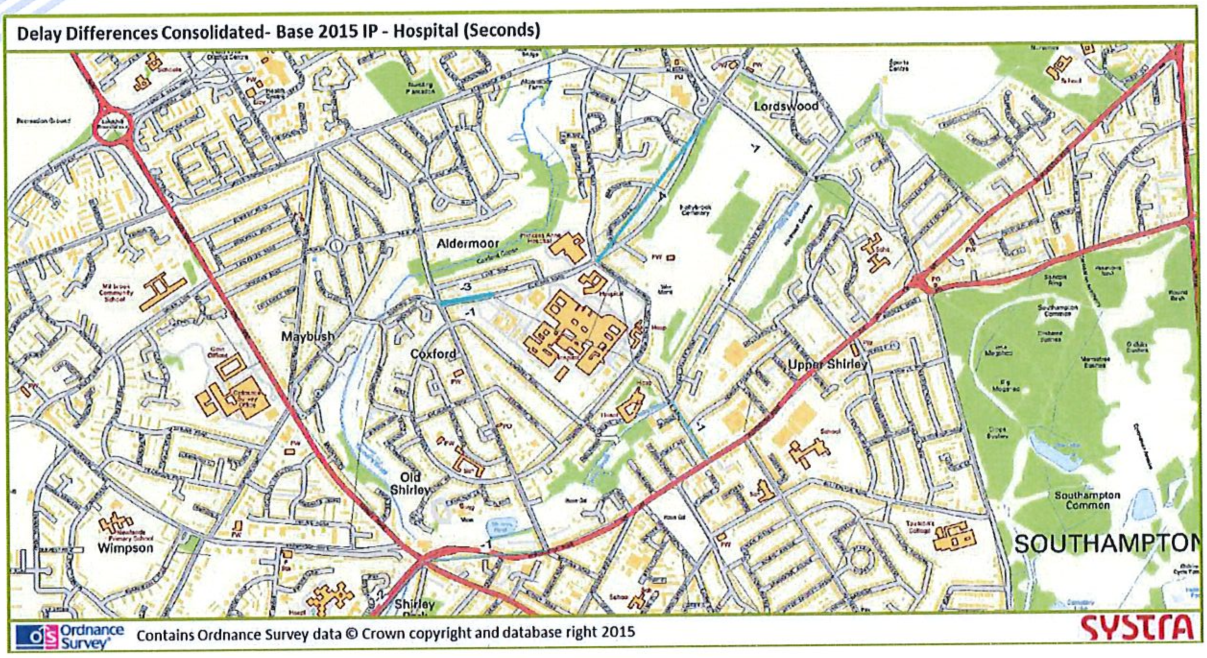
7 APPENDIX A – SRTM OUTPUTS



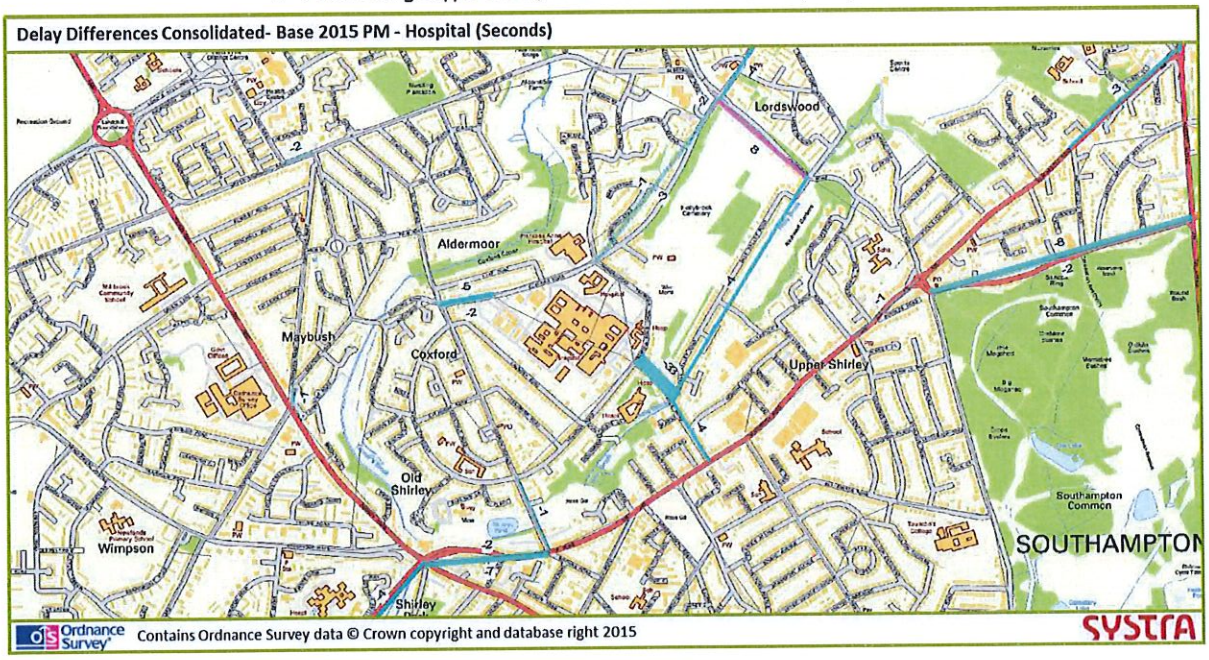
IP Peak Flow Difference (Consolidated v Base, Hospital), SRTM



PM Peak Flow Difference (Consolidated v Base, Hospital), SRTM



IP Peak Delay Difference (Consolidated v Base, Hospital), SRTM



PM Peak Delay Difference (Consolidated v Base, Hospital), SRTM

8 APPENDIX B - WORKSHOP FEEDBACK FORM

Workshop Feedback Form - Transport Systems Catapult

We would be most grateful if you could spare 5 minutes to complete this feedback questionnaire. The purpose of the questionnaire is to gather further insights following today's workshop to provide better support to Local Authorities (LA's) and public sector organisations.

The Transport Systems Catapult is an impartial organisation created to drive and promote Intelligent Mobility – using new and emerging technologies to transport people and goods more smartly and efficiently. We are one of the eleven elite technology and innovation centres established and overseen by the UK's innovation agency, Innovate UK.

1. Please indicate what sector do you represent

- ◯ Local Authority
- ◯ Central Government
- ◯ Other Public body
- ◯ Academia & Education
- ◯ Freight operator
- ◯ Consultancy
- ◯ Other - Please specify

2. Based on the results shown today, do you believe consolidation models can play a key role on the Road to Zero emissions UK target?

- ◯ Strongly Agree
- ◯ Agree
- ◯ Not sure
- ◯ Disagree
- ◯ Strongly Disagree

3. Can you please briefly indicate why?

4. Based on the results shown today, do you think consolidation support policy objectives for implementing Clean Air Zones (CAZ)

- ◯ Strongly Agree
- ◯ Agree
- ◯ Not sure
- ◯ Disagree
- ◯ Strongly Disagree

5. Can you please briefly indicate why?

6. How useful & applicable do you find the study to your organisation and/or LA?

- ◯ Very useful and applicable
- ◯ Useful but not sure how to take this forward
- ◯ Not very useful
- ◯ Totally irrelevant

7. Can you please briefly indicate why?

8. Would having access to the assessment model shown today be of any use to your organisation and/or LA?

- ◯ Strongly Agree
- ◯ Agree
- ◯ Not sure
- ◯ Disagree
- ◯ Strongly Disagree

9. Can you think of any large public organisation that could benefit from the implementation of consolidation as shown in the Southampton case study?

10. Data Accessibility - Please indicate the most relevant choice for each of the following datasets

	Ready available	Not available but easy to get/collect	Not available and difficult to get/collect	Not sure if available or what refers to
ANPR Data	◯	◯	◯	◯
Transport Model	◯	◯	◯	◯
Delivering and Service Plan (DSP) Data	◯	◯	◯	◯
Business as Usual internal operations Data	◯	◯	◯	◯

11. Can you think of any barriers to get /collect any of the above datasets

12. Could you please provide any suggestions to take this study forward - How can we scale the results up? For instance: Including collaborative procurement

13. Do you identify any barriers to implement consolidation within your Local Authority?

14. Overall, was the workshop useful to you?

- ◯ Strongly Agree
- ◯ Agree
- ◯ Neither Agree or Disagree
- ◯ Disagree
- ◯ Strongly Disagree

15. Could you please tell us what you would have done different?

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