IATSS Research 35 (2011) 1–6

Contents lists available at ScienceDirect

IATSS Research

Evaluating the use of an urban consolidation centre and electric vehicles in central London

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ARTICLE INFO

Article history:
Received 19 January 2011
Received in revised form 13 June 2011
Accepted 16 June 2011

Keywords:
Urban consolidation centre
Freight transport
Logistics system
Electric vehicles
Greenhouse gas emissions

ABSTRACT

The paper focuses on the role that can be played by urban consolidation centres (UCCs) in reducing freight traffic and its environmental impacts in towns and cities. It is based on the before and after evaluation of a trial led by a major stationery and office supplies company in which urban freight deliveries in central London made from a depot in the suburbs using diesel vehicles were replaced with the use of an urban micro-consolidation centre located in the delivery area together with the use of electrically-assisted cargo tricycles and electric vans. The results show that the total distance travelled and the CO_2eq emissions per parcel delivered fell by 20% and 54% respectively as a result of this delivery system. However, the evaluation has also indicated that the distance travelled per parcel rose substantially in the City of London delivery area as a result of the electric vehicles having far smaller load limits in both weight and volume compared with diesel vans. But, at the same time, the trial system was able to virtually eliminate CO_2eq emissions per parcel delivered in the City of London. The trial proved successful from the company's perspective in transport, environmental and financial terms. The company therefore decided to continue the operation beyond the end of the trial with it being officially launched during 2010.

1. Introduction

This paper focuses on the potential for urban consolidation centres (UCCs) to alleviate local environmental and traffic problems within urban areas. The paper begins with a brief overview of UCCs and their potential benefits. It then presents the results of a UCC trial that took place in the City of London in 2009. This involved the use of a consolidation centre in the delivery area from which electric vans and tricycles were operated for delivery to receivers. The traffic and environmental impacts of the operation before and during the introduction of the UCC and electric vehicles are quantified.

A UCC is a logistics facility that is situated in relatively close proximity to the urban area that it serves be that a city centre, an entire town or a specific site such as a shopping centre, airport, hospital or major construction site. Goods destined for these locations are dropped off at the UCC. The UCC operator sorts and consolidates these loads dropped off by logistics companies and makes delivers to the final destinations, often using environmentally friendly vehicles such as electric and gas-powered goods vehicles, and electrically-assisted tricycles [1].

By improving the lading factor of goods vehicles making final deliveries in congested locations, UCCs reduce the total distance travelled by delivery vehicles in urban areas, as well as reducing greenhouse gas emissions and local air quality pollutants associated with these journeys (both through reductions in the total distance travelled, and through the use of low emission vehicles) [2]. In addition the total kerbside time and space occupied by vehicles making on-street deliveries can be reduced through consolidation further reducing the impact of freight operations on traffic congestion. Other social and environmental advantages can include noise reductions through the use of quieter vehicles, reductions in conflicts between goods vehicles and other road users, and greater pedestrian safety [3,4].

The logistics companies dropping their loads at the UCC benefit by avoiding the need to enter congested urban areas and thereby saving time and costs. Those receiving goods from the UCC benefit in terms of delivery reliability. In addition to consolidation and final delivery, a range of other value-added logistics and retail services can also be provided at the UCC including off-site stockholding, consignment unpacking, preparation of products for display and price labelling. These can benefit receivers by reducing their on-site space requirements, saving time by reducing the tasks that have to be performed on-site, and enhancing productivity and sales in core activities.

Initial research into UCCs as an urban freight initiative commenced in the early 1970s and has continued ever since with levels of interest in this approach increasing during the last decade (see for example [1,5–8].

2. Background to the trial

In 2009 a major supplier of stationery and other office supplies to businesses in the UK made the decision to trial a new urban delivery

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0386-1112/$ – see front matter © 2011 International Association of Traffic and Safety Sciences. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.iatssr.2011.06.002

system in the City of London in order to reduce the environmental impacts of their delivery operation. This decision was taken as part of the company's corporate social responsibility and environmental efforts [9]. However, it was also necessary for the new scheme trialled to produce a cost-effective service which met their customers' needs if it was to be implemented on a permanent basis [10]. The trial involved the use of an urban micro-consolidation centre together with electrically-assisted cargo tricycles and electric vans. This centre, located in the City of London delivery area, was used as a transhipment facility for the transfer of parcels from the suburban depot onto the electric vans and tricycles for final delivery. The trial of the urban micro-consolidation centre and the deliveries made from it were operated by a new company[1] specialising in green urban freight deliveries. The trial therefore implemented two major logistics and technological changes simultaneously. First, the use of a micro-consolidation centre adjacent to the delivery area in an attempt to reduce the total stem mileage and greenhouse gas emissions travelled by vehicles to and from the suburban depot and the delivery area in the City of London. Second, to substitute electric vans and tricycles for diesel-powered vans for making deliveries in the customer catchment area.

The customers to whom deliveries were made were all located in the City of London which is the historic core of London with an area of 2.9 km^2. It contains London's business and financial centre. The City of London lies within the Clear Zone Partnership which is used as a testing ground to research, trial, monitor and set best practice for new transport technologies, innovations and physical measures, to be implemented on a local or regional scale. Since 1999 the London Borough of Camden, the City of London and the City of Westminster have worked jointly to achieve this. This resulted in the London Borough of Camden making a small financial contribution towards the trial. All the other costs were met by the office supplies company, which expected the new delivery system to have similar costs to their existing system. The system was trialled in the City of London as it comprises a high concentration of the company's delivery locations. This results in a relatively short travel distance between delivery locations.

The trial was the first of its kind in the UK combining an urban micro-consolidation centre and electric vans and tricycles, with the exception of some far smaller inconsequential pilots [11]. Similar electrically-assisted cargo tricycles are also being operated for urban freight deliveries in other countries, the most notable example being La Petite Reine in France [12].

The trial was of particular interest as the company's existing delivery system prior to the trial already involved a high degree of product consolidation and hence high vehicle lading factors. It did not therefore typify the types of operation in which UCCs are usually considered beneficial – namely systems with poor load consolidation. The trial represented the first attempt to fully evaluate the transport and environmental impacts of using a UCC in conjunction with electric vehicles in such a supply chain.

3. Operation before the trial

The situation before the introduction of the trial was studied by interviews with the office supplies company's managers and drivers and a survey in which a researcher accompanied a driver on a typical delivery journey in order to collect detailed operational data.

Prior to the trial the office supplies company operated a distribution system for deliveries in the City of London that involved using 3.5 tonne gross weight diesel-powered vans that were despatched from a warehouse located 29 km away in the London suburbs. Seven vans carried out multi-drop delivery journeys to customers in the City of London. A total of approximately 1,200 parcels were delivered per day, all to business addresses. The delivery area has very heavy traffic flows in the morning peak and comprises a mix of very narrow roads and wider roads on which no stopping is allowed. Vans were loaded at the warehouse overnight and drivers arrived to start their delivery journeys from 06:00 onwards. The vans used had a payload capacity of 1.3–1.6 tonnes and 9–10 m^3. The vans had external dimensions of 5.71 m long and 1.98 m wide. Each van typically travelled approximately 15,000 km per year. Each van journey to the City of London consisted of 140–180 parcels. Some addresses received a single parcel while others received several. At some stops the driver was able to make deliveries to several addresses due to their close proximity to one another. In these cases the driver returned to the van to collect the parcels for each delivery in turn. In total the drivers made 20–25 stops per journeys. The vans typically returned to the depot by lunchtime. Up to two additional afternoon delivery journeys to the City of London were also made by vans from the depot.

Table 1 provides detailed data from the delivery journey to the City of London on which the surveyor accompanied the driver. The distance between each stop was measured, and the stop time and start time recorded (the duration of each stop was calculated as the elapsed time between the vehicle arrival and departure at the stopping location). The office supplies company verified that this journey was representative of their van operations.

Table 1 reflects the difference in average speeds in the City of London and the journey in the rest of London to and from the suburban depot. The difference between the journey speed to the City of London and the return journey to the suburban depot is due to the latter taking place during the late morning off-peak. The journeys to and from the suburban depot accounted for approximately one-third of the total journey time, while the driving between deliveries in the City of London and the stopping time while making deliveries accounted for 21% and 48% of total journey time respectively.

4. Operation during the trial

During the trial the office supplies company's delivery operation continued to serve the same clients with the same volumes of product

Table 1
Data from the observed diesel van delivery journey prior to the trial (October 2009).

Operational features	Diesel van
Distance travelled on journey	
Distance from suburban depot to City of London (each-way) (km)	29
Distance travelled by van in City of London (km)	10
Total distance travelled by van on delivery journey (km)	68
Deliveries on journey	
Number of stops to make deliveries	20
Number of parcels delivered during journey	168
Parcels delivered per stop	8.4
Time use (as % of total journey time)	
"Stem" driving time from depot to first stop	21%
Time running on the road between first and last stop	21%
Time unloading between first and last stop	48%
"Stem" driving time from last stop to depot	10%
Total journey time (hours and minutes)	05:24
Driving speed	
Driving speed from depot to City of London (km per hour)	26
Driving speed from City of London to depot (km per hour)	48
Driving speed in the City of London (km per hour)	8
Fuel use	
Fuel use (litres per 100 km)	12.8
Fuel use in litres per journey	8.7
Fuel use per parcel delivered (litres)	0.052

Source: own survey 2009.

[1] The operator of the micro-consolidation centre, tricycles and electric vans was GNewt Cargo.

as before the trial delivered. The key changes in the delivery operation were:

- A new urban consolidation centre was established close to the Tower of London in the City of London in a covered secure facility underneath a railway bridge. This consolidation centre was used as a transhipment facility for the transfer of parcels from the suburban depot onto electric vans and tricycles and for overnight storage of the electric vans and tricycles. Because the centre itself was small (approximately 20 m by 8 m) it was referred to as an "urban micro-consolidation centre". The urban micro-consolidation centre and the deliveries made from it were operated by a new company specialising in green urban freight deliveries, on behalf of the office supplies company. A member of staff was based at the micro-consolidation centre during the daytime.
- An 18-tonne goods vehicle was used to transport parcels from the office supplies company's warehouse in the suburbs of London to the micro-consolidation centre in the City of London (a distance of 30 km – only 1 km of which was in the City of London). The delivery was made overnight from the office supplies company's suburban warehouse to the consolidation centre in the City of London.
- Electrically-assisted cargo tricycles and electric vans were used to make parcel deliveries from the urban micro-consolidation centre to customers in the City of London. The operation of these vehicles did not result in any fossil fuel consumption or greenhouse gas emissions as the electricity they used was produced from renewable sources. This was ensured by purchasing electricity from a green electricity provider that matches the electricity used with purchases of electricity produced from a renewable source.
- In the initial stages of the trial heavier, bulkier products than parcels continued to be delivered directly by the office supplies company to customers using diesel-powered vans from the suburban depot (in the same way as before the trial). However by the end of the trial diesel van deliveries from the suburban depot had ceased and all deliveries were made via the micro-consolidation centre using and electric vans and tricycles.

Figs. 1 and 2 provide an illustration of the differences in the delivery system and vehicle operations before and during the trial.

The electrically-assisted cargo tricycles were manufactured in France by La Petite Reine. The empty weight of the tricycle is 110 kg, including the two batteries (i.e. without the driver and load weight). It can carry a load of up to 180 kg and has a load space of 1.5 m^3. It is 2.35 m long and 1.03 m wide and has a typical speed of approximately 15 km per hour in free-flow conditions. The tricycle requires a four-hour recharging overnight. Fig. 3 shows one of the tricycles used.

Aixam Mega electric vans were used in the trial. They had a load capacity of 445 kg and a load space volume of 3 m^3. Their external length was 3.32 m and their external width was 1.49 m. The vans require an overnight recharging [13]. Fig. 4 shows one of the electric vans used.

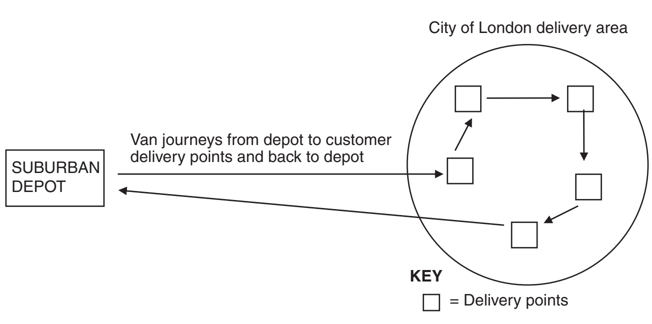

Fig. 1. Logistics system for deliveries by diesel vans from the suburban depot.

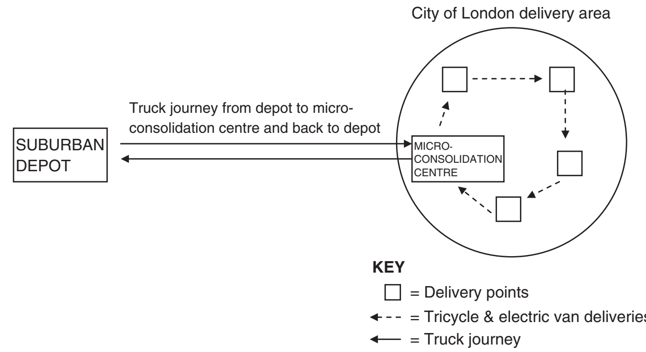

Fig. 2. Logistics system for deliveries by tricycles and electric vans via the micro-consolidation centre.

The City of London trial began in November 2009. Data collection commenced in December 2009 and continued until July 2010. During the trial the proportion of the office supplies company's parcel traffic delivered via the micro-consolidation centre was gradually increased, as were the number of tricycles and electric vans used. The tricycle delivery journeys started at 08:30, with the tricycle returning to the micro-consolidation centre for reloading at the end of each journey. Each performed 2–4 delivery journeys per day with a maximum of 8 operating hours per day. The variable range of parcel sizes and weights made it unviable for all parcels to be delivered by tricycle. The electric vans were used to deliver larger parcels from the micro-consolidation centre, also performing a similar number of journeys per day.

By July 2010, 6 tricycles and 3 electric vans were being operated each day from the micro-consolidation centre. One diesel truck was used to transport goods from the suburban depot to the micro-consolidation centre. All diesel vans deliveries direct to customers from the suburban depot had ceased and been replaced by electric van operations from the micro-consolidation centre.

Table 2 provides details of the electric van and tricycle delivery operations in the City of London. These results are based on detailed surveys and observations of fourteen delivery journeys by tricycle and three delivery journeys by electric van. The tricycle and electric van delivery operations can be seen to share many similarities in terms of the number of delivery stops per journeys, the establishments delivered to per stop, the total journey time, and the split of journey time between different types of activity.

The results in Table 2 can be compared with the diesel van operation before the trial shown in Table 1. The diesel van carried a far greater load than either the electric van or the tricycle and delivered more parcels per stop. As the diesel van operates from a suburban

Fig. 3. Electrically-assisted cargo tricycle used in the trial.

Fig. 4. Electric van used in the trial.

London depot this has implications for the proportion of total journey time spent travelling between stops and stopped while making deliveries. The operation of the tricycle and electric van resulted in no fossil fuel consumption or greenhouse gas emissions as the electricity they use has been produced from renewable sources.

5. Analysis of the before and after situation

5.1. Distance travelled and greenhouse gas emissions

Table 3 shows the delivery system in October 2009 before the implementation of the trial when only diesel vans were used from the suburban depot, and in May 2010 when all deliveries were made using tricycles and electric vans via the micro-consolidation centre and all diesel van operations from the suburban depot had ceased. Table 3 shows the effect of these two delivery systems on distance travelled, and greenhouse gas emissions.

The results in Table 3 show that by May 2010 the use of the micro-consolidation centre together with the complete replacement of the diesel van fleet by electric vans and tricycles led to a reduction of 20% in the total distance driven by all vehicles per parcel delivered between the suburban depot and the customer delivery locations. The

Table 2
Data from the observed tricycle and electric van delivery journeys in the City of London (July 2010).

Operational features	Electrically-assisted tricycle	Electric van
Distance travelled per journey		
Distance travelled making deliveries in City of London (km)	8.9	12.4
Deliveries per journey		
Number of stops to make deliveries	17	14
Number of establishments delivered to during journey	17	19
Number of parcels delivered during journey	33	42
Parcels delivered per stop	2.0	3.0
Parcels delivered per establishment	1.7	2.5
Establishments delivered to per stop	1.2	1.2
Time use (as % of total journey time)		
"Stem" driving time from depot to first stop	10%	12%
Time running on the road between first and last stop	28%	26%
Time unloading between first and last stop	54%	52%
"Stem" driving time from last stop to depot	9%	10%
Total journey time (hours and minutes)	02:42	02:15
Driving speed		
Average driving speed in the City of London (km per hour)	8	8

Source: own survey 2010.

Table 3
Comparison of the distance travelled and greenhouse gas emissions before and during the trial.

	Before trial (Oct 2009)	During trial (July 2010)
Fleet mix used	No micro-consolidation centre – 7 diesel vans only	Micro-consolidation centre – 0 diesel vans, 6 tricycles, 3 electric vans, 1 diesel truck
Distance travelled in the City of London		
Kilometres per parcel	0.06	0.27
Change compared with before trial	–	349%
Distance travelled rest of London		
Kilometres per parcel	0.36	0.07
Change compared with before trial	–	−82%
Distance travelled in all of London		
Kilometres per parcel	0.41	0.33
Change compared with before trial	–	−20%
CO_2eq emissions in City of London		
CO_2eq per parcel (kg)	0.020	0.003
Change compared with before trial	–	−83%
CO_2eq emissions in rest of London		
CO_2eq per parcel (kg)	0.122	0.062
Change compared with before trial	–	−49%
CO_2eq emissions in entire system		
CO_2eq per parcel (kg)	0.142	0.065
Change compared with before trial	–	−54%

Source: Own survey 2009–2010.
Note: CO_2eq – carbon dioxide equivalent which includes carbon dioxide, nitrous oxides and methane.

total CO_2 equivalent (CO_2eq) emissions per parcel delivered was 54% lower in May 2010 than in October 2009 before the trial. This was due to the reduction in the total distance travelled per parcel and the use of electric vehicles using fuel generated from renewable, carbon-free sources in the City of London.

The distance travelled between the suburban depot and the City of London per parcel delivered fell by 82% due to the use of a single truck to transport goods between the suburban depot and the micro-consolidation centre in the City of London. However, within the City of London the total distance travelled per parcel delivered increased by 349% by May 2010. This is due to the lower carrying capacity of the electric vans and tricycles compared to the diesel vans together with the guaranteed delivery times that have to be met, thereby resulting in the need for more delivery activity per day. In terms of CO_2eq emissions, these fell by 49% per parcel delivered between the suburban depot and the City of London, and by 83% per parcel delivered within the City of London compared with the situation before the trial.

Electrically-assisted tricycles offer several advantages over diesel vans including lower purchase prices, tax, insurance, storage and depreciation costs; tricycles can be parked more easily than vans, do not receive Penalty Charge Notices (PCNs) for loading and unloading infringements, and are not liable for the London Congestion Charging Scheme [11].

Also, tricycles are generally viewed as less intimidating and safer than diesel vans in a busy urban area with limited space. The public perception of both vans and van drivers tends to be rather negative. Survey work suggests that a similar tricycle freight and micro-consolidation centre scheme in Paris was supported by the majority of the general public due to its environmental credentials and 92% of respondents felt that this kind of trial should be supported by the local authority [12]. The London trial indicates that the tricycles travel at the same speed as the prevailing traffic and do not therefore cause delay to other road users.

These advantages over diesel vans have to be balanced against the limited weight and volume that a tricycle can carry, which typically results in greater distances being travelled per item delivered as reflected in the trial. Tricycles are also limited in terms of the distance they can realistically be used to deliver over. However the distances involved in the trial were ideally suited to tricycles.

5.2. Daytime road occupancy

In order to consider the effect of the trial distribution system on road traffic conditions it is possible to consider the effect on vehicle kilometres per parcel as shown in Table 3. This showed a substantial reduction (of 83%) in vehicle kilometres per parcel outside the City of London but a substantial increase within the City of London as a result of use of the micro-consolidation centre and electric vehicles.

However this does not reflect the entire situation as the vehicles used after the introduction of the micro-consolidation centre have different lengths and widths to the diesel vans used before its introduction and therefore occupy different amounts of road space. In addition, the time taken to perform the delivery operations differs (with the tricycles and electric vans being operated over more hours than the diesel vans), as does the time at which some of the activity takes place (especially in terms of the overnight distribution of parcels to the micro-consolidation centre by truck). Therefore it is necessary to calculate the effect of these different distribution systems on road space requirements. This can be achieved by multiplying the number of hours the vehicles are driven on the roads by the vehicle footprint (square metres) in order to derive the total road space and time occupied by the vehicles, and then dividing by the number of parcels to determine the road space and time occupied per parcel delivered (to measure the square metres-hours of road space and time required per parcel delivered). The duration over which vehicles are operated can be taken into account by dividing the result by the average hours of daily operation of each vehicle type (six hours for diesel vans, and seven and a half hours for tricycles and electric vans). This reflects the effect of the delivery activity on road space and time occupancy during each hour of operation (as operations that take place during a congested period will have a lesser effect on traffic congestion if they are spread over the entire period rather than carried out in a narrower time window). Given that the truck deliveries of parcels to the micro-consolidation centre take place during the night when roads are uncongested, this activity can be disregarded in these road space and time occupancy calculations. Only operations that take place between 06:00 and 20:00 were included as it is during this period that traffic flow is greatest and roads become congested.

Table 4
Comparison of the daytime road space and time occupied by the vehicles per parcel delivered before and during the trial (based on metres^2-hours per hour per parcel).

	Before trial (Oct 2009)	During trial (July 2010)
Fleet mix used	No micro-consolidation centre – 7 diesel vans only	Micro-consolidation centre – 0 diesel vans, 6 tricycles, 3 electric vans, 1 diesel truck
Driving in City of London	0.013	0.014
Change compared with before trial	–	+11%
Driving in rest of London	0.019	0.0
Change compared with before trial	–	−100%
Total driving in all of London	0.032	0.014
Change compared with before trial	–	−56%

Source: Own survey 2009–2010.

Table 5
Comparison of the kerbside loading space and time occupied by the vehicles per parcel delivered before and during the trial (based on metre-hours of kerbside occupancy per parcel per hour).

	Before trial (Oct 2009)	During trial (July 2010)
Fleet mix used	No micro-consolidation centre – 7 diesel vans only	Micro-consolidation centre – 0 diesel vans, 6 tricycles, 3 electric vans, 1 diesel truck
Kerbside delivery stops in City of London (metre-hours per hour per parcel)	0.015	0.013
Change compared with before trial	–	−10%

Source: Own survey 2009–2010.

The results are shown in Table 4 and indicate that the total daytime road space and time occupation of the delivery system increased by 11% in the City of London by the end of the trial compared with before its start. This compares with a 349% increase in vehicle kilometres. The increase in road space and occupation is far less than the increase in vehicle kilometres due to use of shorter, narrower vehicles (tricycles and electric vans) in the trial than before it start (when longer, wider diesel vans were used) together with the longer operating hours of tricycles and electric vans in making the deliveries.

Outside the City of London the daytime road space and time occupation of the delivery system reduced by 100% during the trial compared with before its start (due to the trucks delivering to the micro-consolidation centre being operated at night). This compares with an 82% reduction in vehicle kilometres.

The overall daytime road space and time occupation of the delivery system (i.e. both in and outside the City of London) reduced by 56% during the trial compared with before its commencement. This compares with a 20% reduction in vehicle kilometres.

5.3. Kerbside occupancy while unloading make deliveries

The same analytical approach can be used to compare the effect of the trial on the kerbside loading space and time required when vehicles stop to make deliveries in the City of London. However, whereas it was appropriate to use square metres as the measure of use of road capacity (in Table 4), it was decided that metres were a better measure of kerbside loading activity. Therefore kerbside loading occupancy was calculated by multiplying the amount of time each vehicle type spends at the kerbside by the length of the vehicle and dividing by the number of parcels delivered – as measured in metre-hours. This result was then divided by the duration over which vehicles were used to make deliveries to reflect the effect of the kerbside activity during each hour of operation (as was done for the road space occupancy calculations). The results are shown in Table 5 and indicate that the kerbside metre-hours per hour were 10% lower

Table 6
Direction of change in cost components as a result of the new distribution system.

Cost component	Effect of new system on delivery costs
Total distribution centre operating costs (including micro-consolidation centre buildings and staffing)	Increase
Total vehicle capital costs	Reduction
Total vehicle fuel costs	Reduction
Total vehicle insurance costs	Reduction
Total vehicle excise duty costs	Reduction
Total vehicle maintenance costs	Reduction
Total vehicle driver costs (number of drivers increased but hourly wage rates decreased)	Slight increase

when using the micro-consolidation centre with tricycles and electric vans than prior to the trial when using diesel vans.

5.4. Impact of the trial distribution system on operating costs

The office supplies company that initiated the trial has calculated that the distribution system used in the trial with its tricycles, electric vans and micro-consolidation centre has the same operating costs as the previous system using diesel vans dispatched from the suburban London depot [10]. Although the costs of the two systems are not available due to commercial confidentiality it is possible to indicate which cost components reduced and increased as a result of the new system. This is shown in Table 6.

6. Conclusions

This paper has evaluated a trial in which goods dispatched from a suburban London depot were delivered to customers in the City of London. In the trial diesel vans making deliveries direct from the suburban depot to customers in the City of London were replaced by electric vans and tricycles operating from a micro-consolidation centre in the City of London. The results show that the total distance travelled and the CO_2eq emissions per parcel delivered as a result of this delivery system fell by 20% and 54% respectively.

However, the evaluation has also indicated that the distance travelled per parcel rose substantially in the City of London delivery area as a result of the electric vans and tricycles having far smaller load limits in both weight and volume compared with diesel vans. But, at the same time, the trial system was able to virtually eliminate CO_2eq emissions per parcel delivered in the City of London. The results therefore reflect the trade-off between total distance travelled and greenhouse gas emissions associated with the use of electric vehicles in place of diesel vehicles that have greater size and volume payloads. In addition, the use of the micro-consolidation centre with electric vans and tricycles also reduced the daytime road space and time occupancy per parcel delivered in London as well as the kerbside loading space and time required per parcel.

The trial proved successful from the office supplies company's perspective in transport, environmental and financial terms. The company has calculated that the new system with its electric vehicles, tricycles and micro-consolidation centre has the same operating costs as the previous system using diesel vans dispatched from the suburban London depot [10]. The company therefore decided to continue the operation beyond the end of the trial. The scheme was officially launched in 2010 [10]. It has now permanently replaced their original diesel van delivery operation from the suburban depot. The office supplies company intends to implement the same delivery system in other cities, and is also considering the potential use of electrically-assisted tricycles in other environmentally sensitive locations or where noise pollution is an issue such as manufacturing plants, and university campuses [10].

The operator of the micro-consolidation centre in the City of London, and the delivery operations using electric vans and tricycles has continued to operate this system for the office supplies company. The operator is now also offering the service to other customers for delivery in the City of London catchment area.

The trial demonstrated that even in a supply chain in which goods are already highly consolidated there is still the potential to achieve further benefits in terms of further reductions in total distance travelled and greenhouse gas emissions through additional consolidation efforts and the use of electric vehicles. This is especially true in logistics systems that involve substantial stem distances between depots and delivery areas. The system operated in the trial also contributes to air quality improvements and noise reductions.

The UCC operation evaluated could readily be implemented in other urban areas, thereby generating similar benefits in terms of reducing freight trunking traffic between depots and delivery areas through greater consolidation of loads as well as providing major reductions in greenhouse gas emissions.

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