Report on the Portering Trial

TfL Consolidation Demonstrator project

30 May 2018

Sam Clarke, Gnewt Cargo

Julian Allen, University of Westminster

Tom Cherrett, University of Southampton

Fraser McLeod, University of Southampton

Andrew Oakey, University of Southampton

Contact:

Sam Clarke

Gnewt

Menzies/Gnewt Depot, Unit E-F Twelvetrees Crescent, London E3 3JG

Tel. 07970 977 937

Email: samclarke@gnewt.co.uk

Contents

Executive summary

This report describes trials and an evaluation of using on-street porters for parcel delivery in central London. Information in the report includes:

i) Summary results from 'pre-trial' surveys that describe existing parcel delivery operations
ii) Consideration of portering options and design specifications
iii) Results from two portering trials in central London with the parcel carrier Gnewt
iv) Desktop analyses that consider various portering scenarios.

Pre-trial surveys in 2016 and 2017 (sections 2 to 4) indicated that:

i) Parcel carrier vans were parked for approximately 60-70% of their working day (3.5 – 4.5 hours per vehicle per day).
ii) Nearly all parking took place on-street at the kerbside with each stop taking 8-9 minutes on average with vehicles typically being parked in different places 25 to 40 times per day.
iii) The average distance driven within central London was 12 km (7.5 miles) at a mean driving speed of 7.1 kph (4.4 mph), excluding parked time.
iv) The average distance walked per round by the driver was 8 km (5 miles).

Analysis of combined driving and walking deliveries (section 5) suggested that round time may be reduced by making fewer stops than at present and making a greater number of deliveries and collections on-foot each time the vehicle is parked. Such a solution is capable of reducing the total round time by approximately 25% and the total driving time and distance in the delivery area by approximately 50% but with a 20% increase in parking time and up to 50% more walking. This analysis suggested that portering could be a good option.

Portering options and design specifications are discussed in sections 6 to 10, with many variations possible. For the trials, portering comprised:

i) Sorting of parcels at Gnewt's depot into suitable loads for porters, according to size, weight and delivery locations. In the first trial, this relied on driver knowledge; in the second trial, sorting was done according to predefined portering patches.
ii) Separation of large/heavy items for the driver to deliver along with multiple items to the same address.
iii) Three or four porters supported by a driver and vehicle servicing them, either the same driver as above or a different one.
iv) Use of wheeled holdalls (140 litres in first trial and 200 litres in second) by porters to make deliveries; bags occasionally had to be carried up stairs.
v) Pre-sorted parcels handed over to porters at pre-agreed meeting points by the roadside (avoiding busy main streets).
vi) Communication between porter and driver by mobile phone App.
vii) Separate mobile phone App used to obtain signature as proof of delivery.

Portering trials were undertaken by Gnewt in Southwark, on Wednesday 24th January 2018 (sections 11 and 12) and the City of London, on Friday 9th March 2018 (sections 13 and 14). The results and further analyses (sections 15 to 18), including costings and extrapolation of results to consider all parcel delivery activity in London's Central Activities Zone (CAZ) indicated that:

i) Kerbside parking time in the trials was reduced by around 50% as the driver workloads were much reduced (53% of parcels in the first trial and 39% in the second). Further analyses suggested that an 86% reduction in time parked could be achieved if the driver were assigned only 10% of parcels.
ii) Vehicle driving time reduced by 52% in the first trial but increased by 4% in the second trial, partly due to the trial covering a larger area than normal for the driver (1.5 vehicle rounds were combined). Further analysis suggested that driving time would typically reduce by 35%, and to a 60% reduction if a larger vehicle (double the capacity) were used to service the porters.
iii) Driving distance reduced by 29% in the first trial and by 4% in the second trial, the latter again influenced by the larger round area used.
iv) Total vehicle deployment time reduced by 39% in the first trial and by 34% in the second, with savings up to 60-70% estimated for all activity in the CAZ.
v) Total labour time (driver(s) plus porters) increased by around 20% for both trials.
vi) Estimated total costs for the trials, based on porters being employed by carriers and receiving the London Living Wage, indicated that portering increased costs by 19% in the first trial and by 43% in the second trial, however, it was estimated that portering would be cost neutral if porters carried 90% of parcels.
vii) The cost of portering can be reduced further if:
    a. Porters are self-employed.
    b. Portering takes place over a larger area (e.g. the CAZ) giving opportunities for economies of scale and reducing the vehicle fleet and driver requirements.

In conclusion, portering provides the opportunity for substantial kerbside parking, driving time and distance savings but with organisational and financial challenges to resolve before wide-scale implementation can be considered.

1 Introduction

The portering trial is a Transport for London (TfL) Consolidation Demonstrator project. The trial consists of a live demonstration and evaluation of portering in the delivery of parcels and packages in central London. The trial and analysis is intended to investigate the scope for the application of an alternative method of last-mile parcel operation in which walking porters are responsible for the final delivery/collection of parcels, rather than delivery drivers with vehicles. An animation of the portering concept and trial has been commissioned and can be viewed at: https://vimeo.com/272338256/1f53b65cc2

At present, the van driver parks the vehicle at the kerbside and then makes on-foot parcel deliveries to consignees. In the live portering trial, porters with wheeled bags/trolleys are to be used, instead of drivers, to carry out the majority of these parcel deliveries. Drivers and porters will rendezvous briefly at the kerbside for porters to receive their bag-loads of deliveries. This will permit the driver to quickly drive away from the kerbside, thereby freeing up this space for other road users. It will also result in fewer stopping locations on each vehicle round, as porters could be handed far more parcels than drivers currently deliver each time they park the vehicle. It is envisaged that drivers would continue to make deliveries of items that are awkward and difficult for porters to handle including large and heavy parcels, as well as making deliveries to buildings receiving substantial quantities of parcels in a single delivery.

Portering has the potential to provide traffic and environmental benefits. These could include reduced time and space occupation of the kerbside by parcel vans in busy locations in central London during the working day, as well as a potential reduction in the vehicle kilometres travelled and time spent driving on London's road network. It could also help bring about operational benefits for parcel companies, by helping them to address issues concerned with longer and increasingly unreliable journey times, difficulties experienced in kerbside parking and reducing vehicle fleet requirements.

This report describes all of the stages and tasks undertaken in the portering trials, including pre-trial analyses and preparation, live implementation and post-trial evaluation.

2 Study of parcel operations in central London in 2016

Parcel collection and delivery is an important generator of road freight transport activity in the UK. It has been estimated that the total UK parcel market handled 2.8 million items and generated revenues of £10.1 billion in 2016 (which represents approximately 65% growth in items and revenues over 4 years). Nine out of 10 of the population is reported to have sent or received at least one parcel in the previous 6 months. Forecasts estimate a 33% increase in the volume of parcels handled by 2021, with a 22% increase in revenues, with much of this growth being contributed by ecommerce and online retailing (Mintel, 2017).

The parcel sector is characterised by many independent players competing in an 'everyone-delivers-everywhere' culture leading to much replication of vehicle activity. This in turn negatively impacts on congestion and the need to reduce emissions in cities.

Before the portering trials had been conceived, the FTC2050 project undertook surveys in October 2016 that provided a unique insight into the operations of parcel carriers' vehicles in central London. Surveyors accompanied drivers from Gnewt Cargo and a second carrier company on their delivery rounds and data were collected using:

- GPS trackers (Figure 1) – one carried by the driver and another kept in the vehicle
- The IPhone tracking app, Route Tracker 2 – carried by the surveyor
- Manual recording by surveyors of stopping locations and times, and of the work done by the driver
- Manifests (supplied in spreadsheet format by carriers after completion of rounds, including delivery and collection times and locations).

Figure 1 - QStarz Q1000XT GPS Tracker

The survey showed that multi-stop parcel vehicle delivery rounds in the West End of central London have an average round duration (from the vehicle leaving the depot until its return) of approximately 7 hours (ranging from 5-10 hours) and an average distance driven within central London of 12 km (7.5 miles) (ranging from 4-20 km). The mean driving speed was 7.1 km per hour (4.4 mph) (ranging from 3-12 kph), reducing to 1.9 kph (1.2 mph) (ranging from 1-3 kph) when the time spent parked was included. On average, 127 items were delivered/collected to 72 consignees per vehicle round. The vehicles made 37 stops on average to service these customers, with 3.4 parcels delivered/collected per stop.

Vehicles were parked for approximately 60% of the total round time (~4.6 hours per vehicle round) while the driver unloaded, sorted and delivered parcels. The average distance walked by the vehicle driver per vehicle round was 8 km (5 miles), which accounted for 28% of the total journey distance travelled from the depot (i.e. including distance driven), with 95% of vehicle stops taking place on-street at the kerbside. The mean drive time between vehicle stopping locations was 3.1 minutes, with an average 8.1 minutes kerbside parking time at each vehicle stop. Average driving and parking times per parcel were 1.5 and 2.3 minutes respectively. The findings suggest that last-mile parcel delivery operations are characterised by walking, with the vehicle left stationary at a kerbside that is in great demand by many road users for a wide range of purposes.

In addition, observational work and interviews with drivers indicated that vehicle circulation takes place when kerbside space is unavailable, further adding to the heavy, daytime road traffic conditions in central London. Driving times between delivery stops are exacerbated by one-way systems, and observational work suggests that the frequent ingress and egress of these vehicles from the kerbside negatively affects road traffic flow. These kerbside and road traffic situations in central London are expected to worsen over time as road- and kerbside-space is reallocated away from goods vehicles due to competing demands from other road users including cyclists and buses.

The proximity of parcel carriers' depots to central London is also expected to continue to deteriorate over time, as rising land values and rental costs in London, due to housing and office space pressures, are leading to warehousing and logistics facilities being relocated ever-further from the centre of London (Allen and Piecyk, 2017). Parcel carriers are, and will increasingly be, unable to afford the costs of ideally situated depots in close proximity to central London, given the relatively low profit margins in the sector, and the prices residential and other commercial land users are prepared to pay. This is leading to increases in the unproductive stem distances that vehicles have to make (i.e. from depot to delivery area and back). As stem distances increase, so too does vehicle activity in London, and journey time unreliability.

3 Study of parcel operations in central London in 2017

As a year had elapsed since the previous study (section 2), and with selection of portering trial areas in mind, further detailed surveys of selected Gnewt Cargo vehicle rounds (Figure 2) were undertaken from 14-16 November 2017, using surveyors accompanying drivers to collect similar data. The surveyed round areas included the two proposed by Gnewt Cargo for portering as they represented the lowest and highest drop densities of all their rounds, namely Southwark (SE1, driver A) and the City of London (EC3, driver B), respectively. The vehicle trace for each driver shows their round on one of the three days that were surveyed, with the round being quite consistent between days as drivers tend to develop their preferred route over time. It can be seen that the Southwark round had a typical driving distance of 7.3 km and the City of London round was 10.0 km.

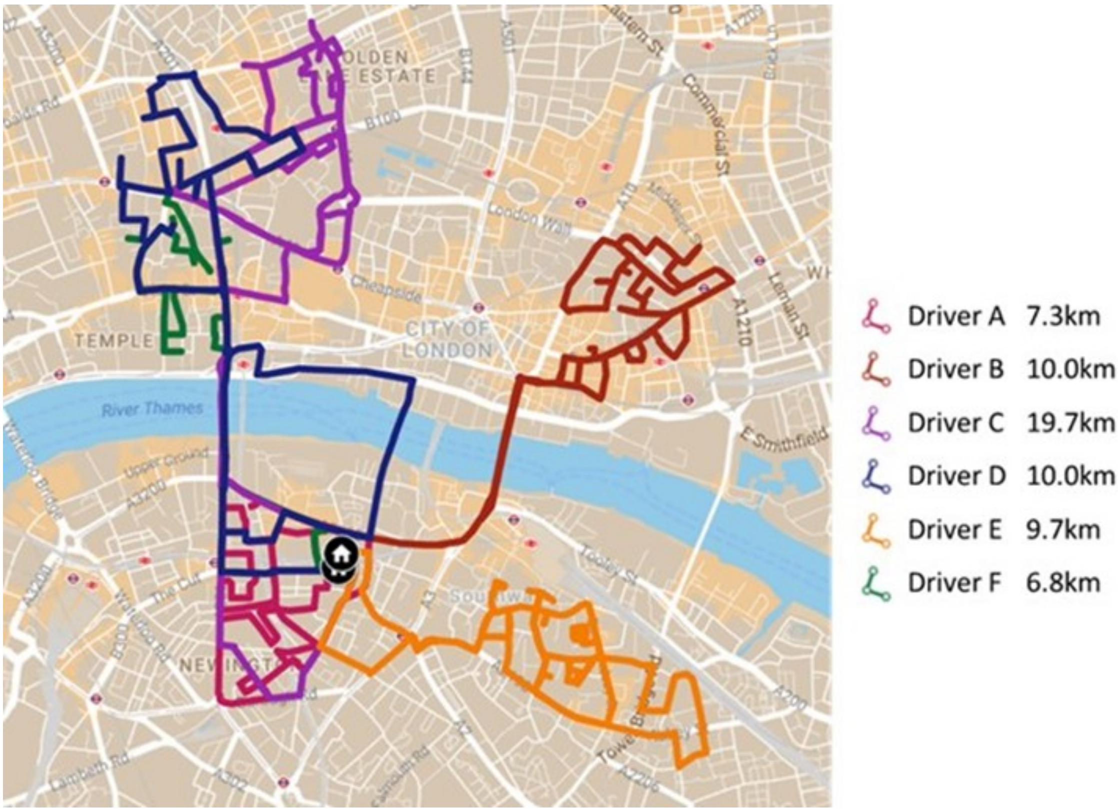

Figure 2 - Gnewt Cargo rounds surveyed in November 2017

These vehicle rounds were operated from Gnewt Cargo's depot in Southwark (depicted by a house symbol in Figure 2) and took place using either a Nissan Voltia ENV200 Maxi electric vans which have a payload limit of 600 kg and a volume limit of approximately 8m^3 (which based on a roof height extension is double their manufactured volume – see Figure 3) or smaller vans with approximate capacity of 4m^3.

Figure 3 - Gnewt Cargo's Nissan Voltia ENV200 Maxi Vans

3.1 Survey results and analysis

The round durations (Table 1), including return to the depot, ranged between 4 and 7 hours with an average of 5 hrs 10 mins. Across all the rounds, the vehicles spent an average of 30% (1hr 33min) driving and 70% (3hrs 36mins) parked while the driver sorted and delivered (and occasionally collected) parcels.

On average, drivers delivered 139 items and made 4 collections on these rounds each day. With an average of 57 consignees per vehicle round, each consignee received between 1.8 and 3.6 parcels (an average of 2.5 parcels). In carrying out these operations, drivers parked on average 25 times per round, and served 2.4 consignees each time they parked their vehicle. The average parking time spent per consignee was 3.8 minutes, and the average time spent at each parking site was 8.7 mins. Virtually all of this parking activity took place on-street at the kerbside.

Table 1 - Results from the November 2017 pre-portering vehicle round survey

	Driver Average						**Overall Average**
Driver	**A**	**B**	**C**	**D**	**E**	**F**	
Round Time (hrs:mins)	04:22	06:57	04:18	05:33	04:17	05:36	05:10
Driving Time (hrs:mins)	01:38	01:54	01:45	01:35	01:24	01:05	01:33
Parked Time (hrs:mins)	02:44	05:02	02:33	03:58	02:53	04:31	03:36
Parcels Delivered	118	257	64	80	87	226	139
Parcels Collected	5	2	1	7	5	6	4
Parcels Returned (failed delivery)	6	0	1	0	2	2	2
Consignees	60	80	37	39	60	64	57
No. of times vehicle parked	33	30	21	17	33	16	25
Analysis							
Driving time (as % of round time)	37%	27%	41%	29%	33%	19%	30%
Parking time (as % of round time)	63%	73%	59%	71%	67%	81%	70%
Parcels per consignee	2.0	3.3	1.8	2.2	1.5	3.6	2.5
Consignees per parking stop	1.8	2.7	1.8	2.3	1.8	4.0	2.4
Parcels per parking stop	3.8	8.8	3.1	5.1	2.8	14.5	5.7
Time per parking stop (min:sec)	5:01	10:15	7:17	14:00	5:11	16:56	8:42
Parking time per parcel (min:sec)	1:20	1:10	2:21	2:44	1:52	1:10	1:31
Driving time per parcel (min:sec)	0:48	0:27	1:37	1:06	0:55	0:17	0:39
Total time per parcel (min:sec)	2:08	1:37	3:58	3:50	2:47	1:27	2:10
Parking time per consignee (min:sec)	2:43	3:48	4:08	6:06	2:52	4:16	3:50
Driving time per consignee (min:sec)	1:38	1:26	2:50	2:26	1:24	1:02	1:39
Total time per consignee (min:sec)	4:21	5:15	6:58	8:32	4:16	5:18	5:29

This survey reinforced some of the findings of the survey work in October 2016. It shows that delivery drivers are spending significant periods of time (on average 70% of total round time or 3.5 hours per day, but as high as 81% in the case of driver F) away from their vehicle each day while carrying out deliveries and collections on-foot. Their vehicles are therefore being used more for mobile storage than for transportation.

Quantities of parcels delivered varied across different areas due to the size of each round, and daily and seasonal demands. The number of parcels per consignee did vary considerably between regions, with the routes South of the river in Southwark (Driver A, Driver E) receiving fewer parcels per consignee than North of the river (Driver F, Driver B, Driver C, Driver F) indicating the differing drop densities in these two locations. This North-South trend also follows for parking events per consignee, with the drivers in Southwark serving fewer consignees per parking site. The vehicle rounds North of the Thames tend to be more densely constructed with more high-rise buildings and more people and thereby more parcels generated per unit of area.

Driver A’s round (one of the two identified by Gnewt Cargo for the live portering trial), Figure 1, shows the van and driver walking trace data on one day of the November 2017 survey). Given that this round is co-located with the Gnewt Cargo depot, Driver A chooses from experience to start their round by delivering on foot to the addresses closest to the depot (indicating the benefits of not using a vehicle where possible). They then return to the depot and carry out the rest of the round by van, taking an approximately 4.5 hours. Driver A drives approximately 8 km every day, serving 123 parcels to 60 customers.

Analysis of Driver A’s routing choices shows that they differ very little day-to-day, with nearly 90% route similarity across the three days surveyed.

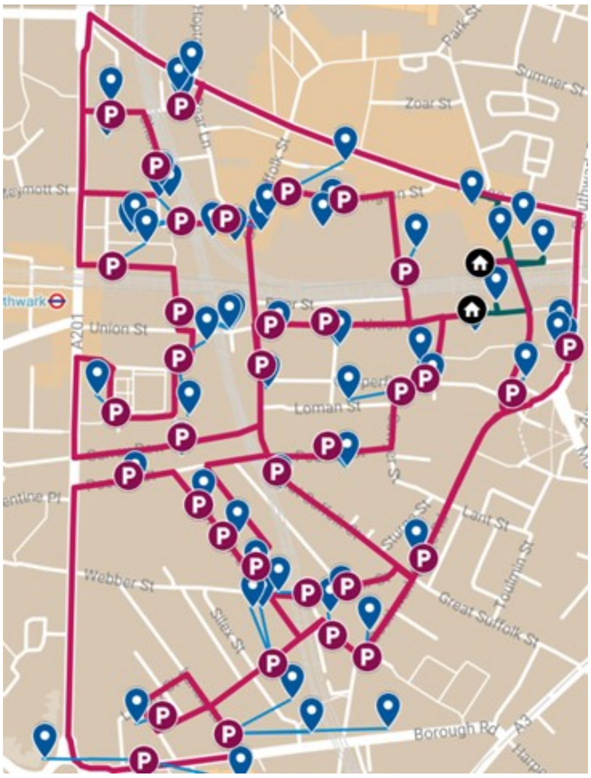

Figure 4 - Driver A's SE1 round (14th Nov) showing parking sites (shown as ‘P’) relative to consignees (shown as blue pins with a white dot). Green tracing shows the initial walking route. Black houses indicate the depot entrances.

A route comparison tool was used to analyse the similarity of the routes taken by other drivers that were surveyed (Table 2) shows the collated output from the programme.

Table 2 - Collated results from D. Brown's Route Similarity Tool for the November 2017 movement survey

	Route Similarity			
Driver	14/11 v 15/11	14/11 v 16/11	15/11 v 16/11	Average
F			85.0%	85.0%
B			89.9%	89.9%
E	80.8%	83.6%	84.0%	82.8%
A	85.5%	90.3%	91.8%	89.2%

An overall average of 86.9% similarity between the route choice of drivers over the days surveyed indicated that the majority of their time and distance involves little deviation from a standard vehicle route. It is apparent that the drivers choose to travel on very similar routes and driven distances each day regardless of their load, making only minor deviations to reach infrequently visited addresses.

Considering specifically the operations of Driver A (Southwark) and Driver B (City of London) as these were the two used in the live portering trials, they also exhibit some differences to the results of the far larger survey of parcel operations in the West End in October 2016. These include the stem driving distances (i.e. the distance travelled from the depot to the delivery/collection area served), the parcel drop densities (and hence proportion of parking/walking time and inter-drop driving distances), the number of parcels per consignee, the overall number of parcels handled per vehicle round, and the experience of the drivers.

Driver A’s operation includes no stem driving distance as this round was adjacent to the Gnewt Cargo depot. Therefore, the driver chose to walk from the depot to deliver some of those parcels destined for addresses located closest to it. Parking time comprised 73% of Driver B’s round, indicating the extremely high drop density that this operation comprises (compared with an average of 60% in the West End survey).

The average stem driving distance in the West End survey of 2016 was greater than in either Driver A’s or B’s operation (based on the proximity of Gnewt Cargo’s depot to central London). By comparison, the survey of 2016 included carrier’s depots that were more distant than in the case of the Gnewt depot.

Driver A’s average parcels handled per round (118) was similar to the average quantity of 127 parcels handled in the 2016 West End survey. By contrast, Driver B handled 257 parcels, indicating the greater drop density in the City of London. As mentioned above, this results in driver B spending a considerably greater proportion of time parked and walking than driving compared to the West End survey. It also results in lower inter-drop driving distances (61 metres versus 111 metres in the 2016 survey). The number of parcels per consignee is also influenced by drop density and has an important bearing on how many different addresses the driver has to visit, which, in turn, affects the total time taken per parcel (Driver B had an average of 3.3 parcels per consignee, compared with 2.0 parcels for Driver A, and 1.8 in the 2106 West End survey).

There is also a difference in the complexity of driving around the City of London and the West End compared with Southwark, given the greater number of one-way and dead-end streets, road traffic levels and pedestrian footfall.

The experience and knowledge of the driver also has an important bearing on the speed at which they are able to carry out their work. Driver efficiency impacts on many operational factors that influence the total time taken and distance travelled including: vehicle routeing, the order in which to deliver/collect parcels, where best to park the vehicle, how many consignees to deliver to each time the vehicle is parked, and quickly gaining entry to the building to make the delivery. Analysis of two drivers with varying levels of experience working on the same vehicle round on different days (one had worked on the round in question for about two years and had many years of delivery experience, whereas the other had only been working as a delivery driver for a couple of months and only had a few weeks of experience of the round in question). The difference in their efficiency was considerable with the far more experienced driver managing to carry out the work with approximately 30% less driving time, 40% less parking time, 35% less total time and 45% less total driving distance. Both Driver A and Driver B had several years of experience working on their vehicle rounds in Southwark and the City of London, and can therefore be considered highly efficient drivers.

The overall performance of a parcel delivery driver will depend on all the factors discussed above. This performance is reflected in the total time taken (i.e. driving and parked time while walking) by the driver, per parcel, over the course of their entire daily vehicle round. Driver B, in the City of London, took an average of 1 min 37 sec per parcel, compared with 2 min 8 sec for driver A , and 5 mins 42 sec in the West End survey of 2016. Therefore Driver A and driver B can be considered to be high-performing drivers, working on rounds that have some operational and geographical features that make them more efficient to serve than others.

This analysis of Driver A and B's vehicle rounds suggests that the these two drivers and their rounds, which were used in the live portering trials, are more efficient operations than the average vehicle round studied in the larger survey of parcel delivery operations in the West End in 2016.

3.2 Elevation analysis

Garmin Edge trackers (Figure 5) were carried by drivers, able to measure altitude, giving an indication of the frequency with which drivers had to travel upstairs within buildings. At multi-tenanted, multi-storey buildings, most of which were office blocks in the survey, drivers either:

i) deliver to a centralised mail room or loading bay (with staff employed by the building management then taking responsibility for internal delivery to consignees within the building, or
ii) deliver directly to each individual consignee.

In the case of the latter, the driver will have to use a lift or staircase to reach the tenant. This can result in drivers spending substantial periods of time inside buildings (e.g. waiting for lifts to different floors, climbing and descending stairs), thus increasing vehicle kerbside dwell time. Clearly from a kerbside space perspective, multi-tenanted buildings that provide the opportunity for drivers to deliver all tenants' items to a single mail room or loading bay is preferable.

Figure 5 - Garmin Edge 500 GPS Tracker

As an example, Figure 6 provides data from one vehicle round showing the ascents the driver had to make within buildings. It should be noted that some fluctuations occur in the graphs due to temperature sensitivity of the altitude sensor. The elevation tracking during the entire survey work showed that drivers had to travel vertically to reach approximately 15% of consignees whilst serving their rounds (this includes consignees not located in multi-tenanted buildings, so the proportion of multi-tenanted, multi-storey buildings in which this is necessary is considerably higher). Clearly, the lack of a centralised location at which drivers can deliver parcels for all consignees in multi-tenanted, multi-storey buildings has an important influence on the kerbside dwell time of their vehicles. It is an issue that policy makers may choose to consider in devising future land-use and building planning permission approval.

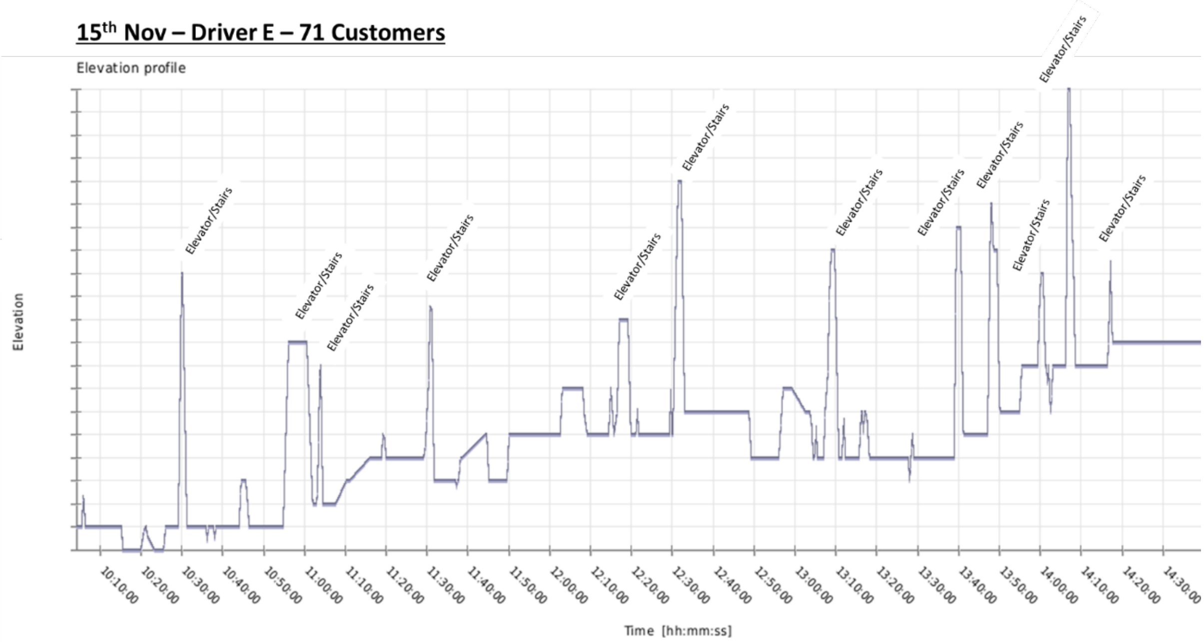

Figure 6 – Elevation graph for Driver E's movements (15th Nov 2017).

4 Survey results and the scope for portering

The survey work carried out in various locations in central London during 2016 and 2017 (West End, City of London and Southwark) provides an evidence base for the potential application of alternative operational methods for carrying out multi-drop parcel deliveries and collections. Both survey work exercises have demonstrated the following findings:

- The substantial periods of time that vans spend at the kerbside while drivers are making collections and deliveries (on average, 3.5 – 4.5 hours per vehicle per day).
- Parking time far exceeds driving time of these vans over the course of their working day (on average 60-70% of the total time that the vehicles are away from their depot each day).
- Drivers are walking long distances over the course of the day in their delivery and collection of parcels (on average approximately 8 km or 5 miles).
- Vehicles are parked on many different occasions over the course of their working day (on average, approximately 25-40 times per day).
- The vast majority (95%) of parking takes place on-street at the kerbside.
- Vehicles are only moved short distances between each parking location (~110 metres per parcel handled).
- Drivers walk on average, 70 metres per parcel delivered or collected but this does not take account of walking inside buildings
- Drivers have to travel vertically up and down inside buildings either by lift or by stairs at approximately 15% of the consignee addresses they visit (this is most common at multi-tenanted buildings and results in vehicles having longer than otherwise necessary kerbside parking times).
- Some parcel carriers, in contrast to those studied in the surveys, have a sizeable proportion of time-guaranteed deliveries that are difficult to achieve while maintaining vehicle and driver operational efficiency.

The above points indicate that a reduction in the amount of time that these vehicles need to be parked on-street during parcel deliveries and collections as well as the number of occasions that they are parked would potentially lead to benefits. It could have benefits for both:

- Policy makers and other roads users, as it would free up kerbside space and time for other road users, and reduce the impact that parking (getting in and out of spaces) has on road traffic flow)
- Parcel companies, as vehicles are expensive assets and for them to be unproductive for so much of their working day provides the opportunity for cost savings.

The freeing-up of kerbside space and time is an important topic given the high demand for this asset. Work by the City of Westminster has identified approximately forty competing uses for the kerbside in addition to freight and servicing vehicles. As well as having benefits in terms of freeing-up kerbside space and time, alternative methods of parcel delivery could also result in reductions in vehicle driving time and distance in central London.

5 Combined driving and walking optimisation

Irrespective of whether porters are used or not, drivers have to make decisions each day about where to park and how to group deliveries together in walking tours. This is a highly challenging and little researched optimisation task which the FTC2050 research team is currently investigating. Results to date have suggested that round time may be reduced by making fewer stops than at present and making a greater number of deliveries and collections on-foot each time the vehicle is parked. Such a solution is capable of reducing the total round time by approximately 25% and the total driving time (and distance) in the delivery area by approximately 50% but with a 20% increase in parking time and an up to 50% increase in walking time and distance. The actual clustering and routing used by the driver is shown in Figure 7, while the optimised strategy is shown in Figure 8. The solid blue line depicts the vehicle driving while the dotted lines illustrate some of the walking that was done. The output of this work, together with the survey results, led to the development of the concept as to how these deliveries and collections could be accomplished with the use of porters.

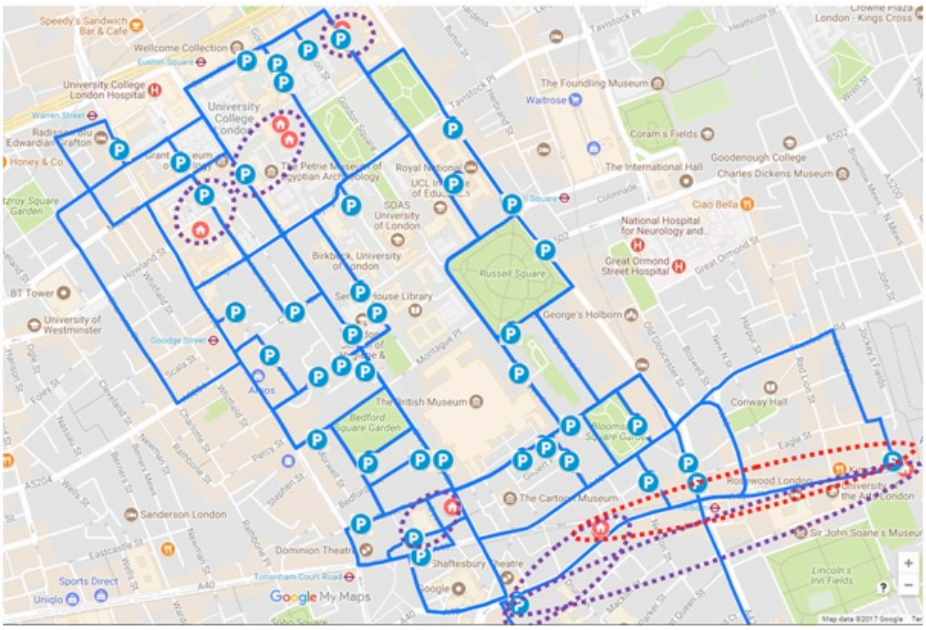

Figure 7 - The actual clustering & routing strategy used by the driver

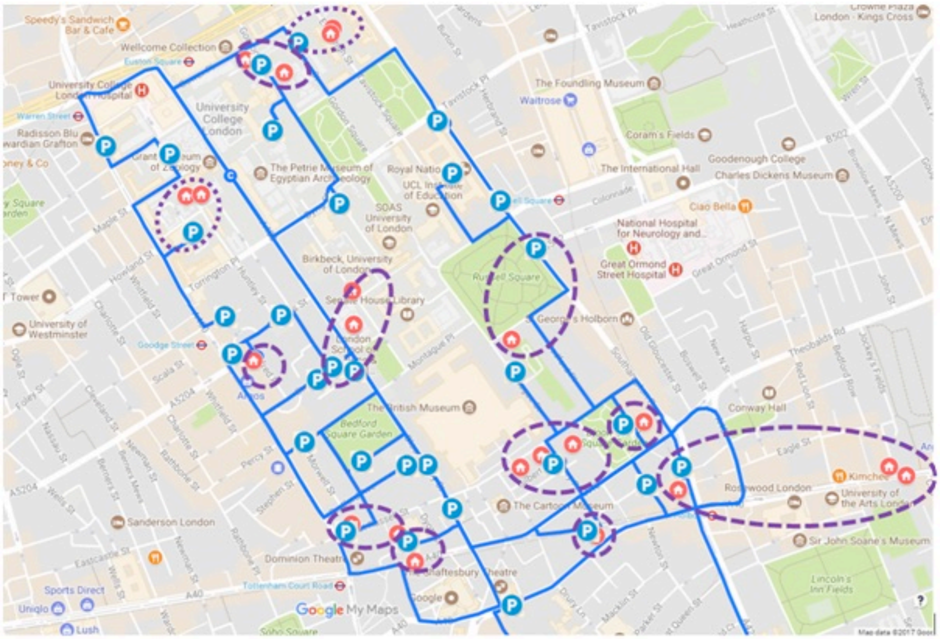

Figure 8 - Routing optimisation of the proposed strategy

6 The portering concept

From the earliest times of human settlement until the mid-nineteenth century, the primary means of transporting goods within the City of London was by foot (Stern, 1960). London's walking 'porters' were involved in two main types of supply chain activity, (i) moving goods between an origin and destination (such as between a ship and a store, or between a store and a customer), and (ii) loading and unloading transport vessels including boats and ships (ibid). Portering was a low-class, often unlicensed occupation, generally carried out by the young and poor (ibid). In the 18th century, porters started to use barrows and hand carts to aid delivery (Armstrong, 2001) and by 1841, 'stands' (locations where porters could wait to be hired, Stern, 1960; Earle, 1994) and 'pitching places' (porter resting places (Barker, 1988)) had begun to appear all over central London. In recent decades, the only remaining forms of outdoor freight transport carried out on foot in developed countries are postal services in dense urban areas, door-to-door leaflet deliverers and door-to-door sales.

Transport for London and London boroughs have an objective to improve freight consolidation to reduce goods vehicle activity in London thereby alleviating traffic levels and associated negative environmental impacts. The organisations are also seeking to reduce freight demand for kerbside space and time. These public policy objectives, together with the understanding of next-day and economy parcel sector operations in central London through the work carried out in the Freight Traffic Control 2050 project, led the project team to identify the potential for the portering of parcels in central London as a means by which to achieve these objectives.

An initial desk-based analysis of the portering concept identified the potential benefits and opportunities of portering shown in Table 3.

Table 3 - Potential benefits and opportunities of portering in the parcels sector in central London

Stakeholder	Potential benefits / opportunities
Policy makers / society	• Reduce kerbside time and space occupancy • Reduce vehicle kms • Environmentally-friendly deliveries
Parcel companies	• Reduced vehicle fleet requirements and operating costs • Provides scope for parcel company collaboration • Could be used in conjunction with autonomous ground vehicles if/when they are operational
Porters / delivery personnel	• Improves health and wellbeing of delivery workers • Potential extra work for existing food / parcel couriers • Generates portering jobs (and could be supported by autonomous delivery vehicles when available)

Methods by which the portering of parcels could be achieved were considered. The following approaches were identified:

1) Porters receive loose parcels at kerbside from driver (dynamic rendezvous between driver and porter).

2) Porters receive carrying devices (e.g. wheeled bags) filled with parcels at kerbside from driver (dynamic rendezvous between driver and porter).

3) Porters obtain carrying devices filled with parcels from a local storage location (such as mobile depot / locker bank / Underground station office – with the carrying devices having been pre-delivered by the driver).
4) Porters obtain carrying devices filled with parcels from a local portering collection / delivery point (a staffed location – with the carrying devices having been pre-delivered by the driver).
5) Porters travel on-board the vehicle with the driver and get out of the vehicle to make deliveries and collections at vehicle stopping points (this approach is similar to the use of a drivers' mate in some logistics operations – it would result in greater vehicle kerbside stopping time than the other four portering concepts above, but less than in existing operations).

The advantages and disadvantages and practicalities of these various portering approaches were considered in relation to conducting a short-term trial with a limited budget (Table 4). However, in determining a method for the portering trial, all project partners were keen to implement an approach that was as realistic and efficient as possible if it were, in future, to be applied across an entire parcel carriers' operation in central London.

Table 4 - Advantages and disadvantages of portering approaches in a short-term trial

Portering system no. from above list	Need to alter current vehicle round sortation method at local depot	Need for porter carrying equipment (inexpensive capital cost)	Need for vehicle adaptation (potentially expensive capital cost)	Need for land / property (potentially expensive capital cost)	Could reduce number of parking stops / distance driven / driving time	Could reduce vehicle kerbside stopping time	Would potentially require large number of porters	Would require communication system / platform between driver and porters	Would be difficult to efficiently co-ordinate between driver and porters given porter numbers	Potential to reduce total vehicle fleet required by carrier
1.	×	×	×	×	×	✓	✓	✓	✓	×
2.	✓	✓	×	×	✓	✓	×	✓	×	✓
3.	✓	✓	×	✓	✓	✓	×	✓	×	✓
4.	✓	✓	×	✓	✓	✓	×	✓	×	✓
5.	×	×	✓	×	×	✓	×	×	×	✓

7 Development of a portering operation that could be trialled in the Gnewt Cargo operation

The management team of Gnewt Cargo and the FTC2050 research team worked closely together to develop the portering system to be used in the trial. It was eventually decided that the portering system to be used would involve parcels being loaded into wheeled bags at the Gnewt Cargo depot, with the driver making a rendezvous with the porters on-street at the kerbside. This was done via a smartphone-based app, to allow the porter and driver to rendezvous and hand over the filled bag for the porter to then make the deliveries on-foot. (This relates to portering system 2 shown in Table 4.)

This portering system was selected based on several factors including:

i. Its potential to generate savings in total kerbside parking time and time taken per parking incident,
ii. The low capital costs and rapid implementation timescale associated with it (as it has no land acquisition or vehicle adaptation requirements),
iii. Its relatively modest porter requirements for the purposes of the trial and straightforward communication requirements between driver and porters,
iv. Its potential to be scaled up across an entire carrier's operation, and/or to be used by several carriers working together.

The portering system decided for use in the live trial is depicted in Figure 9.

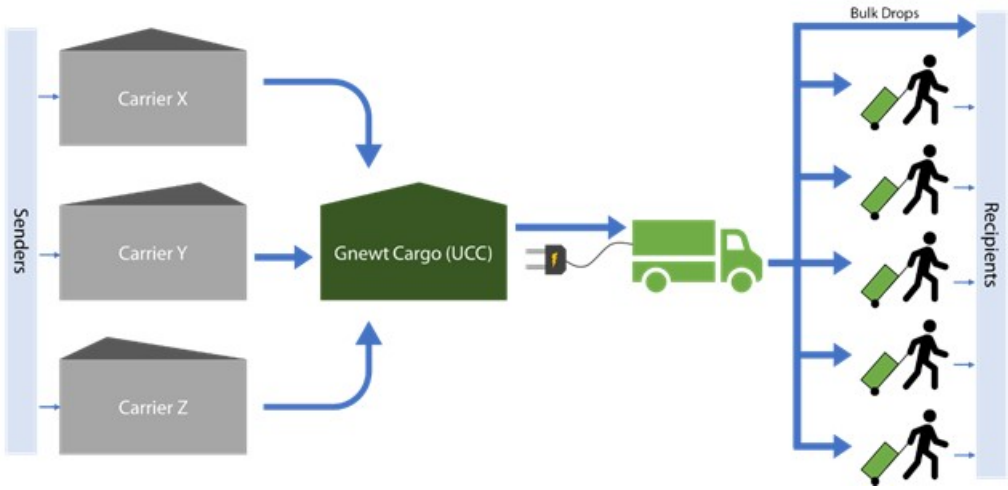

Figure 9 - Overall Schematic of the Porter Served System: from sender to recipient

The live trial was planned to cause as little disruption to the existing Gnewt Cargo operating model as possible, as high delivery service levels provided to customers would need to be maintained. In the portering approach selected, parcels were:

1. Delivered from central hubs to Gnewt as normal (arranged by existing round structures)
2. Sorted at Gnewt's depot in the early morning into defined portering patches
3. Subdivided and placed in bags.

For future portering systems, time at the depot would be saved by specifying round structures to suit the portering requirements and sorting appropriately at the central hub, that is, steps 1 and 2 above take place at the central hub.

Other issues identified in this development of the Gnewt Cargo portering live trial included:

1) If using a system in which porters were provided with bag loads of parcels, some items may be too heavy or large for the porter to take. In this situation these heavy/large items could either be:
   a) Delivered by driver (either by a dedicated driver who only carries out these deliveries, or by the same driver who replenishes bags for porters)
   b) Delivered by a porter who meets the driver at the kerbside and is only given a single item.

   Decision taken: that a survey of parcels' weights and sizes should be carried out in advance of the live trial to establish whether it presented an issue for the proposed portering system (see sections 89). If necessary, large/heavy items would be delivered by a driver / vehicle rather than a porter. The survey work did in fact show that some parcel sizes/weights were inappropriate for portering. Therefore, in the first live trial, a dedicated driver and vehicle carried out these deliveries in addition to a separate driver serving the porters. While it was acknowledged that this would increase the total distance driven by vehicles, it placed less risk on the service delivery to consignees which had to be maintained during the live trial. In the second live trial it was decided that a single driver would both service the porters and deliver large and heavy items, thereby removing the need for a second vehicle and driver and providing a more efficient solution in terms of vehicle/driver requirements and in terms of vehicle kilometres driven.

2) Some consignees receive large numbers of parcels each day. It was therefore necessary to decide whether multiple items destined for a single consignee should be:
   a) Given to a porter
   b) Left for the delivery driver

   Decision taken: it was decided to give these multiple items for a single consignee to the delivery driver rather than the porter.

3) The use of additional modes of transport than walking by porters was also discussed (including bicycles with trailers and cargo-cycles).

   Decision taken: it was decided that, given the timescale and budget of the trial, it was best to limit it to a single mode of transport (i.e. walking porters). Also, the use of cargo-cycles or cycles with trailers was identified as raising security issues when these vehicles were left on-street with items on board, while porters were inside buildings delivering and collecting items from customers.

Given the decisions in points 1 and 2 above, during the portering sortation system at the Gnewt depot it was also necessary to identify and remove any large/heavy parcels and multiple parcels which were destined for a single consignee for direct delivery by driver rather than by porters. This was deemed necessary to ensure the operability of the portering system and that it achieved a suitable level of efficiency. The remaining parcels to be handled by porters would then be loaded into carrying devices with these being loaded onto the driver's vehicle together with the large/heavy items and bulk loads to be delivered directly by the driver. The porters would meet the driver at pre-agreed rendezvous points and be given a pre-filled carrying device, before proceeding to deliver these items to consignees. Upon completion of the deliveries, each porter would contact the driver for replenishment with another carrying device filled with parcels at an agreed meeting point. (See sections 8 to 10 for further discussion and analysis of these issues.)

8 Parcel size and weight survey

Parcel sizes and weights have an important bearing on the potential suitability and design of a portering system, especially if the operation involves a substantial proportion of large and/or heavy items. Such information is not currently available to carriers such as Gnewt Cargo in advance of the overnight delivery of parcels to their depot from the central hub, so it was necessary to carry out our own survey. A survey of one delivery vehicle's load was completed on the 3rd November 2017; this vehicle round was based in the Southwark (SE1) area selected for the live trial. All parcels were weighed using scales and a large bag for containment. They were then sized by comparing the parcel to pre-made samples of defined sizes, based on sizes used in a previous study (Small = 320 x 240 x 100 mm, Medium = 305 x 305 x 305 mm, Large = 405 x 405 x 405 mm) (Cherrett, et al., 2017), Figure 10. In the case of parcels larger than the biggest sample, full dimensions were taken. The sizes and weights were then recorded on a log sheet along with the first line of the address and postal code. The delivery manifest was also made available by Gnewt Cargo to facilitate matching of parcels to consignee addresses.

Figure 10 - Sample Box Sizes

A further size and weight survey took place on 17th January 2018. On this occasion, two rounds were surveyed; one in the Southwark SE1 area and one in the City of London EC3 area, as selected for the live trials. Weights and exact dimensions for all parcels were taken during this survey to create a complete size and weight dataset. Again, Gnewt Cargo made the manifest data available for these rounds.

Table 5 shows the weight data from the January survey compared to the November survey. The mean, median, and standard deviation do not differ greastly between each of the rounds surveyed, despite Driver B's round containing more business customers than Driver A's. These similarities would indicate that whilst the quantities of parcels delivered may vary over time, the essential properties of the parcels do not vary greatly. Between the two areas (Driver A's SE1 and Driver B's EC3), there was no significant difference in the observed weights of parcels, with a difference in mean weight of 140 grams.

Although there are no maximum legal limits on the weights that workers can lift, Health and Safety Executive guidance suggests a typical upper limit of 25 kg for a man ((Health & Safety Executive, 2012). Therefore, based on the mean parcel weight, porters would be limited to approximately 20-25 parcels per load.

Table 5 - Basic weight data from January 2018 weight/size survey compared with November 2017 data

Statistic	November – Driver A (kg)	January - Driver A (kg)	January – Driver B (kg)	January - Combined (kg)
Quantity	160 Parcels	241 Parcels	248 Parcels	489 Parcels
Mean	1.40	1.26	1.13	1.20
Std. Deviation	1.44	1.76	1.24	1.52
Median	0.98	0.80	0.70	0.80
Mode	0.001	0.40	0.40	0.40

The distribution of the weights across the survey in general shows a clear positive skew towards lighter items, as seen in Figure 11, with most parcels weighing less than 900 grams.

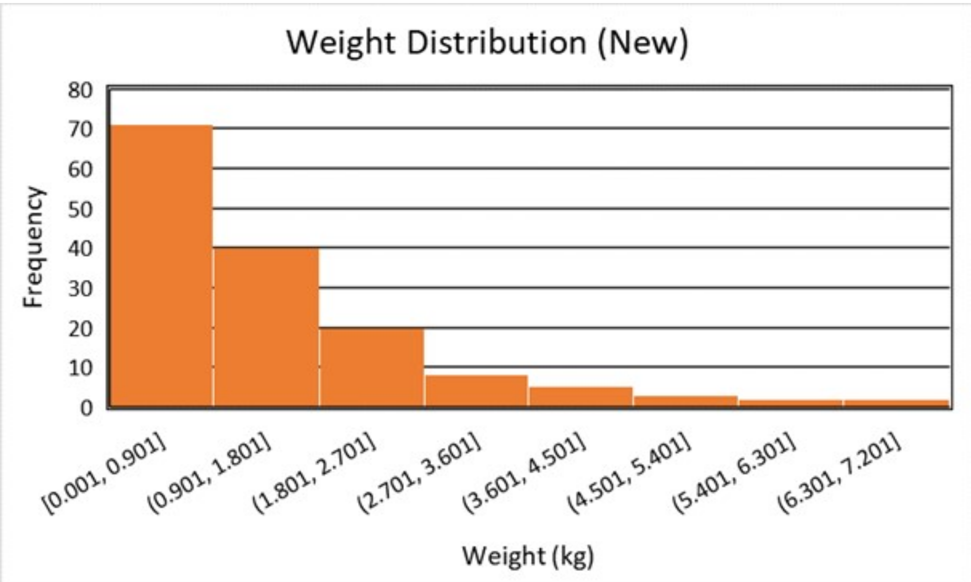

Figure 11 - Weight distribution histogram for January 2018 weight/size survey

Table 6 shows the basic statistical data for parcel size from the November 2017 survey. The survey indicated substantial variability in the volume of items handled (relatively high standard deviation value), however because the sizes in this survey were categorised (small/medium/large) and not measured individually, it was difficult to fully understand the distribution of volumes.

Table 6 - Basic size statistical data from November 2017 weight/size survey

Statistic	Package Volume (litres)
Mean	22.01
Std. Deviation	17.08
Median	27.36
Mode	Medium

Figure 12**Error! Reference source not found.** demonstrates the proportions of each size category, indicating that 72.8% of parcels were 405 x 405 x 405 mm or smaller. This means approximately 27% of parcels are likely to be too large for a porter to carry practically.

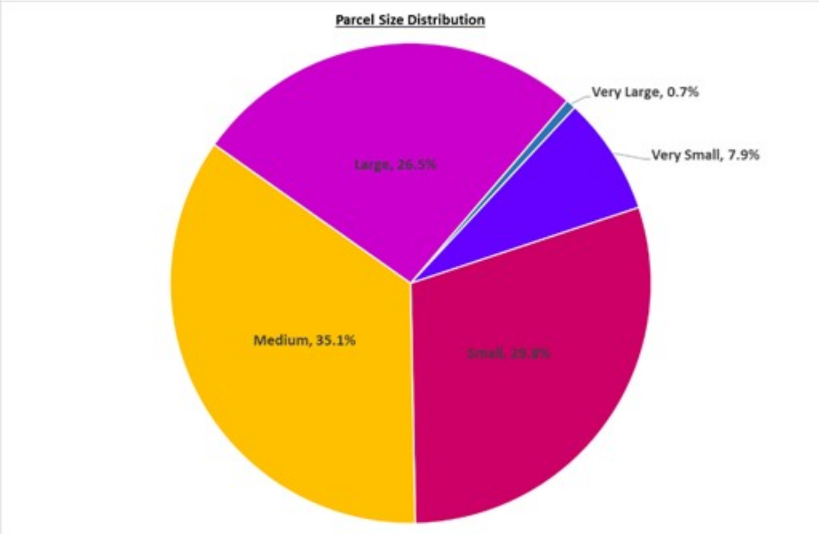

Figure 12 - Nov 2017 Size Survey Distribution Pie Chart

Table 7 shows the item size data from the two January rounds surveyed. The mode is not included in the table because no single volume value had a high enough frequency to be relevant.

Table 7 - Basic size data from January 2018 weight/size survey

Statistic	**January - Driver A (L)**	**January – Driver B (L)**	**January - Combined (L)**
Quantity	241	248	489
Mean	13.27	13.37	13.32
Std. Deviation	16.72	16.32	16.50
Median	7.68	7.34	7.54

As with the weight distribution, the general volume distribution shows a clear positive skew towards smaller parcels, as seen in Figure 13, with most parcels having a volume of less than 15 litres.

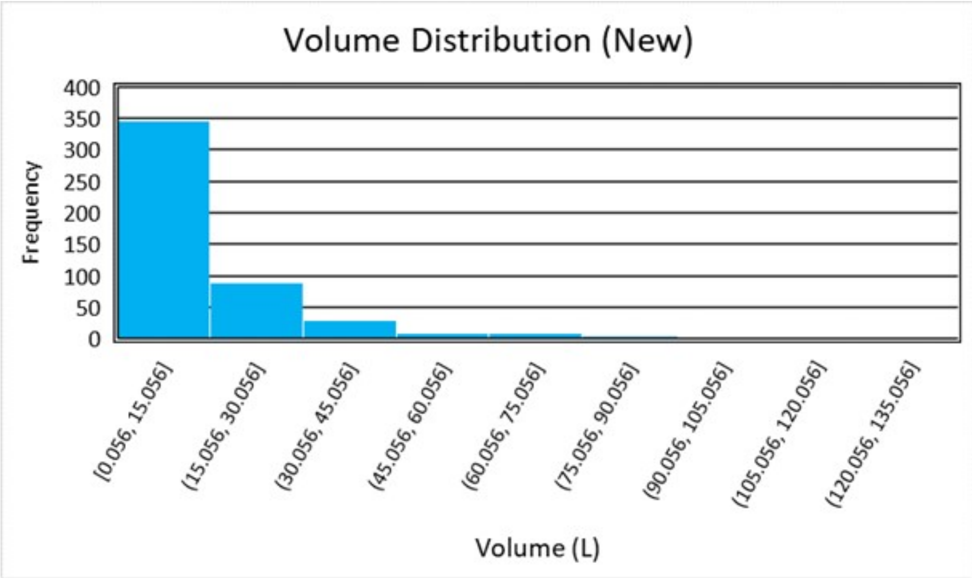

Figure 13 - Volume distribution histogram for January 2018 weight/size survey

Figure 14 shows a 3D histogram plot to show the distribution of the parcels measured in January 2018 with respect to both weight and size (plot generated in MATLAB). There is a very clear trend towards small and light parcels rather than large and heavy ones. This combination of parcels is ideal for a portering system as multiple parcels can be conveyed on-foot at the same time in a carrying device, without the overall weight or volume being excessively large. However, there are clearly parcels which do not fit these criteria, and which lie outside the weight and size limits for a portering system in which the parcels that porters are to deliver are provided to them ready packed in a carrying device. Therefore, in such a portering system, an alternative method would be required for the delivery of especially large and/or heavy items. The easiest method for achieving this in the live trial (and in an on-going portering system of this kind) was for these items to be delivered by a driver using a vehicle.

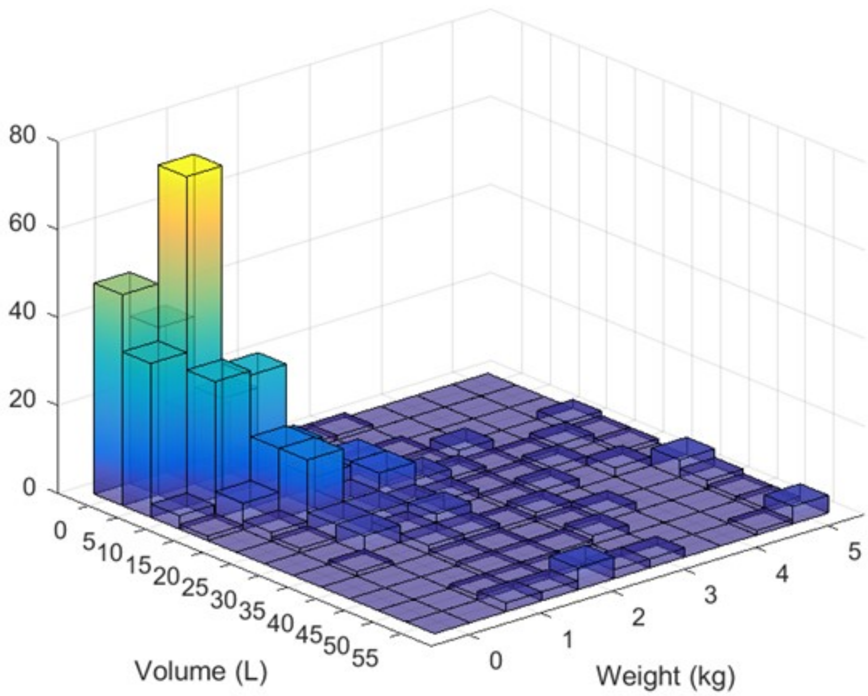

Figure 14 - 3D probability histogram displaying the relationship between weight and volume based on the January 2018 weight/size survey

9 Analysis of the size and weight of parcels on the design of the portering system for the live trial

It was decided that in the live trials, large/heavy parcels would be directly delivered to consignees by a driver/vehicle in the same manner that items are currently delivered. Table 8 shows the sizes and weights of parcels that were deemed too large or heavy for inclusion in porters' carrying devices, and which would instead be delivered by drivers. A decision was also taken to give parcels to the driver if there were five or more for a single consignee, or additional parcels for a consignee that the driver was already visiting with a heavy or large item.

Table 8 - Driver/Porter allocation criteria for the SE1 Southwark Area Manual Patch Simulation

Criteria	Driver served if
Individual parcel volume	Large/Very Large (>30L approx.)
Individual parcel weight	More than 5 kg
Number of parcels delivered to same consignee	5 or more parcels for same consignee
Drop duplication	Consignee already visited by driver due to other parcels meeting the above criteria

Two different sortation processes were developed for sorting parcels into portering areas for the live trials. One involved a manual process based on driver knowledge (which was applied in the first live trial), while the second was based on an automated process (which was applied in the second live trial). These two sortation approaches are described in the live trial descriptions in sections 11 and 13.

Prior to the live trials, analysis was carried out using existing Gnewt Cargo manifest data for the trial areas and the size/weight survey to investigate: i) the appropriate apportioning of geographical areas within the two trial locations to porters, ii) the number of porter carrying devices needed given the consignee demand, iii) the likely split of delivery workload between porters and driver.

Portering areas were described as 'patches' and various approaches were applied to analyse these walking patches. In preparing for the first live trial, several different 'patching' systems were experimented with. These included a static patching system in which the patches would remain the same for each day. This involved a grid of approximately 350m x 350m squares being drawn over the top of the map of the driver's area to divide the area into workable portering patches based on the consignee density (Figure 15). The second approach used a more bespoke shaping of patches, drawing the areas free hand to distribute the loads more evenly (Figure 16). The postcodes falling in each patch were then found so that parcels could be allocated.

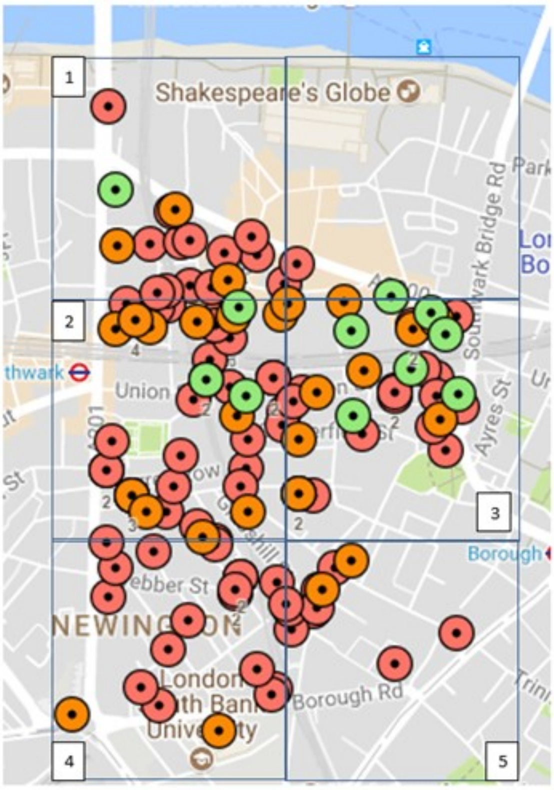

Figure 15 - Grid patching system in the SE1 area, with consignee addresses visited during the November 2017 survey (14-16 Nov). Green points were visited on all days, orange were visited on two days, red on just one. (Google My Maps, 2017)

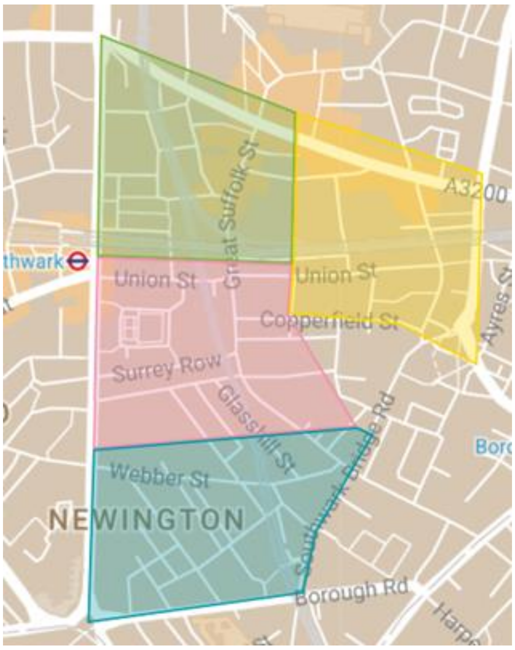

Figure 16 - Bespoke manual patching system in the SE1 area (Google My Maps, 2018)

The static patching analysis assumed the use of 140-litre carrying devices. It indicated that in the SE1 Southwark live trial, 54% of the parcels would be assigned to the driver, and would result in porters covering the remaining 46% of parcels. In terms of consignees, the driver/porter split would be 36%/64% and, in terms of total parcel weight and volume the driver would deliver 65-70% and porters 30-35%. Widening this static patching analysis to all the delivery operations surveyed in November 2017 suggested that porters would deliver approximately 60% of all consignments and 50% of all parcels.

Manual patching was found to give good flexibility, and can use local knowledge, but does not always account for the distribution of parcels, as there is an element of human judgement. Due to variance in parcel volumes, each patch could require either one or two bag loads each day. To try to improve on this manual approach and to reduce the variation in parcel loads between patches, a dynamic approach was developed in which parcels could be automatically transferred between patches, thereby overcoming the problem of patches with fixed boundaries. This dynamic approach can make use of consignee address properties such as the co-ordinates, distance from a certain point, or the associated postcode. The patching can then be completed by sorting the parcels and allocating them to bags in a dynamic fashion so that porter patch sizes/shapes change depending on the parcel loads for each day. The variation in the patches means that possible targets such as one bag per patch can be met exactly. Therefore, dynamic patching can result in a more efficient use of resources by ensuring maximum use of bags and porters regardless of the day-to-day variation in parcel loads.

This dynamic patching analysis was applied to the delivery operations surveyed in November 2017 using the rules concerning whether porters or drivers deliver parcels shown in Table 8, and a larger assumed portering carrying device of 200 litres. This analysis indicated that porters could deliver 83% of all parcels and serve 87% of all consignees with the driver carrying out the remainder.

Prior to the second live trial in the EC3 postcode of the City of London, one week of Gnewt Cargo manifest data from February 2018 for this area were analysed. Dynamic patching was applied to this data using the rules concerning whether porters or drivers should make deliveries, and assuming a 200 litres portering device. The results suggested that porters would service approximately 90% of parcels and consignees, with the driver servicing the remaining 10%.

10 Selection of carrying equipment for portering trials

For a portering system to function efficiently, a durable and easy to use parcel carrying device is needed. Various carrying methods are available, though there are the following constraints to consider:

- **Security Constraints** - Theft and anti-tamper protection of the carrying device and its contents are highly important. Devices cannot realistically be left outside buildings unattended (locked or otherwise) as this introduces opportunities for theft and interference. The carrying device must therefore remain with the porter at all times, even when ascending floors within buildings.
- **Weight Constraints** - According to the UK government workplace guidelines (Health & Safety Executive, 2012), suggest that the average male should lift no more than 25kg. Carrying devices therefore need to be capable of carrying weights is this region. Providing porters with a wheeled device can assist the porter's weight carrying capacity especially when moving on-street between delivery addresses.
- **Volume Constraints** - The size of the carrying capacity is another important consideration. The larger the carrying device, the greater the number of parcels the porter can handle at once, thereby reducing the number of driver replenishments required, and improving operational efficiency.
- **Other Practicality Constraints** - Overly-large carrying devices are more difficult to manoeuvre inside buildings. The carrying device must also be weatherproof as it will be exposed to the elements while the porter is on-street. It needs to be able to be shut or zipped to prevent losing items. It should ideally be self-supporting and able to stand on end. It needs to be sufficiently robust in order to withstand the wear and tear associated with the activities involved in the portering of parcels in a dense urban environment. A side pocket could be useful for storing miscellaneous items such as spare pens or a bottle of water.
- **Cost Constraints** - while providing the above attributes the carrying device needs to be suitably priced so as not to have an important bearing on the cost of the portering operation.

A range of carrying devices were reviewed in order to select a suitable one for the portering trial. These are shown in Table 9.

.

Table 9 - Carrying devices reviewed for use in the live portering trial

Image of bag	Description (including capacity and price)
	*Nimble Scooter XL* 190L Capacity Additional benefit of faster movement; scooter £700 per unit (approx.)
 	*Sports Holdall* 140L Capacity Can be wheeled or carried £30-40 per unit (approx.)
	*Food Delivery Style Rucksack* 100L Capacity £80 per unit (approx.)
	*Mail Trolley with Sack* 220L Capacity £70 per unit (approx.)
	*Royal Mail HCT (or similar)* 360L Capacity (approximated) Can be securely locked. Pricing not available.
	*IKEA Bags* 76L/71L *Capacity (different versions) Could be carried in addition to other modes £3/50p per unit
	*Hockey goalkeepers wheeled bag* 200L capacity £90 per unit (approx.)

The 140 litre wheeled sports holdall similar to the one seen in Figure 17 was selected for the first live portering trial. The second live portering trial made use of the 200 litre wheeled hockey goalkeeper's holdall given its greater size, which was found not to hinder practicality (see Figure 18). It was deemed by porters to be superior due to its stronger self-supporting structure and its ability to stand upright.

Figure 17– The carrying device used in the first live portering trial

Figure 18 – The carrying device used in the second live portering trial

11 Explanation of the live portering trial in Southwark (SE1)

The first live portering trial took place on Wednesday 24 January 2018. The trial took place from Gnewt's depot in Wardens Grove, Southwark and involved a parcel round in the SE1 postcode area close to the depot. This represented Gnewt Cargo's lowest parcel drop density round, and therefore was likely to represent the least beneficial case for portering from the company's perspective. This particular round was also chosen for convenience as it was close to the depot in case any problems arose.

Portering was carried out by four porters, none of whom had any previous experience of parcel delivery or of the area in which the deliveries were to be made. In this sense they represented the most novice porters possible.

The porters were trained in scanning the parcels they would be delivering, and in obtaining the necessary proof of delivery using the Gnewt PDA (Personal Digital Assistant) Smartphone app from the receiver at the delivery point.

A manual sortation method based on the expert driver's knowledge was used to distribute the parcels into portering 'patches' (Figure 16). A manual method based on visual inspection was then used to remove parcels deemed too large and/or heavy for delivery by porters (these were delivering by the driver together with multiple items to same consignee/building, any buildings that were deemed difficult to deliver to in terms of special access or security conditions, and parcel collections).

Wheeled bags with a capacity of 140 litres (Figure 17) were used by porters in this first live trial. Each porter was allocated one of these bags. Additional parcels to be delivered by each porter that did not fit in the first bag were loaded into large sacks which were subsequently brought to the porter on-street for transfer to their holdall.

For the purposes of this trial, the delivery driver only made the deliveries allocated to him and was not responsible for the rendezvous with porters who needed replenishment, this task being undertaken by a manager. As the delivery area was in the immediate vicinity of the depot, all porters started their first bag load on foot from the depot; a second load was transferred to them, at a time and place requested by them, by the manager in their vehicle.

The trial was relatively busy in terms of parcel deliveries required (due to January sales period) with 190 parcels handled in total (compared with the average of 124 parcels observed on this round during the 14th-16th November 2017 pre-trial surveys – approximately 50% more parcels).

A WhatsApp group was established between the driver/manager and the porters. Porters used this WhatsApp group and 'location finder' facility to communicate their whereabouts to the driver for the rendezvous for delivery of the first and subsequent bag loads. Each porter was allocated 2-3 bag loads of deliveries. When porters received their second and third bags from the driver/manager, they loaded these from the sack into their portering bag at the kerbside.

The drivers/vehicles and porters were all monitored using GPS tracking devices (either stand-alone or iPhone-based) so that their routes and timings would be available for subsequent analysis.

The first live trial helped to prove the concept could work operationally and highlighted some of the challenges faced in practice and identified areas for improvement, relating to:

(i) The communications system and Apps used, particularly for providing routing and navigation advice
(ii) The parcel sorting method and alternatives that would rely less on an expert driver

(iii) The bags used and the delivery process
(iv) How the delivery driver may also serve porters.

Figure 19 - Sortation of parcels in the depot during the Southwark portering trial

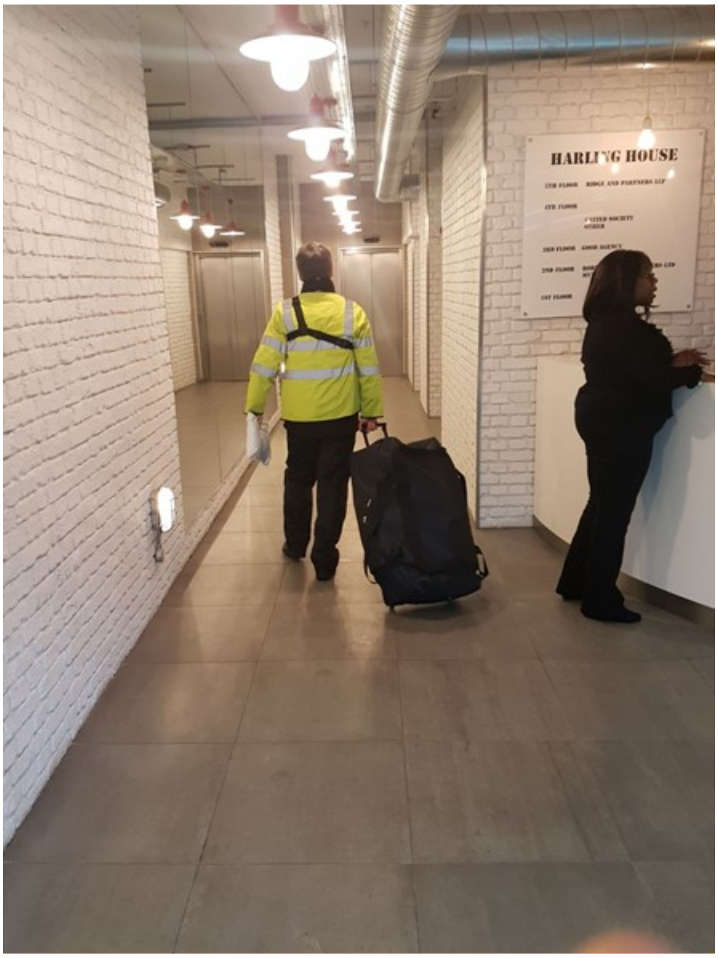

Figure 20 - One of the porters making a delivery during the Southwark trial

12 Results of the live portering trial in Southwark (SE1)

The live portering trial in Southwark (SE1) involved the handling of 195 parcels. Figure 21 shows the allocation of consignee addresses visited by the four porters and the driver. This indicates that in his manual sortation of the parcels, the driver decided to retain the majority of the local deliveries that he usually undertook on foot.

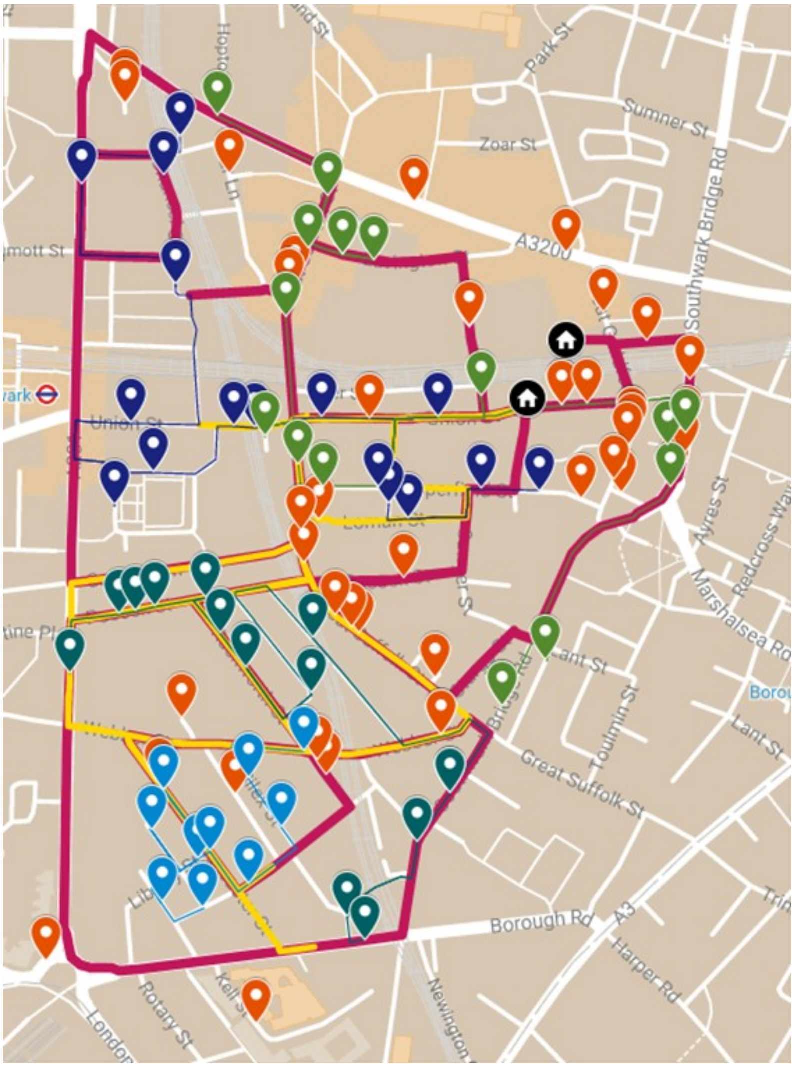

Figure 21 – Locations visited by 4 porters and driver (orange) in Southwark trial

Key:

Porter 1 = light green

Porter 2 = light blue

Porter 3 = dark blue

Porter 4 = dark green

Overall, the driver delivered 53% of the parcels, leaving only 47% for the porters. This was a higher percentage than expected or desired for the purposes of the trial (see Table 10).

Although the porters delivered 47% of all the parcels, their share was slightly higher in terms of total consignees visited (49%) and total buildings visited (56%). The relatively high percentage of parcels for the driver is explained by him taking multiple items destined for the same consignee or building for bulk delivery by vehicle: for example, the driver delivered 15 parcels to 10 different consignees at one building very close to the depot.

Ninety-one separate buildings were identified in the data of which only six were visited by both driver and porter, either by design (e.g. treating two consignees in same building separately) or by accident.

The filled porter bags weighed between 9.0 and 19.6 kg with an average weight of 14.5 kg and a total weight of 116 kg.

Table 10 – Subdivision of work in Southwark trial

	Parcels		Consignees		Buildings		Weight (kg)	
	#	%	#	%	#	%	Bag1	Bag2
Driver	103	53%	79	51%	43	44%		
Porter 1	29	15%	24	15%	15	15%	13.9	9
Porter 2	15	8%	13	8%	10	10%	19.6	18.3
Porter 3	26	13%	21	13%	16	16%	12.8	14.6
Porter 4	22	11%	19	12%	13	13%	15.2	12.7
Total (porters)	**92**	**47%**	**77**	**49%**	**54**	**56%**	**116**	
Total (all)	**195**	**100%**	**156**	**100%**	**97**	**100%**		

Porter performance – actual and optimised

In total the four inexperienced porters took a combined actual time of 12 hr 9 mins to deliver the parcels allocated to them, including any breaks taken. However, this was known to be highly inefficient for various reasons, including:

(i) Lack of knowledge of street and specific building locations resulting in porters frequently walking in the wrong direction and having to double back on themselves (the PDA provided some locational support but was not particularly user friendly and consequently not well used)
(ii) Inexperience in deciding in what order to make deliveries
(iii) Inexperience in packing the bag at the depot and subsequently finding parcels in the bag at the delivery point
(iv) Their lack of familiarity with the PDA system to obtain proof of delivery from consignees
(v) Heavy rain hampering progress throughout the trial.

Theoretical optimal times and distances were calculated for porters, with the aid of Optimap, to provide an indication of what might be possible with more experience (Table 6). For each porter, latitude/longitude coordinates for each location visited were obtained and mapped, then different start and end points were chosen (at opposite ends of area covered) and the optimal A-Z walking route calculated (Table 11). These routes did not consider the walking to and from the depot that actually took place at the start of the porters' delivery work on the basis that, in future, with the Gnewt depot moving, the porters would not do this and would be served by a driver (for all bag loads).

The optimal porter routes ranged from 700m to 1.58km with a combined total of around 5km and a total estimated on-street walking time of 1hr 18 mins, excluding time spent within buildings. Indeed, using an assumed average of two minutes per consignee within buildings (derived from experienced drivers in earlier survey work) more time would be spent by porters within buildings than walking, with an estimated total time in buildings of 2hrs 34mins (Figure 22).

The total estimated optimal portering time of 3 hr 52 mins is therefore considerably less (70%) than the actual time taken by the inexperienced porters in the live trial of 12 hr 9 mins. This optimal portering time represents the time it would be expected to take porters with some parcel delivery experience and equipped with an App that provides a routing/location finding capability to guide them to the relevant building or with local knowledge of the area in which they are delivering.

Table 11 – Time and distance estimates for porters and actual time in the SE1 trial

	From Optimap		Time at consignees (@2 mins /consignee)	Time with parcel carrier (@2 mins/ handover)	Optimal total time (handover + walking + consignee)	Actual total time taken by inexperienced porters in the trial (inc. breaks)
	Walking time	Distance (km)				
Porter 1	00:19:46	1.58	00:48:00	00:04:00	01:07:46	03:54:00
Porter 2	00:08:41	0.70	00:26:00	00:04:00	00:34:41	01:44:00
Porter 3	00:18:50	1.51	00:42:00	00:04:00	01:00:50	03:23:00
Porter 4	00:15:14	1.23	00:38:00	00:04:00	00:53:14	03:08:00
Total	**01:02:31**	**5.02**	**02:34:00**	**00:16:00**	**03:52:31**	**12:09:00**

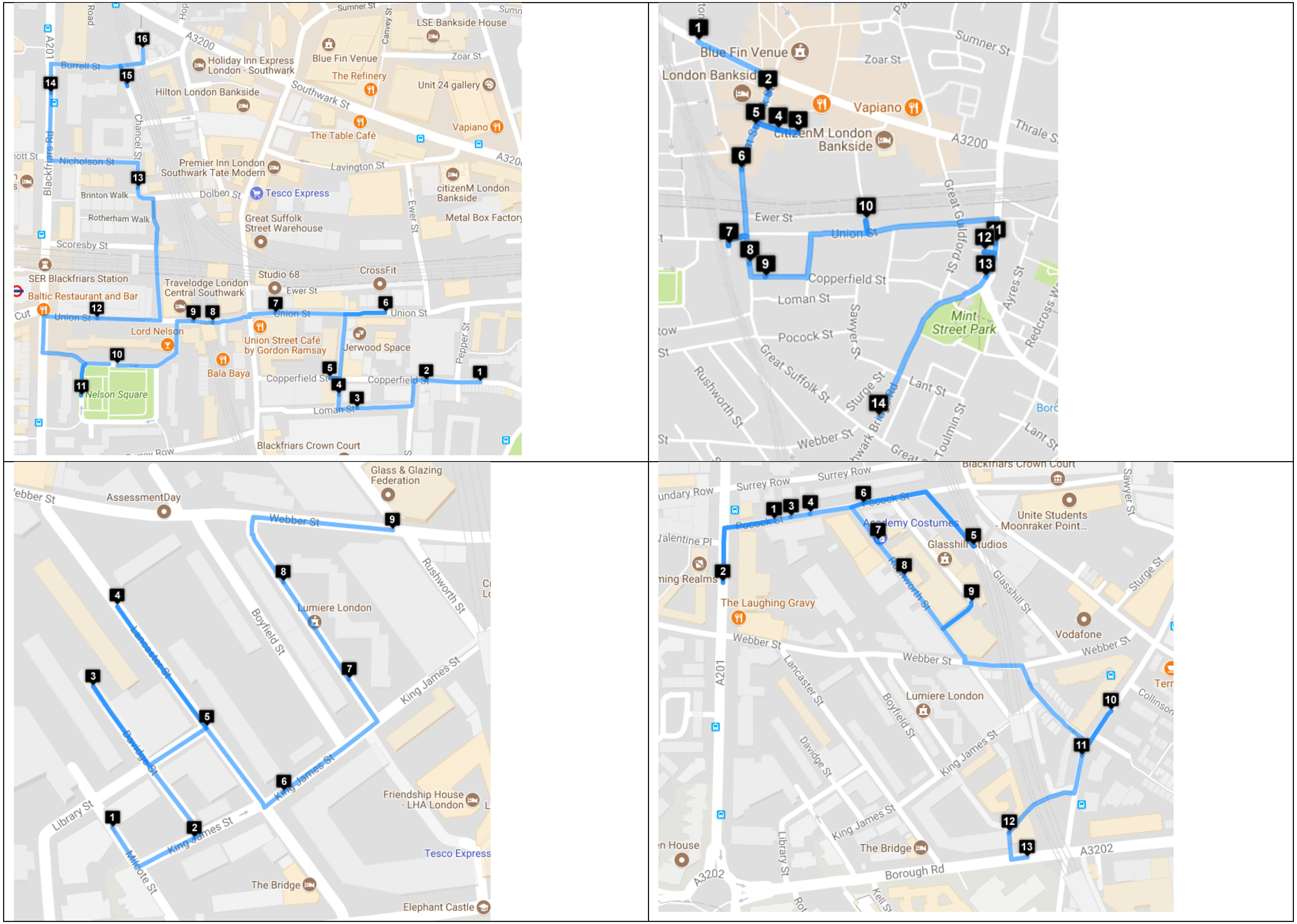

Figure 22 – Optimal walking routes for porters (from top left, clockwise: Porter 3, Porter 1, Porter 4, Porter 2)

Vehicle performance – actual and optimised

Driving routes were obtained from the RouteTracker2 App installed on the survey IPhone kept in the vehicles. The driving distance for the delivery driver was 10.2 km (Figure 23). When compared with the usual driving distance the results suggested that driving distance was not saved. The driver returned twice to the depot and collected/completed any deliveries that the porters have been unable to carry out (due to the carrying capacity limits of the bags or porters running out of time) which increased the distance driven during the portering trial.

The actual time taken by the driver from first delivery to the last was 5 hrs 12mins, but the breaks taken by the driver suggested that the total time taken for the delivery work was no more than 3hrs 39 mins.

In terms of the kerbside parking time savings compared with a normal day, the driver was estimated to have saved at least 2 hr 34 mins parked time at the kerbside, as a result of the use of porters. This is based on the time saved from the driver not having to serve the 77 consignees visited by porters at an assumed 2 minutes per consignee. This represents approximately a 50% reduction in kerbside parking time.

In terms of vehicle driving time, an optimal time taken from first to last delivery of 3 hr 33 mins was estimated for the delivery driver (see Table 12) (the driving distance of 6.44 km is based on an Optimap route around all the locations visited, and the driving time of 55 mins is based on a driving speed of 7 kph from previous survey work carried out in the area).

Table 12 – Time and distance estimates for delivery driver

Driving time	Distance (km) (from Optimap)	Estimated time at consignee (2 mins/consignee)	Total time
00:55:12	6.44	02:38:00	03:33:12

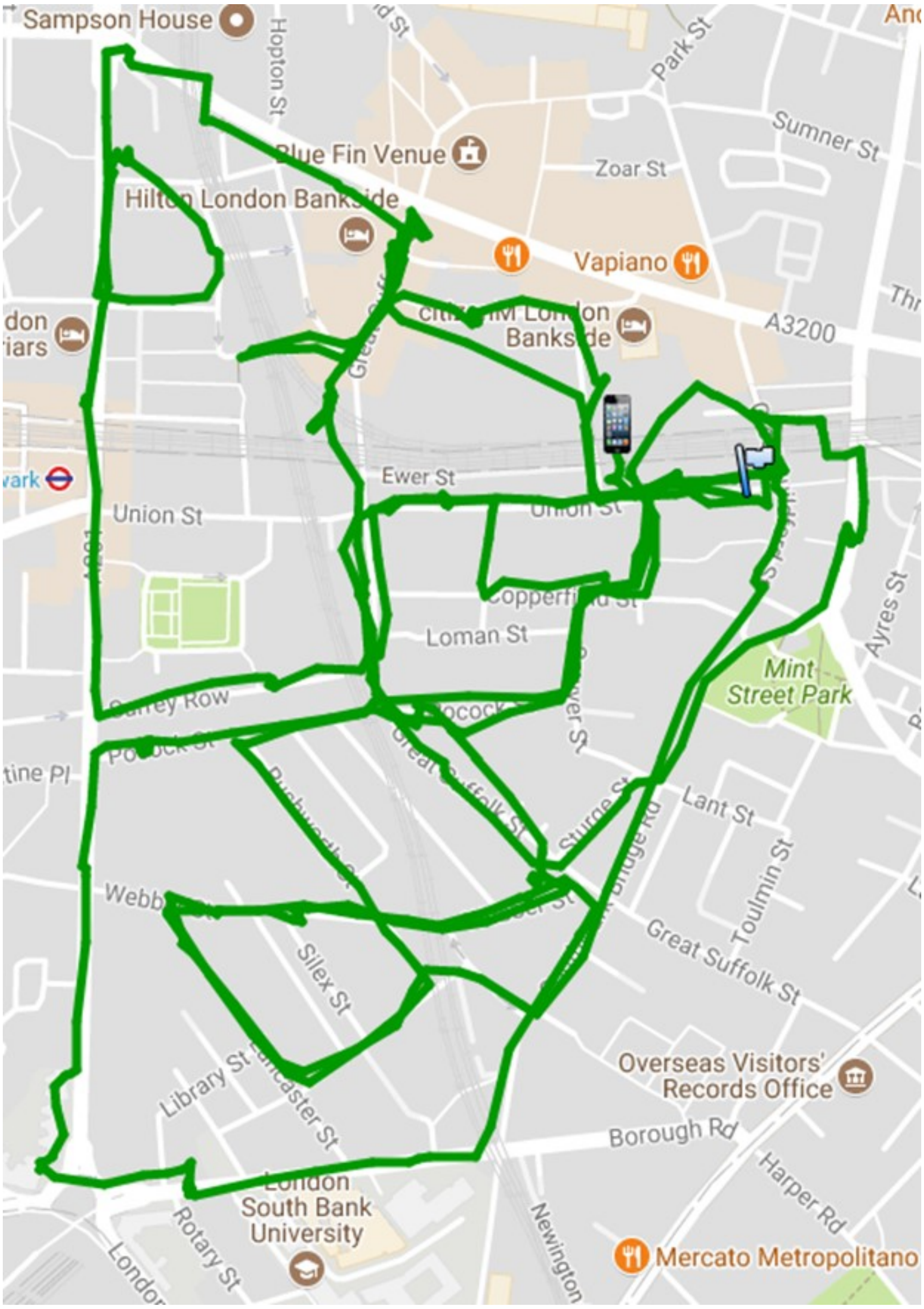

Figure 23 – Actual driving route for driver delivering large, heavy parcels (from IPhone App)

The driving distance for the manager who replenished porters with more parcels when requested was 5.5 km (Figure 24) with rendezvous times and locations as shown, one of these (porter 1) being at the depot; however this included two extra trips visiting some porters to check how they were doing so would not be representative of normal practice. Only one rendezvous was made with each porter as the porters all packed their first bag and walked from the depot. In future practice, such walking from the depot would not normally be possible and all bags would have to be taken to porters waiting at mutually convenient locations (i.e. relatively close to delivery points and with somewhere safe to stop and transfer parcels). An optimal route visiting the porters in order of requested times, starting and ending at the depot is only 2.1 km (Figure 25).

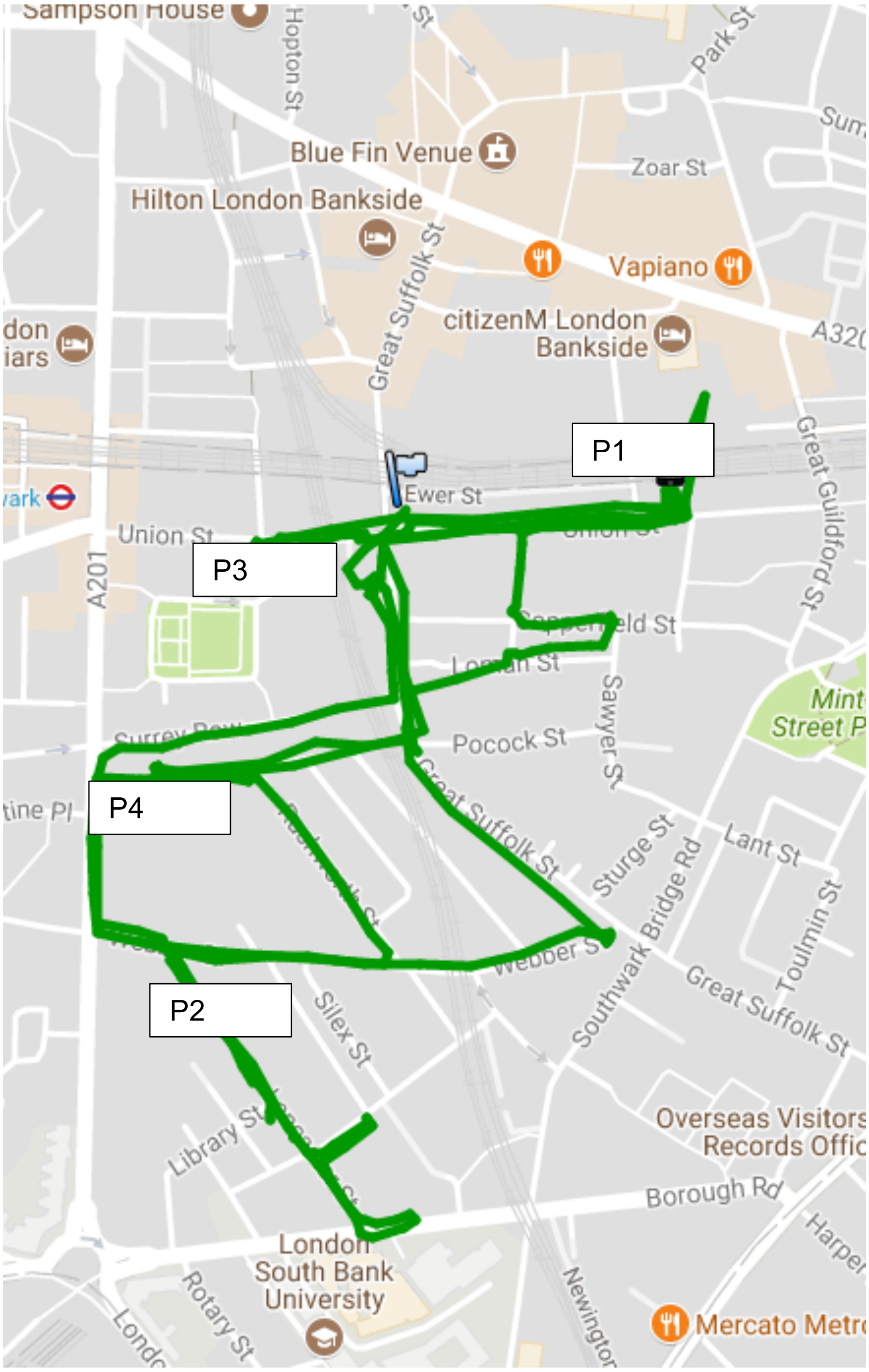

Figure 24 – Actual driving route for driver/managing replenishing porters and meeting times with porters (P1-P4)

(Note: includes extra vehicle trips to check on porters' progress)

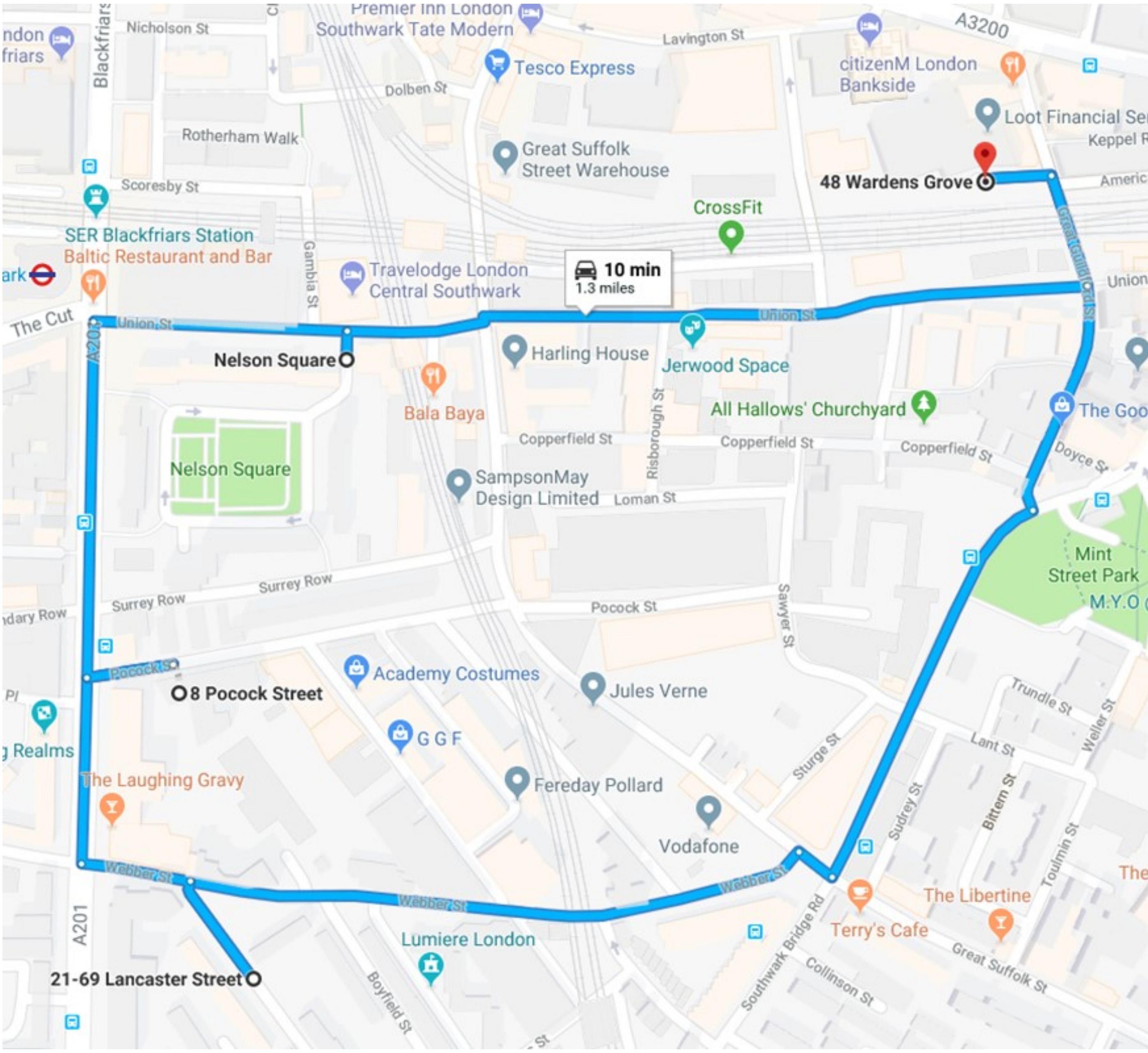

Figure 25 – Optimal driving route for driver serving porters

Following the first live trial, it was decided that the delivery driver should also serve the porters thereby reducing the vehicle fleet requirements for the portering trial from two to one vehicle. If portering were operated on a sufficiently large scale it would be possible to consider whether the driver delivery tasks should be separate from or combined with the task of serving porters. The latter would likely be easier operationally and would prevent disruptions and deviations for drivers making deliveries; however, it would likely need more vehicles and drivers. An alternative solution could make use of static storage facilities (such as available TfL space in Underground stations or recognised drop-off facilities) where porters bags could be delivered by a driver in a van and from which porters could collect additional bags as required.

13 Explanation of the live portering trial in the City of London (EC3)

The second live portering trial took place on Friday 9 March 2018 from Gnewt's new depot in Bromley-by-Bow and involved merging together parts of two existing vehicle rounds in the EC3 postcode area in the City of London (Figure 26). Part of the area includes the round covered by Driver B in the business-as-usual study (Table 1). This area represents Gnewt Cargo's highest parcel drop density area, and therefore is likely to represent the most beneficial case for portering from the company's perspective. The trial involved the handling of 279 parcels.

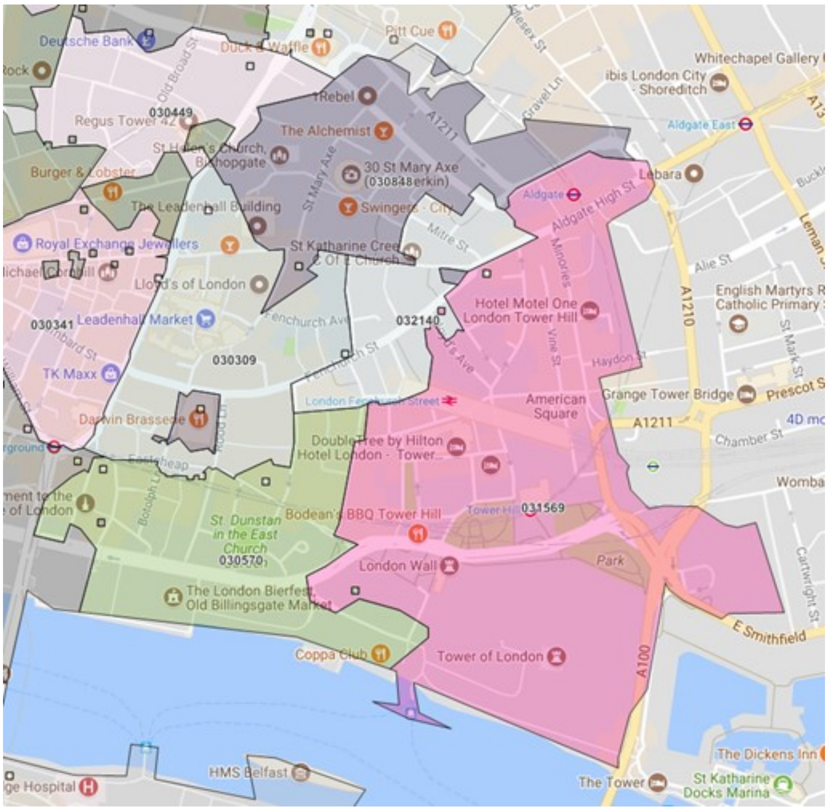

Figure 26 – Gnewt subround areas covered in trial (not including subrounds 030449 and 030341) (Google Maps & Gnewt Cargo, 2018)

Portering was carried out by three porters, all of whom had substantial previous experience of both parcel delivery and the EC3 area. These porters required no training in scanning the parcels they would be delivering, or in how to obtain the necessary proof of delivery and were served by one vehicle and driver.

Wheeled bags with a capacity of 200 litres were used by porters (Figure 18) having a 43% greater volume capacity than the bags used in the first live trial and were more robust and capable of standing upright. Additional parcels to be delivered by each porter that did not fit in the first bag were either loaded into large sacks or into additional, spare bags.

All the porters' bags and additional sacks were loaded onto the vehicle together with the items that the driver would deliver (i.e. large or heavy items and multiple items to the same delivery address). The driver was responsible for rendezvousing with porters who needed replenishment bags as well as delivering the items allocated to him.

A WhatsApp group was established between the driver and the porters with the ‘location finder’ facility being used to communicate their whereabouts to the driver for the rendezvous for delivery of the first and subsequent bag loads. Each porter was allocated 2-3 bag loads of deliveries.

The drivers/vehicles and porters were all monitored using GPS tracking devices (either stand-alone or iPhone-based) so that their routes and timings would be available for subsequent analysis.

For this trial, a more automated sortation method was used with information about the typical delivery addresses and number of items delivered to consignees in the vehicle rounds analysed in advance. This information was used to obtain latitude/longitude co-ordinates of delivery addresses that were then sorted to divide the delivery area into patches running from east to west, each of which accounted for similar levels of daily parcel delivery and collection activity (Figure 27). This approach was adopted as a relatively simple and methodical approach, as opposed to a more ad hoc, manual division of the area; although long thin patches are not likely to be the most efficient in terms of porter walking distances.

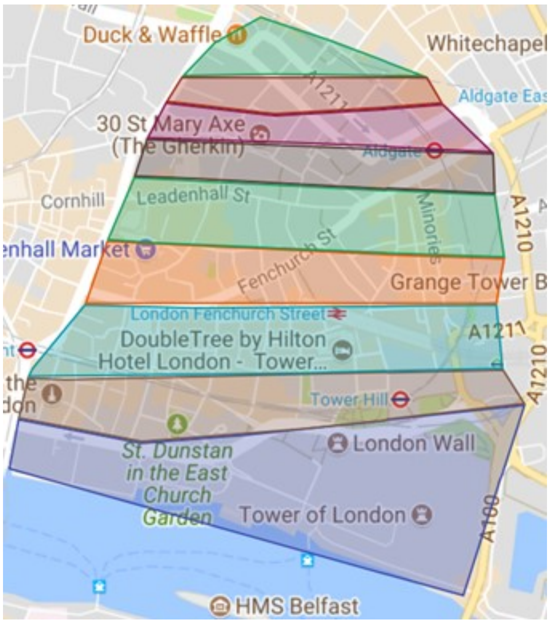

Figure 27 – Patches derived based on lat/long coordinates and historic parcel volumes (Google My Maps, 2018)

The various postcodes within each of the (nine) sections were obtained using an online tool (https://www.doogal.co.uk/FindPostcode.php). On the morning of the trial, parcels were sorted at the depot, using the identified postcodes, into the nine defined patches. All three porters, the driver and management participated in this initial sort. The driver then removed large and heavy items together with multiple items for the same consignee and loaded these directly onto his van. The three porters were then each allocated three adjacent patches and were responsible for sorting their deliveries within each patch into a logical delivery sequence before loading items into 2 or 3 portering bags. These bags were then loaded onto the delivery vehicle along with the items the driver had already loaded for his own delivery.

The porters then travelled to the EC3 area of the City of London, while the driver drove from the depot. Once there, the driver rendezvoused with the three porters to provide them with their first bag of parcels. The driver and porters then proceeded to deliver their allocated items, with porters communicating with the driver via WhatsApp to request bag replenishment when they neared the end of their current load. Images from the trial are shown below (Figure 28 to Figure 32).

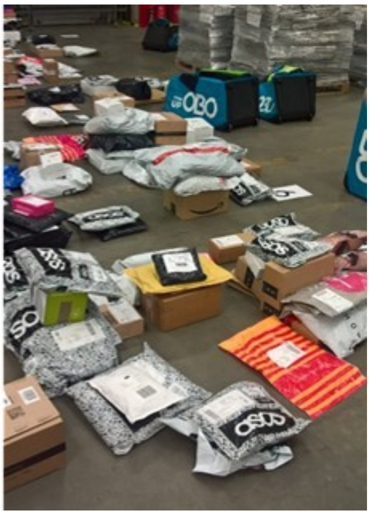

Figure 28 - Parcel sortation for the second live trial in the Gnewt depot

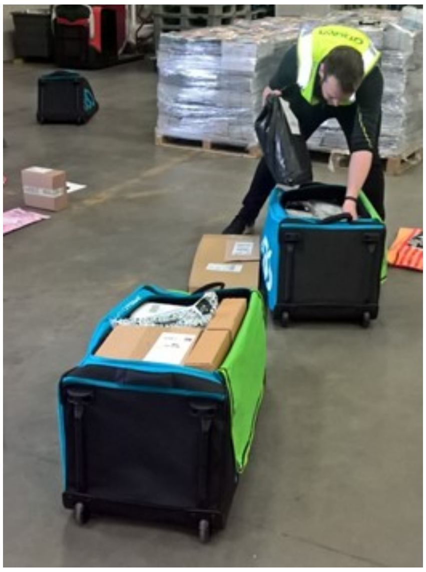

Figure 29 - Filling the portering bags chosen for the second trial with parcels

Figure 30 - The large, heavy and multiple items for the same consignee to be delivered by the driver in the second live trial

Figure 31 - Completion of the sortation and bag filling processes (left) and a porter working on-street with a bag in EC3 (right)

Figure 32 - The van arriving to rendezvous with a porter for a bag replenishment

The second live trial went successfully from an operational perspective, despite the fact that it made use of standard, non-customised communication technology. No problems arose in terms of the delivery of customer's parcels.

A debriefing session was held after the live trial to obtain the thoughts and insights of the porters and depot management team in order to record any difficulties, challenges and opportunities that the trial had helped to identify. All of those involved felt that the trial went well and had functioned according to plan.

14 Results of the portering trial in the City of London (EC3)

Porters handled 61% of the parcels and served 72% of all the consignees, with the driver covering the remainder (Table 13). This represented a greater actual and relative workload for porters than in the first live trial where porters delivered 46% of parcels and served 49% of consignees. As before, the driver carried out more work than was proposed by the pre-trial assessment which had suggested that the porters would cover 90% of all parcels and consignees. This was largely due to driver allocations being done 'by eye', with no measurement of parcel weights or sizes, meaning it was far more difficult to work to the parameters used in the pre-trial assessment. Table 13 shows the distribution of work between the driver and three porters.

Table 13 – Subdivision of work in the City of London trial

	Parcels		Consignees		Number of bags
	#	%	#	%	
Driver	109	39%	33	28%	-
Porter 1	68	24%	29	25%	3
Porter 2	40	14%	27	23%	2
Porter 3	62	22%	27	23%	3
Total (porters)	**170**	**61%**	**83**	**72%**	**8**
Total (all)	**279**	**100%**	**116**	**100%**	

This trial took place from the new Gnewt Cargo depot in Bromley-by-Bow which is further from the central London delivery area and in this respect is similar in its proximity to central London to other parcel carriers' depots with a stem distance from the depot to the EC3 delivery area of 7 km and a one way journey time of approximately 45 minutes.

Figure 33 shows the consignee distribution and traces from the trial. A clear divide between the porter's zones is seen, reducing the inefficiency due to overlap when compared to the first trial. During the trial, only three sites were used for supplying and refilling bags.

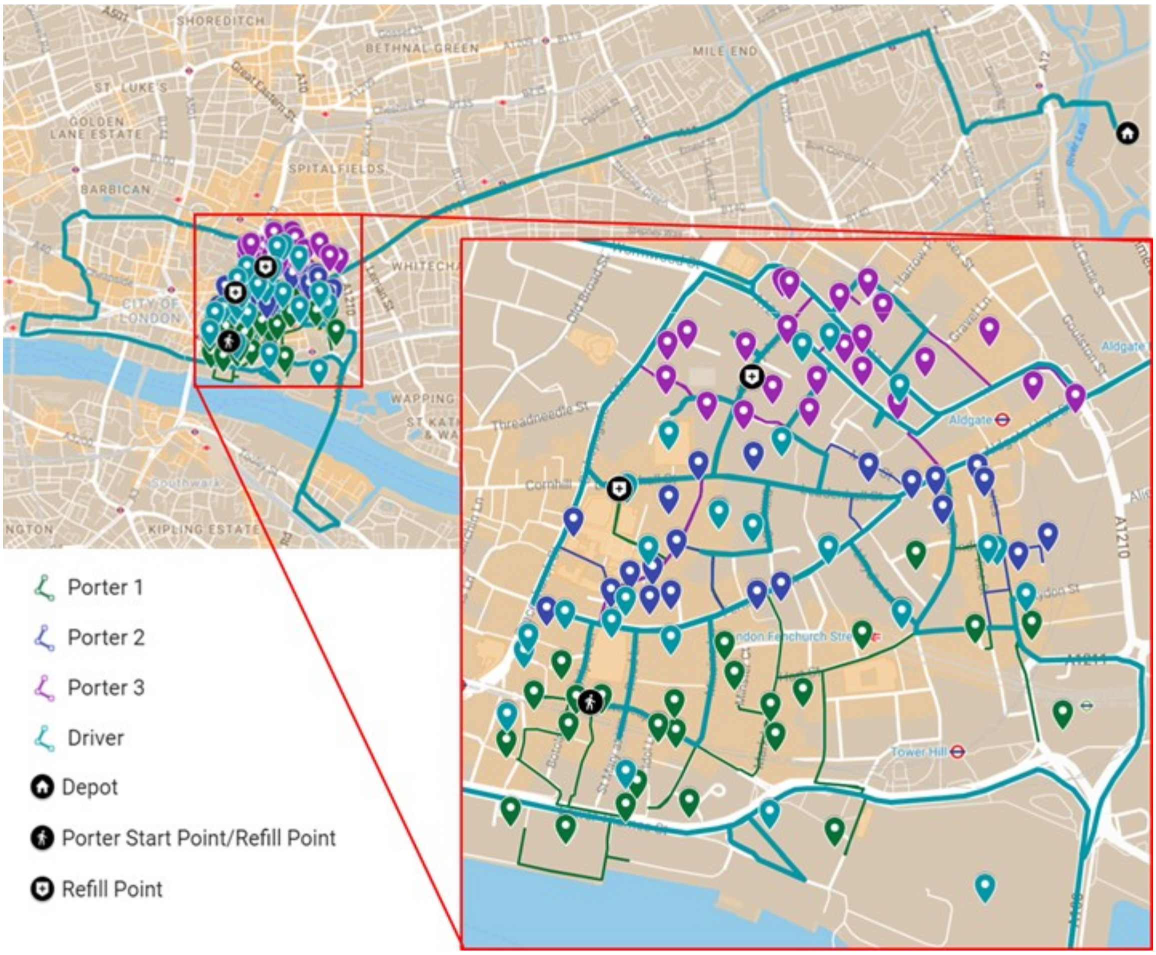

Figure 33 - GPS trace output from the March 2018 portering EC3 area trial (Google My Maps, 2018)

Porter performance

Time and distance measurements for the porters were compared with theoretical optimal values estimated with the aid of Optimap (Table 14). It shows that the 3 porters walked, in total, 15.46km and took 10 hours 11 minutes to complete the work, compared with estimated optimal values of 8.56km and 8 hours 1 minute. If we define 'efficiency' as optimal/actual and express as a percentage, the portering efficiency was 55% in terms of distance walked and 79% in terms of time taken (this percentage being higher as non-walking time was expected to be highly efficient). It should be noted that the optimised values did not take into account any extra time and distance spent getting to and from the meeting points for bag refills. Although the optimised values may be overly optimistic, they suggest that there was still some inefficiency in negotiating the walking element of the work, despite the porters having good knowledge of the area. This may relate to not knowing the locations of some specific addresses or their inexperience in portering, as the job is different from delivering using a van.

Table 14 – Time and distance (actual and optimal) for porters in the EC3 trial

	Actual		Optimal		Time at consignees	Time with parcel carrier (@2 min/ handover)	Optimal total time (handover + walking + consignee)
	Distance (km)	Total time	Walking time	Distance (km)			
Porter 1	6.22	03:42:00	00:45:08	3.42	02:05:52	00:06:00	02:57:00
Porter 2	4.76	02:54:00	00:35:16	2.75	01:34:44	00:04:00	02:14:00
Porter 3	4.48	03:35:00	00:30:50	2.39	02:13:10	00:06:00	02:50:00
Total	**15.46**	**10:11:00**	**01:51:14**	**8.56**	**05:53:46**	**00:16:00**	**08:01:00**

Vehicle performance – actual and optimised

Driving routes were obtained from a GPS tracker positioned in the vehicle; the distance driven was 29.5 km. Optimisation of this round (using Optimap) suggested that it could have been covered in 27 km. Some extra mileage was incurred by the driver due to unfamiliarity with some addresses outside his usual round area and, in the worst case, the driver reported being forced to cross Tower Bridge in a one-way system and then having to turn around and come back. Actual time taken was 6 hours 48 minutes, including stem times from and to depot, although it was estimated that 1 hour 30 minutes was lost due to heavy traffic queuing to travel back across Tower Bridge. For this reason, the total round time was taken to be 5 hours 18 minutes, discounting this lost time (**Error! Reference source not found.**).

The optimised distance estimated for this trial, 27 km, was the same as the driver covered pre-trial (i.e. without the use of porters). Given that the portering trial area covered a geographical area about 50% larger than before (1.5 rounds) it can be deduced that portering reduces driving distance.

Table 15 – Time and distance estimations for delivery driver

Driving time	Distance (km) (from Optimap)	Time making deliveries and replenishing porters	Total round time
02:41:00	27	02:37:00	05:18:00

A more detailed analysis of the breakdown of the total round time between specific driving, porter replenishment and delivery/collection activity is shown in

Table 16.

Table 16 – Detailed breakdown of time spent on various activities by the delivery driver

Driver activities	**Time taken**	**% of total round time**
Total driving time of which:	02:41:00	51%
Stem driving time (to/from depot)	*00:45:00*	*14%*
Driving between deliveries	*01:16:00*	*24%*
Driving to replenish porters	*00:40:00*	*13%*
Total time at kerbside replenishing porters	00:16:00	5%
Total time walking and inside buildings	02:21:00	44%
Total round time	**05:18:00**	**100%**

Portering was estimated to have saved almost 3 hours of vehicle parking time at the kerbside. This represents approximately a 50% reduction in kerbside parking time compared with if the driver had to carry out all the deliveries without the use of porters.

15 Further analysis of the results of the live trials

This section provides further analysis of both of the live portering trials. For both trials, the following performance metrics were calculated:

- Vehicle parking time at kerbside (i.e. the time the vehicle was parked at the kerbside)
- Vehicle driving time (i.e. the time the vehicle was driven for)
- Total vehicle / driver deployment time (i.e. the time that the vehicle and driver were required which includes vehicle driving and parking time)
- Portering time (i.e. the time that porters worked for)
- Total labour time (i.e. driver time plus porters time)
- Total vehicle distance travelled (km – which includes both the stem distance to and from the depot and the distance travelled between deliveries/collections)

These performance metrics have been compared with the Gnewt Cargo delivery driver performance in these same locations pre-trial (from November 2017 data). The workloads differed in the pre-trial operations and operations during the trials in terms of the total number of parcels handled, the total number of consignees and the number of parcels per consignee (Table 17). These fluctuate on a daily basis and it is not possible to operate a trial in which the number of parcels, the number of consignees, and the number of parcels per consignees is the same before and during the trial as these are dictated by user demand and shipment characteristics.

Table 17 - Parcels, consignees and parcels per consignee in the pre-trial operation and the live portering trial

Operation studied	Parcels		Consignees		Parcels per consignee	
	Pre-trial operation	Portering trial	Pre-trial operation	Portering trial	Pre-trial operation	Portering trial
Southwark SE1	123	190	61	156	2.0	1.2
City of London EC3	255	279	77	116	3.3	2.4

Table 18 provides a comparison of the performance metrics between the portering trial in Southwark (SE1) and the pre-trial operation, while Table 19 does the same for the City of London (EC3) trial. To take account of these differences in the workload in the pre-trial operations and the live trials the performance metrics have been expressed on: i) a per parcel basis and ii) a per consignee basis to ensure a standard unit of measurement that is comparable. By providing results on both a per parcel and a per consignee basis helps to indicate the range of impact of portering on the parcel operations studied.

Table 18 - Comparison of the non-portering and portering performance metrics in Southwark (SE1) per parcel and per consignee

	Per parcel			Per consignee		
Metric	**Pre-trial by driver**	**Portering trial**	**% diff.**	**Pre-trial by driver**	**Portering trial**	**% diff.**
Parking time at kerbside (min:sec)	01:00	00:55	8%	02:02	01:07	45%
Driving time (min:sec)	00:48	00:23	52%	01:38	00:28	71%
Total vehicle / driver deployment time (min:sec)	02:08	01:18	39%	04:21	01:35	64%
Portering time (min:sec)	00:00	01:13	-	00:00	01:29	-
Total labour time (min:sec)	02:08	02:31	19%	04:21	03:05	29%
Vehicle distance travelled (m)	63	45	29%	50	54	9%

Key
Improvement
Worsening

Table 19 - Comparison of the non-portering and portering performance metrics in the City of London (EC3) per parcel and per consignee

	Per parcel			Per consignee		
Metric	**Pre-trial by driver**	**Portering trial**	**% diff.**	**Pre-trial by driver**	**Portering trial**	**% diff.**
Parking time at kerbside (min:sec)	01:11	00:34	52%	03:55	01:21	65%
Driving time (min:sec)	00:33	00:35	4%	01:50	01:23	24%
Total vehicle / driver deployment time (min:sec)	01:44	01:08	34%	05:44	02:44	52%
Portering time (min:sec)	00:00	01:43	-	00:00	04:09	-
Total labour time (min:sec)	01:44	02:52	65%	05:44	06:53	20%
Vehicle distance travelled (m)	101	97	4%	335	233	30%

Key
Improvement
Worsening

The analysis shows that both portering trials resulted in improvements in:

- Vehicle parking time at the kerbside (8% per parcel and 45% per consignee improvement in the Southwark trial and 52% per parcel and 65% per consignee improvement in the City of London trial)
- Time taken by driver and vehicle (i.e. driving and parking at kerbside) (39% per parcel and 64% per consignee improvement in the Southwark trial and 34% per parcel and 52% per consignee improvement in the City of London trial).

Vehicle driving time reduced by 52% per parcel and 71% per consignee in the Southwark trial, while it produced an worsening of 4% on a per parcel basis and an improvement of 24% on a per consignee basis in the City of London trial.

Vehicle distance travelled was reduced by 4% per parcel and 30% per consignee in the City of London trial. Meanwhile in the Southwark trial it worsened by 9% on a per consignee basis but improved by 29% on a per parcel basis.

The analysis shows that there was considerable portering time involved in both trials (which obviously had not been required in the pre-trial operations). In terms of the total labour time required (i.e. driver and porters) in the Southwark trial there was a 19% worsening on a per parcel basis but a 29% improvement on a per consignee basis. Meanwhile in the City of London trial there was a worsening in total labour time by 20% per parcel and 65% per consignee.

Greater emphasis should be placed on the results of the second trial in the City of London trial given that it made use of experienced personnel and its results are based on the actual performance of these porters. By comparison, the results of the first portering trial in Southwark are potentially less representative due to the inexperience of the porters and the need to estimate more realistic timings for them and the fact that, at the time of the trial, the stem distance was zero, now changed with Gnewt moving their depot. Table 20 summarises the findings of both trials in terms of the indications they provide about the impact of portering on performance metrics.

Table 20 - Summary of results from the live portering trials compared with pre-trial operation

Performance metric	Indications from trials on impact of portering on performance metrics	Scale of change indicated by City of London trial		Scale of change indicated by Southwark	
		Per parcel	Per consignee	Per parcel	Per consignee
Parking time at kerbside	Potential improvement	52%	65%	8%	45%
Driving time	Potential improvement	4%	24%	52%	71%
Total vehicle / driver deployment time (i.e. parking and driving)	Potential improvement	34%	52%	39%	64%
Portering time	Large increase (as none previously)	-	-	-	
Total labour time (i.e. drivers and porters)	Potential worsening	65%	20%	19%	29%
Total vehicle distance travelled	Potential improvement	4%	30%	29%	9%

16 Costing parcel portering operations in the live trials

For portering to be viable, it has to achieve operating costs that are acceptable to parcel carriers. Therefore an analysis of the costs of the portering live trials were carried out and compared with the costs of the pre-trial system involving drivers carrying out all deliveries.

To carry out this analysis it was necessary to compute vehicle standing and running costs, driver labour costs, portering bag costs and portering labour costs. Vehicle standing and running costs were derived from FTA data for a 3.5 tonne gross vehicle weight diesel-fuelled van (this being the typical vehicle used for parcel delivery and collection). Standing costs taken into account included vehicle acquisition and depreciation costs, vehicle excise duty, and insurance. London Congestion Charging costs were also taken into account as part of vehicle standing costs although these would not be accrued if the carrier used electric vehicles as in the case of Gnewt. For all vehicle standing costs, an eight hour vehicle working day was assumed, which was in accordance with the current Gnewt parcel operations studied. Based on the survey of carrying equipment conducted as part of the project, it was assumed that if a multiple order of portering bags was placed with a bag manufacturer that the purchase cost per bag would be approximately £40. It was assumed that a bag would have an operating life of 100 working days. Depot operating costs and administration and management costs were not included, as these were assumed to remain the same whether or not portering is used.

Running costs taken into account comprised labour, fuel, tyre and maintenance costs. Drivers were assumed to be employed by parcel carriers and paid a rate that was equivalent to the London Living Wage, with employers also responsible for National Insurance contributions, pension contributions, sick pay, holiday pay and maternity/paternity pay. The time taken to train drivers when they are initially engaged was also taken into account. In total, all these indirect labour costs were estimated to be equivalent to 35% of the rate of pay. It was assumed that porters were paid and employed on the same basis as drivers. Table 21 shows the breakdown of these operating costs for a parcel carrier.

Table 21 - Assumed operating costs used in the cost calculations

Cost category	£
Vehicle standing cost per hour (£)	3.71
Vehicle running cost per km (£)	0.41
Portering bag costs per hour (£)	0.40
Driver / porter costs for employer per hour (£)	13.77

These operating costs were applied to the pre-trial and portering trial comparisons shown in Table 18 and Table 19. The results for the Southwark (SE1) operation are shown in Table 22 and for the City of London (EC3) operation in Table 23.

Table 22 - Comparison of the non-portering and portering operating costs in Southwark (SE1) per parcel and per consignee (assuming employment at London Living Wage)

	Per parcel		Per consignee	
Cost category	**Pre-trial by driver (£)**	**Portering trial (£)**	**Pre-trial by driver (£)**	**Portering trial (£)**
Van standing costs	0.13	0.16	0.27	0.20
Van running costs	0.03	0.02	0.02	0.02
Driver labour costs	0.49	0.30	1.00	0.36
Porter labour costs	0.00	0.28	0.00	0.34
Portering bag costs	0.00	0.01	0.00	0.01
TOTAL	**0.65**	**0.77**	**1.29**	**0.93**

Table 23 - Comparison of the non-portering and portering operating costs in the City of London (EC3) per parcel and per consignee (assuming employment at London Living Wage)

	Per parcel		Per consignee	
Cost category	**Pre-trial by driver (£)**	**Portering trial (£)**	**Pre-trial by driver (£)**	**Portering trial (£)**
Van standing costs	0.11	0.07	0.36	0.17
Van running costs	0.04	0.04	0.14	0.09
Driver labour costs	0.40	0.26	1.32	0.63
Porter labour costs	0.00	0.40	0.00	0.95
Portering bag costs	0.00	0.01	0.00	0.03
TOTAL	**0.55**	**0.78**	**1.81**	**1.87**

The costs calculations indicate that, in the City of London, the portering trial was more expensive to operate than the pre-trial operations using only a driver and vehicle. On a per parcel basis, the cost was 43% higher, whereas on a per consignee basis it was only 4% higher. In the case of the Southwark trial, the portering trial was 19% more expensive than the pre-trial operation on a per parcel basis, but was 27% cheaper on a per consignee basis.

Given that greater emphasis should be placed on the results of the City of London trial than the Southwark trial, these findings indicate that portering operations in which the porters are employed on the same rates of pay as a driver may well result in an increase in total operating costs.

Many couriers working in the parcel, grocery delivery and meal delivery sectors are currently self-employed rather than employed, and even among those that are employed the minimum wage is more common than the London Living Wage. Therefore, further cost calculations were carried out based on two different payment rates of self-employment for porters, one assuming that self-employed porters earned a rate equivalent to the London Living Wage, and the other assuming that self-employed porters earned a rate equivalent to the minimum wage. These results for both trials are shown in Table 24.

Table 24 - Comparison of the portering operating costs in the City of London (EC3) trial per parcel and per consignee (assuming various porter employment methods and pay rates)

Employment type	Per parcel		Per consignee	
	Portering labour costs to employer (£)	Total cost of portering trial (£)	Portering labour costs to employer (£)	Total cost of portering trial (£)
Pre-trial operation with driver and vehicle (i.e. no porters)	0.00	**0.55**	0.00	**1.81**
Trial: Porters employed on London Living Wage	0.40	**0.78**	0.95	**1.87**
Trial: Porters self-employed on London Living Wage	0.29	**0.68**	0.70	**1.63**
Trial: Porters self-employed at a rate equivalent to minimum wage	0.23	**0.61**	0.55	**1.47**

The results indicate that, as expected, these less expensive self-employment methods of portering payment reduce the total cost of the portering trials. The results on a per parcel basis indicate that the total costs of the pre-trial operation would remain cheaper than portering even if using self-employed porters earning equivalent to the minimum wage. However, the results on a per consignee basis suggest that the use of self-employed porters earning equivalent to the London Living Wage or the minimum wage would produce lower total costs than the pre-trial operation.

17 Analysis of porters handling a greater proportion of parcels / consignees

An analysis was also carried out in the operational effects and operational costs of giving a greater proportion of parcels to the porters than happened in the trials. Rather than the 61% of parcels and 70% of consignees that the porters served in the City of London (EC3) trial, in this analysis it was assumed that porters would serve 90% of all parcels/consignees and the driver only 10%, as calculated as feasible in the pre-trial analysis.

Given that, in this analysis, the total number of parcels and consignees handled in the trial do not alter, it has been possible to express the performance metrics in terms of the total time and distance involved in carrying out these portering and vehicle/driver operations. The results are shown in Table 25.

Table 25 - Analysis of the impact on performance metrics if the porters had carried out more of the work in the City of London (EC3) per parcel and per consignee

	Per parcel			Per consignee		
Performance metric (mins:secs)	**Porter 61% : Driver 39% (actual trial situation)**	**Porter 90% : Driver 10% (simulation)**	**% diff.**	**Porter 70% : Driver 30% (actual trial situation)**	**Porter 90% : Driver 10% (simulation)**	**% diff.**
Parking time at kerbside	0:34	0:10	71%	1:21	0:32	61%
Driving time	0:35	0:20	41%	1:23	0:52	38%
Total vehicle / driver deployment time (i.e. parking and driving)	1:08	0:30	56%	2:44	1:23	49%
Portering time	1:44	2:33	48%	4:09	5:13	26%
Total labour time (i.e. driver plus porters)	2:52	3:03	7%	6:53	6:36	4%

Key
Improvement
Worsening

The results of the analysis indicate that giving porters 90%, rather than 60%, of parcels would result in substantial reductions in total vehicle parking time at kerbside, total vehicle driving time, and the total time that a driver and vehicle were required for. Total portering would, as expected, increase, which would lead to a small increase in total labour time. The vehicle distance and time savings would have further social benefits in terms of reductions in greenhouse gases and local air pollutant emissions.

Table 26 shows the operational costs of giving 90% of all parcels to porters in the City of London EC3, compared with the 61% of parcels that porters actually handled in the portering trial. The results indicate that this would result in a cost reduction of 1% per parcel and 9% per consignee compared with the actual results of the City of London EC3 portering trial.

Table 26 - Analysis of the impact on operating costs if the porters had carried out more of the work in the City of London (EC3) per parcel and per consignee (assuming porters are employed and paid the London Living Wage)

	Per parcel	Per consignee

Cost category	Porter 61% : Driver 39% (actual trial situation) (£)	Porter 90% : Driver 10% (simulation) (£)	Porter 70% : Driver 30% (actual trial situation) (£)	Porter 90% : Driver 10% (simulation) (£)
Van standing costs	0.07	0.03	0.17	0.09
Van running costs	0.04	0.03	0.09	0.06
Driver labour costs	0.26	0.12	0.63	0.32
Porter labour costs	0.40	0.58	0.95	1.20
Portering bag costs	0.01	0.02	0.03	0.04
TOTAL	**0.78**	**0.77**	**1.87**	**1.70**

Table 27 shows the comparison of performance metrics from the City of London pre-trial operation (i.e. with no portering) with the results from the analysis of 90% of all parcels and consignees handled by porters, with drivers performing the remaining 10%. It indicates the potential scale of improvements in kerbside parking time and driving time if it had been possible to provide porters with 90% of parcels/consignees in the City of London trial.

Table 27 - Comparing the pre-trial operations with the analysis of porters carrying out 90% of the work in the City of London (EC3) per parcel and per consignee

	Per parcel			Per consignee		
Performance metric (mins:secs)	**Pre-trial by driver**	**Porter 90% : Driver 10% (simulation)**	**% diff.**	**Pre-trial by driver**	**Porter 90% : Driver 10% (simulation)**	**% diff.**
Parking time at kerbside	01:11	00:10	86%	03:55	00:32	86%
Driving time	00:33	00:20	39%	01:50	00:52	53%
Total vehicle / driver deployment time (i.e. parking and driving)	01:44	00:30	71%	05:44	01:23	76%
Portering time	00:00	02:33	-	00:00	05:13	-
Total labour time (i.e. driver plus porters)	01:44	03:03	76%	05:44	06:36	15%

Key
Improvement
Worsening

The cost calculations indicate that if porters had handled 90% of parcels and consignees in the City of London EC3 portering live trial this would have resulted in a cost per parcel of £0.77 compared with £0.55 in the pre-trial operation (i.e. with no portering) and a cost per consignee of £1.70 compared with £1.81 in the pre-trial operation (i.e. with no portering).

18 Analysis of the impact of parcel portering in the London Central Activities Zone

Analysis was carried out to gain insight into the potential effects of parcel portering if it was implemented on a larger scale in central London. Also, as explained in section 3.1, the two vehicle rounds in Southwark and City of London that were studied in the live trial are carried out by high-performing drivers and have operational and geographical features that make them efficient operations. By carrying out an analysis of portering across a wider area of central London it was possible to use data from the larger 2016 survey of parcel operations in the West End for estimating the transport impacts and costs of current (i.e. pre-portering) parcel activity. These operations in the West End were found, on average, to be considerably less efficient than in the case of Driver A and B's performance (see section 3.1). As well as providing insight into the potential impacts of portering at a greater scale than the live trials, this analysis also permitted comparison of portering with a current operation with a lower efficiency than in the vehicle rounds of Driver A and B in Southwark and the City of London, and which may therefore be more typical.

In order to carry out this analysis at a larger scale, it was first necessary to estimate the total number of parcels delivered in central London annually. In 2016 approximately 2.8 billion parcels were handled in the whole of the UK, of which approximately half were sent from business-to-business (B2B) and approximately half were sent from business-to-consumer (B2C) (Allen et al., 2016; Ofcom, 2015; Royal Mail, 2013; Mintel, 2017). In addition, forecasts estimate a 33% increase in the volume of parcels handled in the UK between 2016 and 2021, with much of this growth being contributed by ecommerce and online retailing (Mintel, 2017).

The Central Activities Zone (CAZ) which comprises central London is approximately 30 km^2 in size, which is equivalent to only approximately 2% of the land mass of Greater London and only 0.01% of the land mass of the UK. However, despite its small size, it is responsible for 1.7 million jobs, and is home to approximately 250,000 residents (Mayor of London, 2016). This is equivalent to approximately 5.3% of all jobs in the UK and 0.4% of all entire resident population (Office for National Statistics, 2017). In terms of economic output, the CAZ Zone accounts for approximately 10% of the Gross Value Added of the entire UK (Mayor of London, 2016).

Using this data, it was assumed that central London is responsible for:

i) 7.5% of all B2B parcels handled (i.e. approximately 50% greater than the CAZ's importance in terms of jobs given its economic importance and the prevalence of its service sector which is a major generator of parcel traffic)

ii) 2.5% of all B2C parcels handled (an estimate that is several times the relative importance of the resident population in order to reflect their wealth and buying power, together with the prevalence of employees choosing to receive personal online orders at their workplaces).

Applying these assumptions, London's CAZ was estimated to account for approximately 135 million parcels annually (see Table 28).

Table 28 - Estimate of the parcels handled annually in central London

Parcels sector	Estimated parcels handled annually in central London
Business-to-business (B2B)	101.25 million
Business-to-consumer (B2C)	33.75 million
Total	135.0 million

Efforts were then made to estimate the current overall annual transport impacts of this parcel activity in the London CAZ (i.e. without portering) in terms of vehicle driving distance and time and kerbside parking time. To carry out this analysis, several key assumptions were made:

- Parcel carrier operating data derived from 2016 survey of existing parcels operations in the West End of central London in 2016 was used to estimate current transport operations (i.e. without portering). This made use of data concerning interdrop distances, parking times, stem and interdrop driving times.

- All parcels are handled from depots with stem distances of 11.5 km from the London CAZ (based on survey work with a major parcel carrier in 2016 that was felt to be indicative of other carriers' depot locations serving central London).

- All parcels are currently handled using 3.5 tonne gross weight vans (the dimensions of a medium-wheelbase normal roof-height Mercedes Benz Sprinter van were used).

- All vehicle parking while deliveries and collections are made takes place at the kerbside on-street.

Efforts were then made to calculate the impact of applying portering to these current parcel operations in London's CAZ. In addition to the stem distance and other operating assumptions explained above for the current operation, the following assumptions were made for the portering calculations:

- The portering operation would be operated as in the live trials, with porters being provided with bag loads of items for delivery by vehicle drivers.

- All bag handovers to porters take place at the kerbside on-street (as in the live trials).

- The bags used would be the 200 litre bags used in the City of London portering trial (with dimensions of 0.95m x 0.45 m x 0.45 m).

- Porters would be responsible for handling 90% of parcels, while drivers would handle the remaining 10% of large/heavy items and large quantities of items for the same consignee.

- Given the scale at which this parcel portering would be operated, it was assumed parcel carriers would operate two separate types of vehicle operation – first, a fleet of vans that would be dedicated to replenishing porters with additional bags of parcels as they require them, meeting them at the kerbside as in the live trials. Meanwhile, a second, separate fleet of vans would be used by drivers to deliver the large /heavy items and bulk loads for a single consignee as in current parcel operations. This use of two separate vehicle fleets with separate tasks is identical to the operation used in the Southwark live trial.

- Handovers of bags by drivers to porters at kerbside take 2 minutes per bag – as calculated from the live trials (during which time the driver has to park the vehicle, find the bag, and give it to the porter).

- Parking time taken per parcel in portering operations by drivers delivering large/heavy items is 50% greater than in current (non-portering) operations. This was derived from the City of London trial and is due to the reduction in the number of parcels a driver can carry at any one time given their weight/size.

- Inter-drop driving time and distance per parcel in portering operations by drivers delivering large/heavy items is 100% greater than in current (non-portering) operations, due to the reduction in drop density on these rounds.

- Vans used in portering operations by drivers delivering large/heavy items can only carry 30% as many parcels as those typically carried in current (i.e. non-portering) operations (due to the greater average parcel size carried).

Two portering scenarios were analysed. In scenario 1, it was assumed that both van fleets, that is, i) those used to replenish porters, and ii) those used to deliver and collect large/heavy items and bulk loads, would be medium wheelbase, normal roof-height 3.5 tonne vans. Scenario 2 differed from 1 in that the vans used to replenish drivers were assumed to be long-wheelbase vans with higher roofs, providing a larger load space capable of carrying twice as many porters bags than the vans used in scenario 1.

Table 29 shows the results of this analysis, providing the comparison of current parcel activities in the CAZ with these two portering scenarios. The analysis indicates that both portering scenarios would be expected to result in major reductions in total vehicle kerbside parking time (of approximately 80%). Scenario 1 would be expected to reduce total vehicle distance travelled (and driving time) by approximately 35%, whereas Scenario 2 would result in vehicle distance and driving time savings of approximately 60%. Savings in total stem driving distance is even greater than total driving distance savings in the CAZ delivery and collection catchment area, indicating that these benefits would take place outside the CAZ (between it and the parcel depots) as well as in inside it. The total vehicle deployment time on the roads (i.e. taking into account driving and parking) would be expected to fall by approximately 60% in scenario 1 and 70% in scenario 2. This would have major benefits for both society and carriers who would have substantially reduced vehicle fleet requirements (but would obviously be subject to the additional portering costs). The vehicle distance and time savings would have further benefits in terms of reductions in greenhouse gases and local air pollutant emissions.

These results can be compared with those in Table 26 that show the effects of the portering trial assuming that 90% of parcels had been handled by porters (rather than the 61% achieved in the live trial). These estimated reductions in kerbside parking time of 86%, vehicle driving time of 39% and total vehicle deployment time of 71% on a per parcel basis. These two sets of results have been arrived at by separate means and thereby provide a cross-check of the potential transport benefits that could be achieved by the adoption of parcel portering.

Table 29 - Analysis of total annual current parcels operations from depot to customers in London's Central Activities Zone compared with portering scenarios (absolute values and percentage improvement on current operation)

	Current operation (i.e. no portering)	Estimated performance of each portering scenario compared with current operation	
		Scenario 1	Scenario 2
Vehicle time taken metrics			
Total driving time (million hours)	3.7	2.5 (-35%)	1.6 (-58%)
Total kerbside parking time (million hours)	5.3	1.0 (-81%)	1.0 (-81%)
Total vehicle deployment time (million hours) (i.e. driving and parking)	9.0	3.4 (-62%)	2.6 (-71%)
Vehicle distance travelled metrics			
Stem driving distance to/from CAZ (million kilometres)	21.0	12.6 (-40%)	7.9 (-63%)
Driving distance between stops in CAZ (million kilometres)	15.0	10.2 (-32%)	6.8 (-55%)
Total driving distance (million kilometres) (i.e. stem plus interdrop driving)	36.0	22.8 (-37%)	14.7 (-59%)

It was possible to estimate the total operating costs of the current (i.e. non-portering) parcel operations in the London CAZ and to compare this with the two portering scenarios. In order to do this it was necessary to use data concerning the time taken by porters to walk between and deliver/collect parcels from the City of London and Southwark live trials. Vehicle, driver and porter labour costs, and portering bag costs information used is the same as that used in the previously presented cost calculations for the live trials. Drivers and porters were both assumed to be employed and earning the London Living Wage. These results are shown in Table 30.

Table 30 - Analysis of total annual costs of current parcels operations from depot to customers in London's Central Activities Zone compared with portering scenarios (assuming employment at London Living Wage)

Cost category	Current operations by driver (£ million)	Portering: Scenario 1 (£ million)	Portering: Scenario 2 (£ million)
Van standing costs	33.6	12.8	9.6
Van running costs	14.6	9.3	6.0
Driver labour costs	124.4	47.4	35.7
Porter labour costs	0	76.7	76.7
Portering bag costs	0	2.4	2.4
TOTAL	**172.6**	**148.6**	**130.5**

These results indicate that the current operational cost of parcels operations from the depot in central London using data from the 2016 West End survey work are approximately £1.30 per parcel. This compares with the lower costs calculated in the pre-trial operations in

Southwark and the City of London of £0.65 and £0.55 per parcel respectively (due to the operational and performance differences discussed in section 3.1).

The results indicate that the annual operating costs of both portering scenarios would be lower than the current operating costs of parcel delivery and collection in the London CAZ. Scenario 1 is estimated to be 14% cheaper, while scenario 2 (in which larger vans are used for replenishing porters) is estimated to be 24% cheaper than the current method of delivery and collection by driver.

19 Opportunities and challenges for parcel portering

Opportunities

The live trial results and associated analyses suggest that parcel portering has potential in terms of its operational efficiency compared with current parcel collection and delivery operations in central London. Both the live trials and additional desk-based analyses indicated that portering can result in reductions in vehicle parking time at the kerbside, vehicle driving time and vehicle driving distance in parcel operations in central London.

Operating costs for portering are potentially greater than those of current parcel driver/vehicle operations, assuming that porters are employed and paid the London Living Wage. However, the wider desk-based analysis of the London's CAZ, which draws on a larger survey of parcel operations in the West End, with, on average, less efficient current operations than in Southwark and the City of London, suggests that portering could lead to both transport and environmental improvements and operating cost savings. Obviously, the impact of portering on operating costs is likely to be an important factor in the uptake of such an approach by parcel carriers in the short term.

It is important to bear in mind that increasing pressures on road space, kerbside space and parcel depot location are likely to make existing parcel operations more expensive and less reliable over time in central London. This, together with the forecast growth in parcel traffic, will pose a considerable challenge to parcel carriers and their customers, as well as increasing the transport and associated social and environmental impacts of these operations.

Portering could also be useful in operations in which there are a sizeable proportion of time-guaranteed parcel deliveries, which currently can be difficult to achieve while maintaining vehicle and driver operational efficiency. Portering makes it possible to deploy numerous porters on-street at the same time without the need for an equivalent number of vehicles. Therefore using porters to meet demands for guaranteed early morning deliveries could prove to be an effective solution for this situation.

In addition, the trial has demonstrated that substantial kerbside parking time reductions (~50%) can be achieved through the implementation of parcel portering and analyses suggested these could be even greater if porters undertook a higher proportion of the work. Further trials could help to determine whether 90% of all parcels deliveries could be achieved by porters and provide first-hand evidence of the additional kerbside parking benefits of this.

The analysis suggests portering could also provide benefits in total vehicle distances travelled and driving time and associated improvements in greenhouse gas and local air quality pollutant emissions, if implemented for all parcels activity across the CAZ.

The greater the scale of any portering scheme, the greater opportunities it provides for vehicle kilometre and vehicle fleet reductions. This is due to these reductions being related to the total quantity of items handled (i.e. the drop density) and the geographical scale at which the scheme operates.

The research carried out as part of this trial has also demonstrated the extent to which those delivering and collecting parcels have to ascend and descend inside multi-storey, multi-tenanted buildings. This results in vehicles having longer dwell times at kerbside than would be the case if deliveries could be made to ground floor loading bay staff or lockers rather than having to be made direct to consignees wherever they happen to be located within the building.

As explained in this report, there are several different operational approaches by which portering could be achieved, in addition to the system trialled in this project.

Challenges

Parcel carriers are facing an ever-more difficult central urban environment in which to carry out their operations. Reducing traffic speeds, together with increasing competition for kerbside space, the increasingly pedestrian-friendly urban realm and ever-tighter vehicle environmental standards will continue to make their tasks more difficult and expensive to carry out than at present. Land costs and availability are resulting in the relocation of parcel carrier's depots ever-further from central London, resulting in longer stem distances being travelled to delivery and collection catchment areas in central London. Portering offers one potential solution by which to help alleviate these challenges.

The research carried out indicates the important of driver knowledge and experience on the transport intensity of parcel operations in central London. Even with the implementation of portering, driver performance will continue to be an important issue, as drivers would still be operating vehicles to replenish porters and delivering items too large/heavy for portering. Efforts should be directed by both parcel carriers and public policy makers to implement technology and training to ensure that novice drivers and drivers operating on vehicle rounds unfamiliar to them are assisted in order to improve their performance, regardless of whether or not portering is implemented.

City transport authorities (including TfL and central London boroughs) should consider the role that portering could play in providing less transport-intensive delivery and collection solutions. Solutions including portering are likely to becoming ever-more important as policy makers strive to make central London more pedestrian-friendly and reduce the traffic and environmental impacts associated with freight transport.

Actions that these public sector organisations could consider taking to support portering include a review of existing kerbside facilities to support portering (including greater flexibility in where vehicles replenishing porters can stop given the short duration of these stops), and whether portering facilities such as storage locations for portering bags can be made available at appropriate costs.

Public policy makers should also consider policies that would help to reduce the need for delivery drivers having to spend considerable time inside multi-storey buildings and the consequent kerbside vehicle dwell times this results in. There is scope for use of the planning system to address this issue.

Public policy makers also have an important role to play in assisting freight companies and the individuals working for them making deliveries and collections, by helping to make available the exact location of the building entrance via which such deliveries should be made (which is often not the registered building entrance, especially in the case of large buildings). This data could be collected by policy makers working with Business Improvement Districts and building owners and tenants and then made publicly available for use in routeing software and for consultation by drivers and porters.

Parcel carriers would need to make changes to their existing hub sortation systems to make portering as efficient as possible. This would include the installation of equipment to capture sizes and weights of parcels handled. The use of this data would facilitate the sortation of parcels into those to be delivered by porters and those more suited to delivery by vehicle and driver. These data could also be utilised by parcel carriers to put in place hub sortation by portering patch rather than the current approach of sortation by vehicle round. Conversations with parcel carriers suggest that the technology required to achieve the collection of this data already exists and could therefore be implemented in a reasonable timescale if parcel carriers wished to engage in portering.

Parcel carriers choosing to adopt portering would need to put in place a suitable communications and work allocation platform to enable the efficient distribution of work to porters both digitally and at the kerbside.

If parcel carriers chose to adopt portering systems, it would be most efficient for them to collaborate and use a shared network of porters, rather than each using their own dedicated porters. However, history suggests that parcel carriers are typically reluctant to work jointly on operational innovation. This suggests a further role for public policy makers in helping to foster operating systems that generate the greatest transport and social benefits.

Further work would be required to determine whether the size and weight distribution of parcels handled by other carriers is comparable to the findings of this project with Gnewt Cargo. This is necessary in order to determine the extent to which the portering concept proposed in this trial could be readily applied to other parcel carrier's operations. Additional information that could be acquired from other carriers to help assist understanding of the potential benefits of portering would include the proportion of time guaranteed collections and deliveries they handle and the overall performance of their current vehicle operations in central London.

20 References

Allen, J., Piecyk, M. and Piotrowska, M. (2016) An Analysis of the Parcels Market and Parcel Carriers' Operations in the UK, Freight Traffic Control 2050 project report.

Armstrong, J. (2001) 'From Shillibeer to Buchanan: transport and the urban environment', in M. Daunton (ed.), Cambridge Urban History of Britain, Volume 3 (Cambridge), 229.

Barker, T. (1988) Urban transport, chapter in Freeman, M. and Aldcroft, D. (eds) Transport in Victorian Britain, Manchester University Press, Manchester, p.136.

Earle, P. (1994) A City Full of People: Men and Women of London 1650-1750, Methuen, London.

Health & Safety Executive, 2012. Manual Handling at Work, HSE.

Mintel (2017) Delivery Market Posts £1 Billion Increase in Sales in 2016, press release, 5 July.

Mayor of London (2016) Central Activities Zone: Supplementary Planning Guide, Greater London Authority.

Ofcom (2015) Annual Monitoring Update on the Postal Market: Financial Year 2014-15, Ofcom.

Office for National Statistics (2017) UK labour market: Apr 2017, Office for National Statistics.

Piecyk, M. and Allen, J. (2017) Land availability in London, Logistics and Transport Focus, November, pp.38-40.

Royal Mail (2013) Full Prospectus, Royal Mail.

Stern, W. (1960) The Porters of London, Longmans.