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Evaluating the Feasibility of a Shared-Fleet Operation in Healthcare Logistics between Public Organisations

Ismail Aydemir *, Fraser McLeod, Matt Grote and Tom Cherrett

Transportation Research Group, University of Southampton, Southampton SO17 1BJ, UK; f.n.mcleod@soton.ac.uk (F.M.); m.j.grote@soton.ac.uk (M.G.); t.j.cherrett@soton.ac.uk (T.C.)
* Correspondence: i.aydemir@soton.ac.uk

Abstract: Shared-fleet logistics involves collaboration between two or more companies to combine workloads and vehicle capacity to improve vehicle utilisation and transport efficiency and to reduce costs. This study considers the potential environmental and economic benefits of implementing a shared-fleet collaboration between two public organisations: a local government authority and a National Health Service (NHS) Trust. The research focuses on a specific case study using a historical dataset of vehicle movements, wherein the local authority's fleet of electric courier vehicles is shared with the NHS Trust for transporting pathology samples from 78 doctors' surgeries to a laboratory for analysis, thereby replacing the reliance on a third-party logistics provider. The benefits suggested by the results included a 17% reduction in costs, a 3% decrease in overall vehicle kilometres travelled, a 69% decrease in carbon dioxide (CO_2) emissions, a 40% reduction in vehicle numbers, and a 27% reduction in total duty time. These results emphasise the considerable potential of shared-fleet operations to alleviate both environmental and economic problems in urban logistics, encouraging public sector organisations to actively pursue the implementation of collaborative solutions to enhance the efficiency of their own-account vehicles while making positive contributions to environmental sustainability.

Keywords: shared-fleet; freight pooling; horizontal collaboration; carrier collaboration; urban logistics; emissions; road congestion; public sector; healthcare

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1. Introduction

The Department for Transport (DfT; the United Kingdom (UK) Government department responsible for transport) reported that the transport sector was responsible for 27% of the UK's total domestic greenhouse gas (GHG; on a CO_2-equivalent basis) emissions in 2019 [1], with freight vehicles alone (i.e., light and heavy goods vehicles) accounting for 8.5% [2]. Whilst the DfT has developed a plan for "delivering a zero-emission freight and logistics sector" by 2050 [1], the rapid increase in e-commerce and the number of light goods vehicles (LGVs, i.e., vans $\leq$ 3.5 tonnes gross vehicle weight (GVW)) are making the existing challenges more difficult to tackle [3]. Despite deploying new technologies (i.e., shifting to alternatively fuelled vehicles, e.g., electric, hybrid, and hydrogen-propelled vehicles) to reduce emissions, producing innovative operational solutions that fundamentally reduce the number of urban goods vehicles is crucial to achieving the DfT's zero-emission plan by 2050 and relieving congestion in urban areas [4].

In urban settings, city councils employ LGV fleets for various purposes, including library services, housing maintenance, school lunch deliveries, and the transportation of goods and mail between various council sites. In the realm of transportation, the National Health Service (NHS) currently implements a "hub and spoke" system for transporting pathology samples across 29 networks of NHS hospitals [5]. The coexistence of diverse public sector vehicle fleets not only presents environmental challenges but also provides opportunities for shared-fleet operations.

Numerous sustainable solutions are currently employed or have been proposed to address challenges associated with logistics operations in urban and healthcare settings such as consolidation centres [6], mobile city hubs [7], collection points [8], and multi-party collaborations [9]. A variety of measures, often designed and executed in collaboration between companies, enable retailers and parcel delivery services to reduce costs, emissions, congestion, and noise related to urban logistics without compromising customer service quality [9]. Horizontal collaboration between competing goods carriers is known to yield several benefits such as decreased empty running, improved fleet utilisation, enhanced service quality, reduced operating costs, and market share preservation [10,11]. The hypothesis of this paper is that similar advantages may be accrued for collaboration between public sector organisations, specifically between an NHS Trust and a local government authority (LGA), where the LGA undertakes collection and delivery services for the NHS Trust, utilising spare capacity within its vehicle fleet. The associated research questions are "what levels of benefits may be expected, in terms of cost savings, reduced vehicle kilometres, and associated CO_2 emissions?" and "what are the practical challenges that would have to be overcome to enable the collaboration?" [11].

The NHS provides a wide range of healthcare services requiring specialist transportation. One of these is its sample collection service (SCS), collecting pathology samples from GP (general practitioner doctor) surgeries to a testing laboratory for examination. This transportation service is typically outsourced to external commercial courier companies, as is the case in the city of Southampton, UK, with a population of approximately 260,000.

Southampton City Council (SCC) utilises two electric and three plug-in hybrid LGVs to conduct five scheduled courier rounds on weekdays (Monday–Friday). Initially designed to transport SCC's own goods (primarily internal mail) between sites in Southampton, the courier service was purposefully over-provisioned to accommodate unforeseen events. As a result, the courier rounds have spare capacity to cope with any ad hoc demands.

This study aimed to assess the feasibility of using the SCC courier fleet as a "donor" of service capacity to support the NHS Trust in operating its SCS and to enhance the utilisation of SCC's own-account vehicles and earn additional revenue. The existing schedules of these donor vehicles, taking into consideration their specific operating constraints, were optimised to include the pathology collection needs of the SCS in the Southampton area, currently undertaken by a third-party logistics provider. The study aimed to quantify the potential benefits in relation to overall system cost reduction, decreased vehicle kilometres travelled, and the associated reduced CO_2 emissions, as economic and environmental costs, in line with related studies found in the literature review (Section 2), were considered to be the most important concerns.

2. Literature Review

Horizontal collaborations involving public sector organisations in urban logistics is a newly emerging area that has received limited investigation to date; the environmental and operational benefits of shared-fleet collaborations, which involve sharing vehicle capacities between stakeholders to enhance efficiency, have not been extensively studied [12]. However, some notable studies highlight the potential advantages of shared-fleet logistics, in general, typically considering private operators [13–15]. For example, Ouhader and El Kayal [13] introduced a decision mechanism to evaluate the economic and environmental impacts of urban collaborative freight delivery before carriers engage in horizontal collaboration, emphasising potential cost and emission reductions in different scenarios. Various challenges remain unresolved, however, such as integrating operational innovations into existing infrastructure, addressing practical issues (e.g., satisfying specific time windows, driver schedules, multi-depot pickups and delivery, vehicle capacity availability, electric vehicle charging points), route optimisation, and dealing with legal concerns [12,16,17]. Moreover, while computational models have explored the advantages of shared-fleet operations, such as reducing the number of vehicles and emissions, there is a notable gap in understanding the practical challenges associated with their implementation [18,19].

Additionally, existing studies on shared-fleet operations have primarily focused on collaboration between private companies, neglecting the potential of public–public or public–private collaborations [20,21]. This paper addresses these identified gaps by considering a public–public collaboration, identifying expected economic and environmental benefits, and discussing the practical issues faced in realising such a collaboration.

With zero-emission freight and logistics targets set by the central government, vehicle fleet operators are under pressure to adopt alternative modes and fuels, with a shift from diesel to electric LGVs already being seen from several of the major goods carriers. Comparison of diesel and electric vehicles has not received much attention in the context of shared-fleet operations. One contribution is by Muñoz-Villamizar et al. [22] who assessed the efficiency and effectiveness of a horizontal collaboration involving a mixed fleet of diesel and electric vehicles. Their findings, using data from major convenience store networks in Bogota, Colombia, suggested that using electric vehicles within a horizontal collaboration yielded greater economic and environmental benefits than using diesel vehicles, particularly for periods exceeding three years. Our paper contributes here by comparing the use of diesel and electric vehicles.

The two main areas of performance considered in this research relate to economic and environmental criteria, which is in line with most of the related literature found for shared-fleet collaborations between private operators, where these typically comprise carriers sharing transportation requests or sharing vehicle capacity to meet transport demand on a network-wide scale [19–23]. Recent literature reviews in this field reveal that most studies of shared-fleet collaborations use computational methods and artificial data, with comparatively few studies utilising actual fleet operator data [12,17,23]. This paper contributes to this identified gap by using real vehicle fleet operator data (vehicle schedules), which gives more confidence that the input data and resulting output data provide a true representation of operating conditions.

Theoretically based studies have estimated a wide range of economic savings that may be accrued from shared-fleet operations between private companies. Estimated cost savings have ranged from about 9% up to 52% [11,14,24–26], where the efficiency of the current operations is a significant factor in the level of savings available. The size of the transportation network can be a factor as well, but with uncertain effects: in one study [11], cost savings increased with network size, while in another [14], cost savings varied with network size, displaying no clear trend. Estimated environmental savings of up to 81% have been made, which corresponded to the example where 52% cost savings were estimated [26].

Most studies using actual operator data have also investigated shared fleet operations involving private sector organisations rather than public institutions [20,21,27–29]. Aktas et al. [20] assessed vehicle capacity sharing in last-mile deliveries for London's online grocery sector, revealing potential reductions of 17% in kilometres travelled and 22% in the number of vehicle routes. In Pamplona, Spain, Serrano-Hernandez et al. [21] examined the online grocery industry through a collaboration between four major supermarket chains, predicting improvements in service levels and reduced vehicle kilometres based on a survey of local residents. Vargas et al. [27] proposed a novel platform incorporating an algorithm for generating shared-fleet solutions in freight logistics, with a case study application, using data provided by a leading UK construction materials supplier, reporting cost and vehicle kilometre savings of up to 12%. Ballot et al. [28] conducted case studies in the French retail industry, indicating potential CO_2 emission reductions of 25% through carrier collaboration. Additionally, through a discrete-event simulation-based methodology, Jerbi et al. [29] investigated the impact of supply chain transportation pooling strategies. A numerical case study involving two manufacturing companies and three customers was conducted. The findings revealed that implementing transportation pooling strategies can lead to a CO_2 emissions reduction of up to 13% compared to non-pooled strategies.

Some of the authors of this paper addressed the impacts of shared-fleet collaborations in a public organisational setting, examining shared-fleet operations within the context of healthcare logistics [30]. Utilising data from the NHS, the study focused on a collaboration between the NHS's sample collection service and their patient transport service. In the city of Southampton, using the patient transfer service to also collect pathology from GP surgeries resulted in an estimated 16% cost reduction, 13% fewer vehicle kilometres, and a 12% decrease in CO_2 emissions. Our study broadens the scope by exploring shared-fleet collaborations not confined within a single public organisation but spanning across two [30]. In summary, much of the existing research has predominantly employed theoretical and computational methods, leading to a scarcity of empirical studies on shared fleets using real-world data. The focus of the current literature has been mainly on the potential benefits derived from hypothetical, large-scale alliances of commercial carriers collaborating to meet the transportation demands for general goods. There appears to be a limited number of investigations exploring the feasibility of smaller-scale scenarios that involve individual demands in terms of optimisation (e.g., time windows for specific tasks, electric vehicle range, driver duty periods and breaks, vehicle charging times, etc.) for the transportation of specialised payloads in shared-fleet operations. In such cases, the public sector could serve as potential fleet providers, aiming to optimise the utilisation of their own vehicles.

3. Data and Methods

This section provides a comprehensive description of the data used and the analytical methodology, focusing on two distinct scenarios for comparison: the "business-as-usual" (BAU) scenario, describing existing operations, and the "intervention" scenario, which models shared-fleet operations. Figure 1 gives an outline of the methodology used in this study.

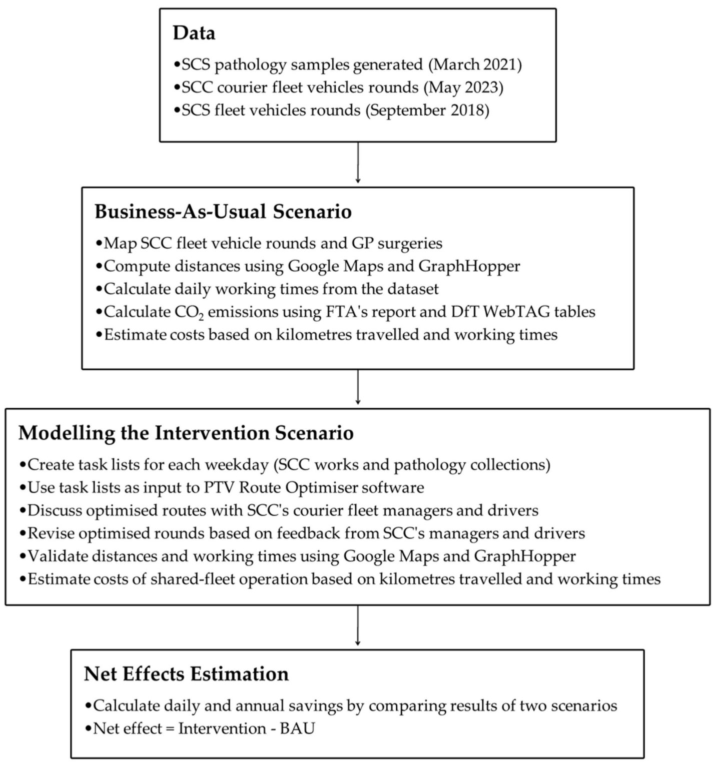


Figure 1. Flowchart showing the steps of the methodology.

3.1. Data

The study utilised two historic datasets that provided information on vehicle round structures and daily vehicle movements (locations visited and estimated typical arrival times at each location): one covering five SCC courier fleet vehicles from May 2023 and another covering ten SCS fleet vehicles from September 2018. A separate dataset from the

SCS gave the number of samples produced each day by 78 GP surgeries and delivered to Southampton General Hospital (SGH) for testing during March 2021 (Figure 2).

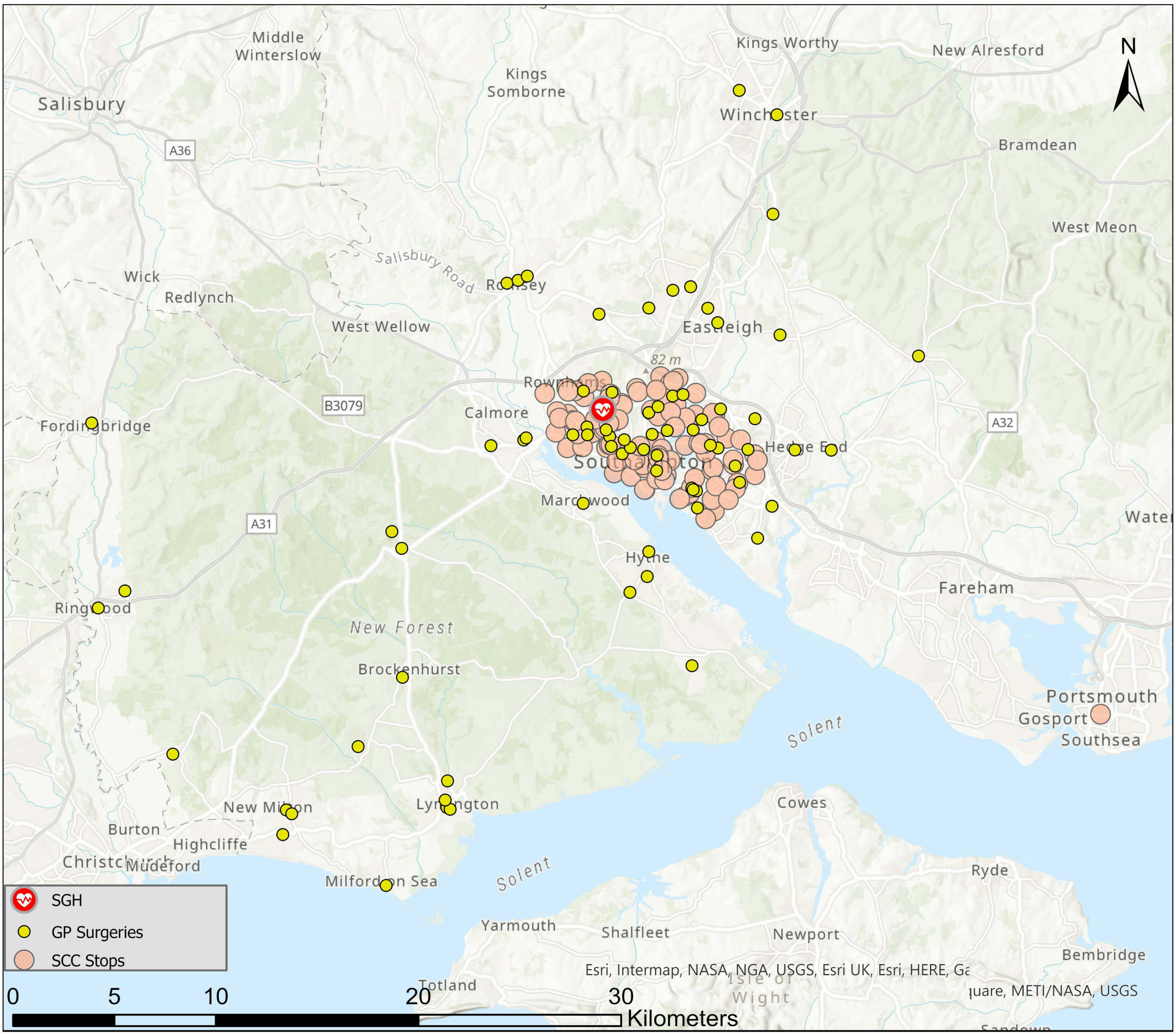


Figure 2. Map showing the 78 GP surgeries and SGH and SCC courier vehicles stops.

The two SCS datasets (describing vehicle rounds and pathology samples, respectively) were first used by some of the authors in [30], from which the following summary observations are drawn:

(i) Each GP surgery produced between 1 and 200 samples daily (the wide range reflecting patient numbers at each), with an average of 40 samples per surgery per day. Samples were packed by each surgery into a medical carrier bag known by the brand name of Versapak, capable of holding up to around 125 samples (Figure 3, Ref. [31]).

(ii) Each surgery was visited twice daily, typically in the morning and afternoon, collecting a single Versapak, containing samples, at each visit.

(iii) Each SCS vehicle collected from up to 18 GP surgeries on their morning or afternoon round before delivering the samples to SGH.

(iv) Each SCS vehicle driver dropped off an empty Versapak at each GP surgery at the same time as making a collection.

(**a**) (**b**) (**c**)

Figure 3. (**a**) pathology sample packaging; (**b**,**c**) insulated medical carriers (Versapaks). The medical carrier has the capacity for approximately 125 pathology samples (photos by the author).

Most collections (nearly 99%) took place from Monday to Friday, with some surgeries also occasionally visited on Saturdays.

3.2. Methodology for Business-as-Usual (BAU) Scenario

Distances travelled by vehicles and the duration of each round were derived from the SCC and SCS datasets. The distances between the postcodes of each stop during the vehicle's route were estimated using Google Maps and confirmed with GraphHopper (a web-based application resembling Google Maps). Round durations were computed by finding the difference between the recorded times of vehicles leaving and arriving back at the vehicle depot in the datasets.

CO_2 emission values for vehicles were acquired from the WebTAG tables disseminated by the DfT [32] and the "Manager's Guide to Distribution Costs" published in the UK by the Freight Transport Association (FTA) [33]. The values indicated 0.28 kg/km for diesel vehicles and 0.07 kg/km for electric/hybrid vehicles. While this is a simplistic assumption, more complex emissions models could not be used due to a lack of information about various influencing factors such as speed–time profiles, congestion levels, road gradients, and driver styles.

Driver and vehicle operating costs were taken from the "Manager's Guide to Distribution Costs" [33]. A profit margin of 3% (i.e., $costs \times 1.03$), approximately in accordance with logistics industry standards [34], was applied to the estimated costs, apart from the costs for the SCC's internal services. It was assumed that courier driver wages would be similar to those given for drivers of light rigid vehicles ($\leq$7.5 tonnes GVW) (GBP 11.93/h, including pay for overtime and productivity), and all vehicles were assumed to have a single operator (i.e., the driver). A combined vehicle operating and standing cost of 0.3391 GBP/km was assumed for both electric/hybrid and diesel LGVs, based on vehicle operating and standing costs published by the FTA for diesel vehicles [34]. The same cost was assumed for electric/hybrid vehicles on the basis that the total cost of ownership has been shown to be similar in Europe for the two vehicle types [35].

3.3. Methodology for Intervention Scenario

In the proposed shared-fleet operating model, it was assumed that all samples were collected by SCC vehicles instead of relying on the external courier company currently contracted by the SCS. This alternative scenario diverges from BAU by incorporating four additional electric vehicles (identical to the Toyota Proace Electric vehicles employed in the BAU scenario) to accommodate both the SCC's own logistics work and the collection and delivery of pathology samples from the 78 GP surgeries. This would expand the SCC fleet from five to nine vehicles, plus two vehicles reserved for contingency purposes ('spare vehicles'). Daily task lists encompassing SCC work and sample collections and deliveries were generated using the historical datasets. All specific collection or delivery requirements associated with the tasks (e.g., time windows) were also specified here. These task lists were used as input data for the commercially available vehicle routing and scheduling software, PTV Route Optimiser, to identify the most efficient routes to undertake all the work.

In close consultation with SCC staff, it was established that adhering to designated time windows for completing time-sensitive tasks is of utmost importance. Specifically, SCC is responsible for delivering school dinners to various schools using their courier vehicles. To accommodate this service, five vehicles have been specifically allocated and made available from 10:30 a.m. to 13:00 a.m. to ensure timely school dinner deliveries. Furthermore, all routes have undergone optimisation procedures to ensure compliance with regulations that stipulate that drivers must take a minimum break of 45 min after driving for no more than 4.5 h. The route optimisation also considers the need for vehicle charging and allows for completing miscellaneous tasks. Moreover, tasks with more flexible timelines, including sample collection and delivery, were reoptimised alongside other tasks to achieve an efficient overall schedule.

Time windows for the morning and afternoon sample collections were set at 09:30–13:00 and 14:30–16:30, respectively, while delivery time windows for the collected samples were established at 13:00–14:30 (from morning rounds) and 16:30–17:00 (from afternoon rounds), respectively.

SCC vehicle capacities (i.e., electric vans: Toyota Proace Electric 75 kW, with a capacity of 5.3 m^3, range of 330 km, and a payload of 1000 kg [36]; plug-in hybrid vans: Ford Custom Trend 340 L1, with a capacity of 6.0 m^3, pure electric range up to 56 km and more than 500 km of total range [37], and a payload of 1150 kg, ref. [38]) were considered in the optimisation of the shared-fleet operation, ensuring that a maximum of 20 Versapaks were carried simultaneously by each vehicle. Vehicle service time per stop was assumed as three minutes for each SCC task, four minutes for each GP surgery (collection of Versapaks), and eight minutes for the delivery of collected Versapaks.

The BAU duty periods for SCC drivers, as outlined in the SCC courier vehicle rounds dataset, typically had a maximum duration of 9.5 h (with an average of approximately 8.7 h), which was also assumed as the maximum for the intervention scenario (with a maximum of 9.5 h and an average of about 8.65 h). Break requirements for SCC drivers were taken into consideration (60 min for lunch and 10–15 min for an afternoon break in BAU). In the intervention scenario, drivers were assumed to have breaks in line with SCC requirements (1 h for lunch and 50 min while their vehicle is being charged). Regarding the charging of electric vehicle batteries, a minimum of 50 min was allocated for charging each vehicle in the intervention scenario. Since only one fast charging point is available at the SCC courier depot (with plans to increase the number), charging periods were assigned separately to avoid conflicts or delays. Moreover, SCC required a daily "spare time" of 120 min to handle unforeseen issues or inquiries. To accommodate this requirement, one of the nine routes was optimised to ensure a 120 min time window was available. This was achieved by limiting the working hours of a particular route to allow for a 2 h period of free time before the end of the daily shift.

Additionally, it should be noted that SCC drivers use their homes as depots, starting and finishing their daily routes from their home addresses. This constraint was taken into account in the intervention scenario for five routes. The SCC courier depot was designated as the start and end point for the four new routes created to accommodate the combined workload of SCC and SCS.

Vehicle kilometre and duty time data came directly from the route optimisation software outputs, with costs and emissions derived from these using the same methods as described for the BAU scenario (Section 3.2). Regarding the distance range of the vehicles, the study implemented a constraint where the total distance covered in each route did not exceed the electric vehicles' range of 330 km [36].

During the feasibility stage of evaluating SCC/SCS shared-fleet operations, the use of readily accessible commercial software proved adequate in helping the identification of efficient solutions. Proposed vehicle rounds were sense-checked by SCC's courier services managers and drivers to ensure they could be implemented in practice. The optimisation algorithm used within the software remains confidential, due to commercial sensitivity. Nonetheless, it follows the traditional technique that underlies the classic travelling salesman problem [39].

4. Results and Discussion

The analysis of vehicle movements in the BAU scenario revealed a considerable overlap between the SCS's and SCC's operational areas (Figure 4). This spatial overlap presents a favourable opportunity to implement a collaborative shared-fleet operation.

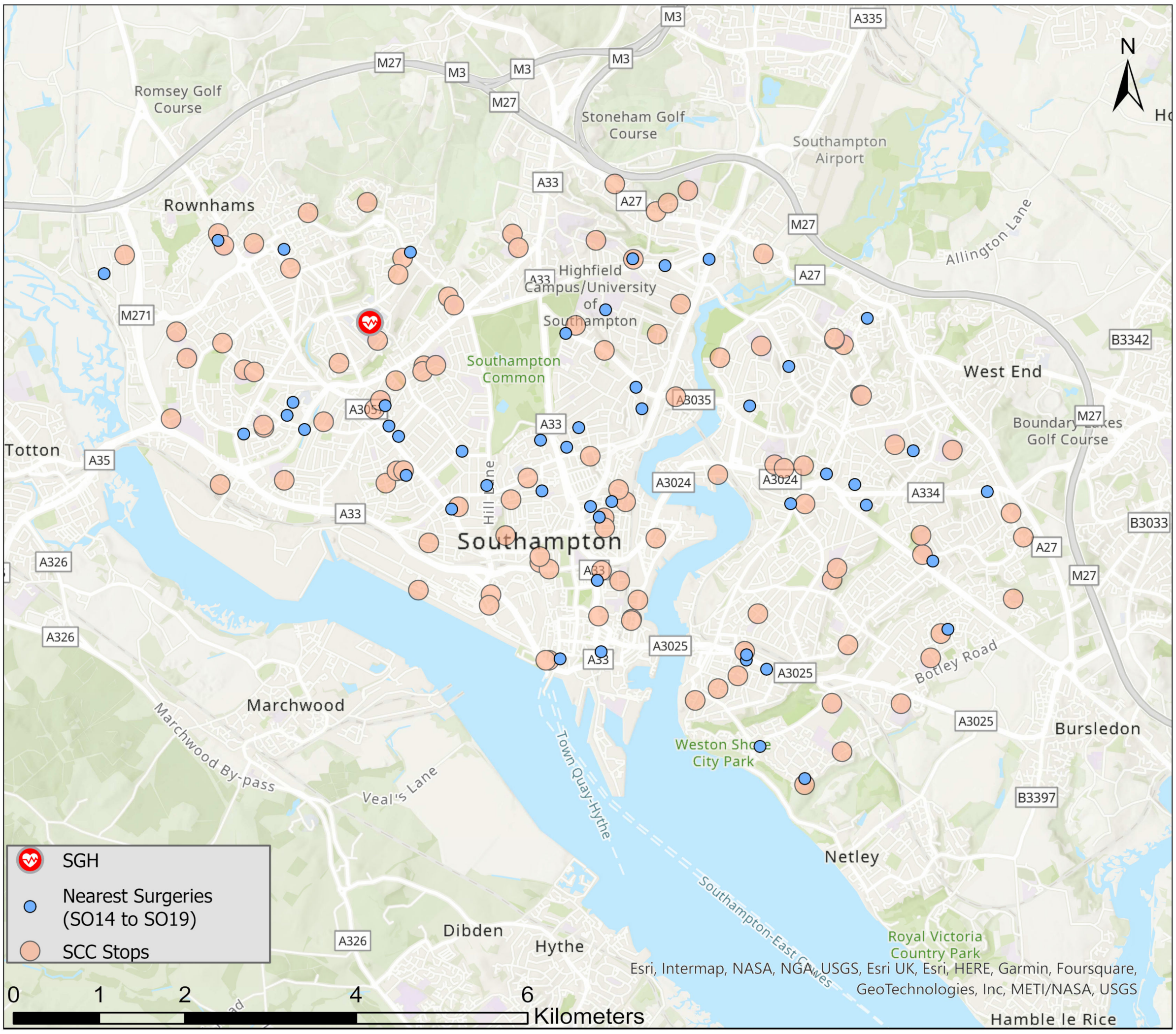


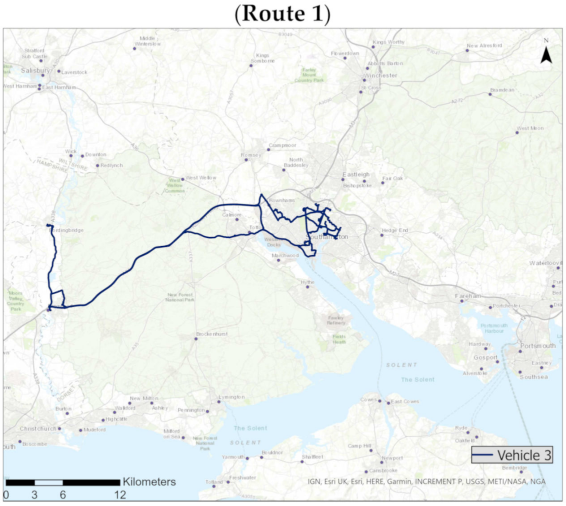
Figure 4. Map showing the GP surgeries (blue circles) and the location of stops of the SCC's five courier vehicles (orange circles) in the Southampton urban area.

In the intervention scenario, four additional vehicles (excluding two vehicles reserved for contingency purposes) were required to accommodate the workload of both the SCS and SCC effectively. Consequently, a total of nine vehicles were allocated, resulting in the creation of nine daily routes (Figure 5). Extensive discussions were held with the staff of SCC to ensure the feasibility of implementing these routes, considering various constraints such as charging times, breaks, working hours, and the availability of vehicles during the collection and delivery of school dinners.

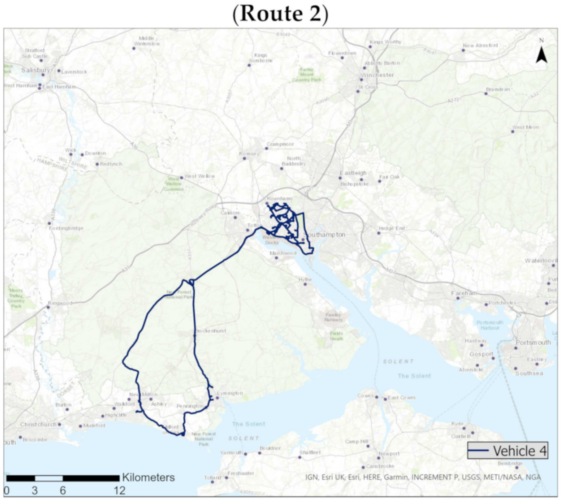
In order to assess the potential benefits of implementing a shared-fleet operation, a comparative analysis was conducted between the results of the BAU and intervention scenarios (Table 1). The case study's findings indicated a considerable reduction in CO_2 emissions, amounting to 69% (237 kg/day), mainly achieved through the use of electric/hybrid vehicles in the intervention scenario. A modest reduction of 3% (52 km/day) in vehicle kilometres was also observed. Moreover, substantial reductions were observed in the number of vehicle routes, duty time, and costs, demonstrating reductions of 40% (six vehicles/day), 27% (27.12 h/day), and 17% (GBP (£) 305/day), respectively.

(**Route 1**)

(**Route 2**)



(**Route 3**)

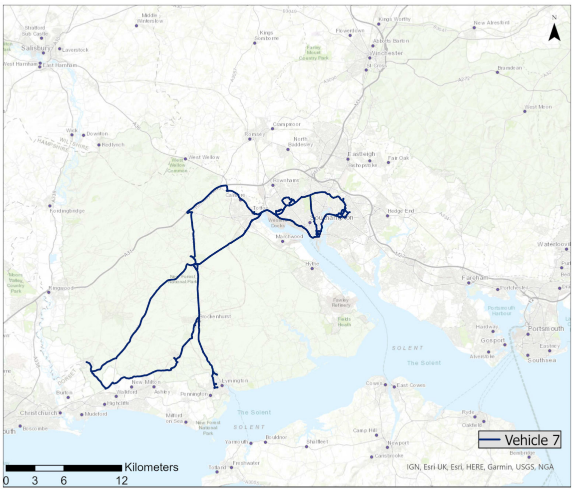


(**Route 4**)

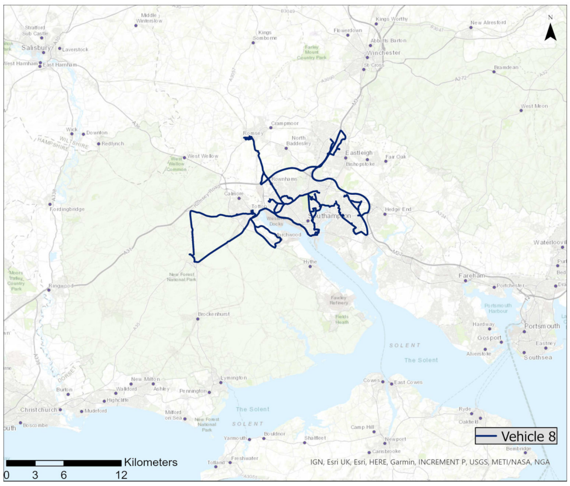
(**Route 5**)

(**Route 6**)

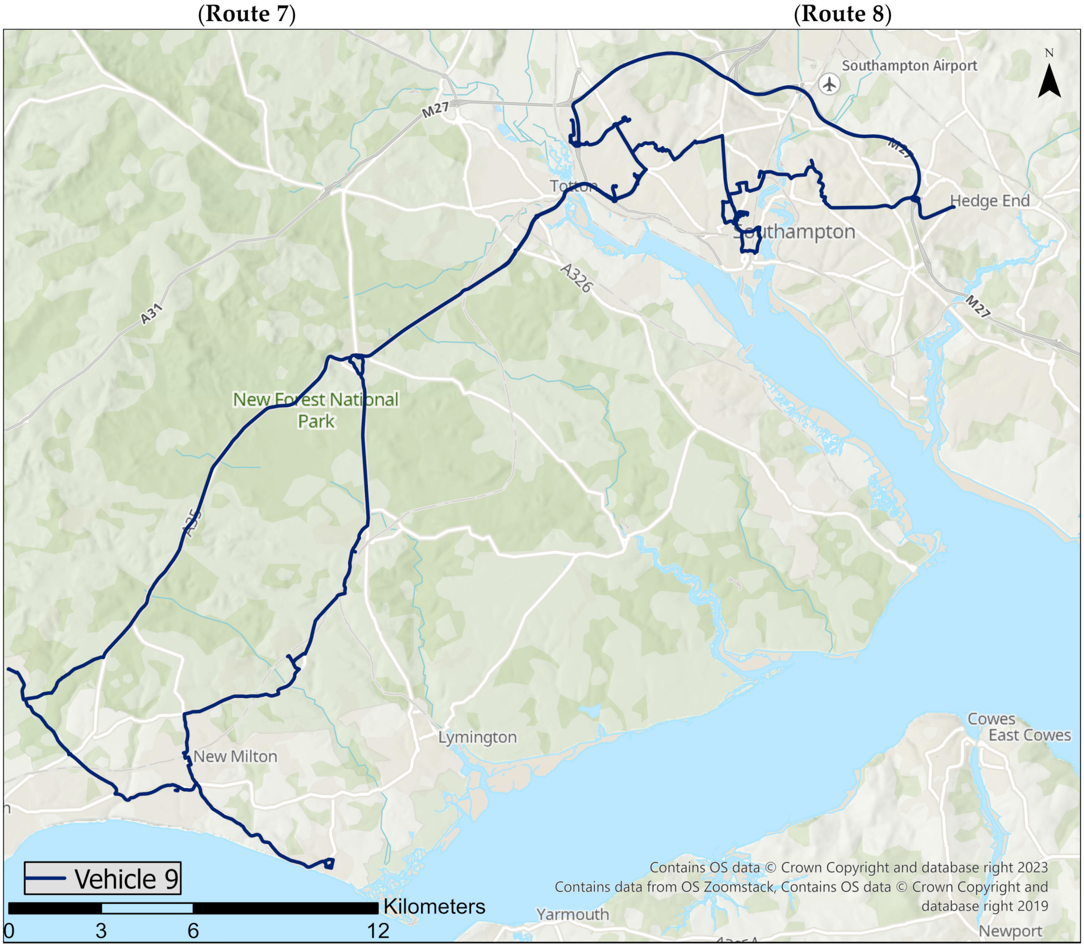
Figure 5. *Cont.*



(Route 7)



(Route 8)



(Route 9)

Figure 5. Maps showing movements of SCC's nine vehicles on Mondays in the intervention scenario.

It was possible to extrapolate annual estimates by multiplying the daily average values by 253, representing the total number of working days per year. Based on this approach, the findings indicated potential annual savings as follows: a reduction of 1518 vehicle routes, amounting to 13,156 km travelled, 6860.52 h of duty time, 59.961 tonnes of CO_2 emissions, and GBP (£) 77,297 in costs (Table 1). The longest route distance of the nine new routes was 225 km, which falls within the electric vehicles' range limit of 330 km. It can be inferred that all routes are feasible in terms of the vehicles' distance capacity.

Table 1. Daily and annual statistics for SCC and SCS in the BAU and intervention scenarios.

	Scenario and Service				
	BAU Daily/Annual Average [1]			Int. Daily/Annual Average [2]	
	SCC	**SCS**	**Total**	**Shared-Fleet**	**Net Effect [3] (% Reduction)**
No. of Vehicle Routes	5/1265	10/2530	15/3795	9/2277	6/1518 (40%)
Vehicle kilometres	420/106,260	1182/299,046	1602/405,306	1550/392,150	52/13,156 (3%)
Duty Time (h:m)	43:30/11,005:30	57:38/14,581:14	101:08/25,586:44	74:01/18,726:13	27:07/6860:31 (27%)
CO_2 (kg)	29/7337	317/80,201	346/87,538	109/27,577	237/59,961 (69%)
Cost (GBP)	£661/£167,328	£1121/£283,621	£1782/£450,950	£1477/£373,653	£305/£77,297 (17%)

[1] BAU is business-as-usual. [2] Int. is intervention. [3] Net effect = BAU − Int.

The analysis conducted in this study has demonstrated the feasibility of implementing a shared-fleet operation involving two public sector participants using an own-account electric vehicle fleet. Specifically, during March 2021, the modelled collaboration between SCC and SCS allowed for the fulfilment of all transportation requirements for pathology samples as well as the daily tasks of SCC. Even if the SCC and SCS are integrated into the vehicle rounds in the intervention scenario, the savings for each service (SCC and SCS separately) can also be estimated by calculating the distances travelled and duty times spent for each service from the nine vehicle routes derived in the intervention scenario. While the cumulative savings are comprehensively detailed in Table 1, it is noteworthy to highlight the distinct cost reductions associated with each service. Even with the nine SCC vehicles jointly executing both services during the intervention scenario, an analysis of their respective statistics derived from the integrated nine routes reveals a 31% reduction in duty hours and a 21% decrease in costs for the SCS, while the SCC's internal operations saw reductions of 21% in duty hours and 11% in costs when compared to the BAU scenario.

The findings highlight the significant cost-saving opportunities for the NHS and the potential additional revenue for the LGA. The potential revenue is particularly significant considering the financial constraints faced by LGAs worldwide due to austerity measures [35]. Public sector organisations, such as the NHS and SCC, should consider implementing policies to harness these benefits. These policies also have the potential to reduce the negative externalities associated with road logistics, such as air pollution, especially where electric vehicles are used, and road congestion. Although this research centred on a prominent public sector institution in the UK, namely the NHS, its findings could be relevant globally. In various regions, public sector bodies such as national and local governments, healthcare institutions, educational institutions, and infrastructure providers manage their vehicle fleets. These entities might gain advantages in a similar way by identifying opportunities for collaboration and making better use of existing vehicle fleet capacity.

Practical Issues and Research Limitations

Despite the potential benefits highlighted by implementing a shared-fleet operation, it is important to acknowledge the practical considerations and constraints that may act as barriers to wider implementation [27,30,40]. These may include:

1. Overly restrictive collection or delivery time window requirements.
2. Unforeseen delays in vehicle operations (e.g., traffic jams, vehicle breakdown issues, driver's health, etc.).
3. Highly variable travel times or loading/unloading times leading to unreliable journey times.
4. Existing contracts (e.g., with a courier company) and service level agreements, which may inhibit or delay a change in operation.
5. Ensuring the secure storage of items carried within vehicles.

6. Quality control measures necessary to monitor and mitigate any required in-vehicle conditions such as temperature or vibration control which might impact cargoes.
7. Mitigating against the risk of loss or damage to items carried.
8. Persuading all stakeholders of the advantages of participating.
9. Ensuring the availability of sufficient spare capacity in the vehicles being used.
10. Ensuring that vehicle rounds are as efficient as possible and that they are regularly monitored and revised to meet changing demands.

In addition to the above, shared fleet operations between public sector organisations will only arise where there is some form of active engagement between the various stakeholders to identify the opportunities available to do this and to establish what the expected benefits for each side are. A mutually beneficial agreement would have to be established, detailing work requirements, management processes, and covering financial and legal issues, among other things. Initiating discussions between stakeholders and reaching an agreement is not likely to happen quickly between public sector organisations, given that managers are typically dealing with many other more pressing concerns daily. There may also be an element of silo thinking, a lack of awareness or lack of consideration of such opportunities, or it may be simpler or more convenient to place transport contracts with known, approved suppliers.

The above factors highlight the practical challenges and constraints that must be addressed to initiate a shared-fleet operation and to realise the potential benefits. The authors are engaging with two LGAs in the Solent region and two NHS Trusts, and providing them with case study analyses to promote shared-fleet operation and initiate discussions between them. This may lead to practice trials, before any full-scale implementation, to further investigate and quantify the benefits suggested by the findings of this study.

Regarding research limitations, it is important to acknowledge that the data used in this study have certain temporal differences, as the SCS data were obtained in March 2021, while the SCC data were collected in May 2023. The historic pathology sample generation dataset utilised in the analysis indicated a relatively consistent demand pattern over time, with no discernible seasonal variations and a stable monthly sample volume from the participating surgeries. Consequently, in a real-world implementation, it is unlikely that the SCC vehicle fleet would encounter unexpected sample collection requests beyond those accounted for in the analysis.

Furthermore, it should be noted that the benefits identified in this study are specific to the case study examined. To comprehensively assess the feasibility and effectiveness of shared-fleet operations between public organisations, conducting real-world trials and expanding collaborations to include additional parties is imperative. New case studies and trials would enable a broader assessment of the potential benefits and limitations of collaborative initiatives, thereby informing future decision-making processes and facilitating the adoption of efficient and sustainable transportation practices within the public sector.

5. Conclusions

Our study presents a novel perspective on shared-fleet collaborations, being the only research to date that involves two distinct public organisations. Furthermore, the incorporation of feedback from council service operators on vehicle rounds lends a realistic dimension to our intervention scenario, making our approach distinctly grounded and pragmatic. The research findings demonstrate the feasibility and potential benefits of collaborative shared-fleet operations between public sector organisations, emphasising their significant impact on environmental sustainability and transport-related challenges. The results of the case study showed that shared-fleet operations could reduce vehicle numbers and associated vehicle kilometres, addressing inefficiencies in urban traffic and congestion. The substantial 69% reduction in CO_2 emissions achieved through the adoption of electric vans contributes to climate change mitigation and improved air quality in the operation area. It can be suggested that LGAs play a crucial role in promoting the use of electric vehicles and integrating them into their own operations.

Furthermore, the shared-fleet operation offered economic advantages, with a 17% cost reduction providing potential savings for public sector organisations. The collaboration between the SCC and SCS presented an opportunity to generate additional revenue for the donor participant of the collaboration (SCC), particularly valuable for local authorities facing financial constraints. Overall, these findings underscore the potential of shared-fleet operations to address environmental and economic challenges, fostering sustainable transport practices and financial sustainability for public sector own-account vehicle fleets.

These findings also have important implications for management and decision makers in public organisations running their own-account vehicle fleets. Actively pursuing policies exploring the opportunities for deploying shared-fleet operations to optimise vehicle routes can lead to significant benefits and potential reductions in public sector expenditure. To further support and validate these implications, conducting real-world trials of shared-fleet operations is crucial. These trials would shed light on the practical realities and potential impact of factors such as developing a new business model to allocate costs and benefits among collaborating parties, establishing agreements on cost allocation and management processes, and forming a new contract specifically for the transportation of pathology samples utilising SCC electric courier vehicles, rather than relying on external commercial courier services. Additionally, future studies could perhaps focus on the investigation and creation of novel algorithmic optimisation strategies on shared-fleet operations to optimise vehicle routes more efficiently.

In summary, this study made several significant contributions. Firstly, it provided evidence supporting the feasibility and prospective advantages of shared-fleet collaborations including public sector own vehicle fleets and addressing healthcare logistics demands for specialised payloads, a relatively unexplored area in the previous literature. Secondly, the study quantified the potential benefits of such collaborations, highlighting their value in practical terms. Thirdly, it identified the potential for wider implementation of shared-fleet operations by other public sector organisations facing similar challenges worldwide. Lastly, this research helped address the existing gap in the literature, specifically the lack of studies based on real-world activity data related to shared-fleet collaborations.

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