# Locating urban freight micro-consolidation centres: a practical methodology

Andrew Bullock[a*], Fraser McLeod[b] , Matt Grote[b], Djamila Ouelhadj[a], Jonathan Crabb[a], Tom Cherrett[b], Graham Wall[a], and Graham Fletcher[a]

[a] *Intelligent Transportation Cluster, University of Portsmouth, Portsmouth, UK*

[b] *Transportation Research Group, University of Southampton, Southampton, UK*

* Andrew Bullock, Intelligent Transportation Cluster, University of Portsmouth, Lion Gate Building, P01 3HF, UK, email: andrew.bullock@port.ac.uk

# Locating urban freight micro-consolidation centres: a practical methodology

Micro-consolidation centres (MCCs) can offer sustainable freight logistics solutions in urban areas. This paper presents a novel methodology for Local Government Authorities (LGAs) to promote the future development and use of MCCs by freight logistics companies through identifying suitable sites for such facilities in urban areas within their districts. The methodology is practical for LGAs to use within the constraints of limited financial and human resources, and is based on a distillation of previous research, showing how a simple, structured methodology can work with imperfect real-world data. The methodology was trialled in practice in Portsmouth, UK, where two preferred MCC sites were successfully identified for progressing to real-world trials. The methodology was designed to be transferrable, and the case study application to Portsmouth identified insights into the challenges affecting its utility in other urban areas, such as maintaining equity between stakeholders and engaging personnel whose time resources are scarce.

Keywords: site selection criteria, urban planning, micro-consolidation, Local Government Authority, parcel delivery.

## 1. Introduction

Freight Micro-Consolidation Centres (MCCs) in urban areas facilitate the transhipment, temporary storage, and last mile delivery of goods to homes and businesses, typically using zero or low emission vehicles such as cargo bicycles or electric vans, and enable load consolidation, whereby suppliers or logistics service providers agree for their goods to be combined and delivered by a third party. They can also offer added value for the local community if used as parcel pick up and drop off (PUDO) points (Katsela *et al.*, 2022). MCCs can offer an alternative, more sustainable logistics solution in urban areas for business-to-business (B2B) or business-to-customer (B2C) deliveries that ordinarily depend on diesel vans traveling between depots, sub-depots, and delivery destinations, often with the less-than-full-loads that are known to reduce the

efficiency of road freight movements (Grote *et al.*, 2021).

Although micro-consolidation initiatives are usually industry led, LGAs can take a more proactive role in promoting or supporting such initiatives, as they do with other LGA-led sustainable freight initiatives. For example, provision of centrally located spaces for shared-use distribution (Rosenberg *et al.*, 2021; Buldeo Rai *et al.*, 2022; BEHALA, 2024) and funding schemes for the use of cargo cycles or other low emission vehicles (Lenz and Gruber, 2021; GOV.UK, 2022). However, identifying suitable locations for MCCs can be difficult, especially in densely populated and ever-changing urban environments where land uses and the demands upon them are diverse, and particularly for LGAs with the limited human and financial resources they can dedicate to the task. The aim of this research was to develop a practical methodology for use by LGAs in identifying suitable sites for MCCs in urban areas within their districts.

The methodology was developed (building on prior work), and then tested by application to a case study of the city of Portsmouth, UK in collaboration with the relevant LGA, Portsmouth City Council (PCC), who is actively engaged in investigating MCC options, alongside other goods delivery models (e.g., macro-consolidation and use of drones), as part of the UK central government funded Solent Transport Future Transport Zone (FTZ) project. A practical and systematic methodology was developed to identify potential sites for MCCs and to compare the sites, evaluating them across a range of criteria drawn from the related literature on micro-consolidation and decision-making methodologies (Section 2), to produce a shortlist of preferred sites. The research was thus a distillation and application of known methods. The research also aimed to help PCC decide whether the MCC concept would be appropriate for Portsmouth and, if so, what the most appropriate business model would be for a specific area within the city, and

which areas or specific sites within the city would be best suited for implementation as a pilot project.

The research has wider relevance beyond Portsmouth because the case study area (i.e., Portsmouth) is an urban area reasonably typical of those found in developed nations around the world, and because the methodology was designed to be transferable to other similar urban areas (e.g., similar local government structures, transport infrastructure, and parcel delivery systems), helping to promote the future development and use of MCCs.

## 2. Selecting locations for urban MCCs: a review

The concern of this paper was the development and application of a practice-oriented methodology, and therefore literature addressing theoretical optimisation techniques to determine ideal numbers and locations of MCCs was deemed to be out of scope.

### *2.1. Benefits of MCCs*

MCCs located in urban areas are widely regarded as an emerging solution to help mitigate the detrimental effects associated with the last-mile delivery process (e.g., greenhouse gas emissions, air pollution, road traffic congestion), offering an important opportunity to improve the efficiency and sustainability of freight logistics, to reduce costs, and to promote collaboration within the sector (e.g., consolidating vehicle loads through sharing vehicle capacity) (Katsela *et al.*, 2022; Novotná *et al.*, 2022; Mpogas *et al.*, 2020; Grote *et al.*, 2021; Paddeu, 2025). However, an important question for municipal LGAs wanting to adopt a policy of implementing MCCs is where such facilities would be best located within their districts (Novotná *et al.*, 2022), which is a difficult question for LGAs to answer, given their limited human resources and

publicly funded finances.

### *2.2. Locating MCCs*

Useful advice for municipal LGAs when considering MCCs was given by Assmann *et al*. (2019) in their planning guide for cargo bike transhipment hubs. Recommendations included: specification of the intended effects (e.g., improving air quality) and the planning horizon; planning of the rough concept and associated requirements; analysis of which stakeholders should be involved and their roles; analysis of freight volumes involved and related hub requirements (e.g., space needed); development of standardised and scalable solutions. Stated characteristics of an 'ideal' transhipment hub included: good access for vans and bikes; location in a dense, mixed-use area, close to main roads and the city centre but unobtrusive; minimum two-year availability; good cycling infrastructure (e.g., paths wide enough for cargo bikes); electrical power; safe overnight loading and storage facilities. Other stated site requirements or preferences for a MCC in central London included avoidance of one-way road systems, floor space between 90-185 $m^2$, a minimum height access of 2m, access from 6am to 8pm, short leases with a high level of flexibility, and CCTV (Cross-River Partnership and Steer, 2020).

Obtaining affordable spaces to buy or rent in city centres for storage and distribution use can be difficult. Land prices have been a dominant factor in the trend of 'logistics sprawl' (distribution centres moving further away from city centres), a long-lasting trend that has been observed worldwide (Dablanc and Browne, 2020), and only partially countered in recent years due to increasing demand for just-in-time delivery, which requires more centrally located hubs (Fried and Goodchild, 2023). As logistics sprawl results in increased freight vehicle stem mileage to serve cities, MCCs have the potential to reduce these distances and associated

negative environmental impacts (Katsela *et al.*, 2022), and are a form of 'proximity logistics', a term adopted by Buldeo Rai *et al.* (2022) to refer to more centrally located logistics facilities.

The financial viability of any freight consolidation initiative is a concern, as many urban consolidation centres (UCCs) have failed due to lack of profitability, sometimes related to insufficient demand (Janjevic and Ndiaye, 2017). A MCC differs from a traditional UCC in being smaller in scale, both in terms of size of building and size of delivery area, and in being closer to the delivery area. Whereas a traditional UCC may be located on the outskirts of a city, a MCC will tend to be within the city, although it is suggested they should be on the periphery of any local market area to avoid issues of freight vehicle congestion (Katsela *et al.*, 2022). Whilst at a smaller scale, the introduction of a MCC still involves increased building, vehicle, labour, and operating costs that may compromise financial sustainability. Katsela *et al.* (2022) observed that some companies were willing to bear increased costs to support green deliveries and proposed that the costs of externalities should be accounted for in any financial scheme evaluation.

### *2.3. Site selection criteria and analysis methods*

A key challenge in the development of a MCC, whether publicly or privately developed and/or owned, is how to design transparent and quantifiable site selection criteria to guide the location decision. Three broad criteria proposed by Janjevic and Ndiaye (2014) were: 'relevance' relating to market demand, with density of deliveries in the surrounding area often being a key factor; 'suitability' relating to operational usability of the site; and 'feasibility' relating to levels of support from relevant stakeholders. Many multi-criteria decision-making analysis (MCDMA) methods and hybrid variations have been developed, with a comprehensive review provided by

Sahoo and Goswami (2023). The general approach, also adopted in this paper, is to identify specific site selection criteria of interest, then weight each criterion according to its perceived importance and produce an aggregated overall score for each site to rank them. It is outside the scope of this paper to describe the attributes and merits of specific MCDMA methods. However, for reference, MCDMA methods that have been used in the context of urban freight consolidation site selection include the Analytic Hierarchy Process (AHP), the Best-Worst Method (BWM), Criteria Importance Through Intercriteria Correlation (CRITIC), Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE), the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Data Envelopment Analysis (DEA), and Weighted Aggregated Sum Product Assessment (WASPAS) (Aljohani and Thompson, 2020; Rudolph *et al*., 2022; Novotná *et al*., 2022; Bajec *et al*., 2023).

The use of geographic information system (GIS) software has also been proposed to incorporate spatial aspects such as proximity to road networks or to delivery areas, where the latter may be defined with reference to carrier delivery data or population data (Rudolph *et al*., 2022).

Site selection criteria would ideally be identified in consultation with urban freight stakeholder groups such as shippers, receivers, carriers, citizens, landowners, and municipal LGAs (Ringsberg *et al*., 2023). However, effective engagement with and communication between appropriate stakeholders can be highly challenging to achieve (DiMoG, 2023). Each stakeholder group, and individual people or organisations within them, can have differing and sometimes conflicting objectives. A proposed method for considering these equitably is ‘multi-actor, multi-criteria analysis’ (MAMCA) (Macharis *et al*., 2012). Another approach is the so-called ‘living lab’, whereby stakeholders are directly involved in the co-creation, design,

development, and implementation of a specific thing or concept (Garus *et al*., 2023). For example, the living lab approach was used to develop a pilot MCC in Seattle, USA, where the participating stakeholders were the landowner, a supplier of cargo bike infrastructure (storage and towing), a cargo bike manufacturer, a logistics startup (vehicle routing and scheduling), the local transport authority, and a university research team (Gunes *et al*., 2024).

### *2.4. Policy, regulations and guidelines*

It has been reported that, in many countries, LGAs are not particularly welcoming of logistics facilities development in urban areas for various reasons, including the associated negative externalities, relatively small tax contributions, relatively few jobs per land space, and perhaps due to insufficient engagement by the authorities with industrial stakeholders (Buldeo Rai *et al.*, 2022). This may be less of an issue for the development of a relatively small MCC but, nevertheless, LGAs can promote more sustainable freight operations by, for example, adopting more freight-friendly policies and regulations, as well as offering financial subsidies, local publicity campaigns, and networking opportunities. As an example, the Paris zoning ordinance of 2016 included MCCs as "public services or activities of general interest", giving certain derogations and exemptions for construction of logistics buildings in dense urban areas, and identified 61 areas of land which would require a logistics hub to be integrated into any new development projects (Dablanc, 2023).

Municipal LGAs in the UK, Europe and much of the western world have obligations to consider all relevant stakeholders when making any decisions about public land use and associated transport-related issues such as access and parking. The provision of a MCC by a public authority requires an open and transparent method of offering it for use by one or more

operators. From a municipal LGA perspective, it will likely be important that the development is compatible with surrounding land uses (e.g., industrial, commercial, residential) (Rudolph *et al*., 2022). However, there appear to be no fundamental policy or regulatory barriers to development of a MCC, although larger sites will likely need planning permissions if a change of use is involved.

In general, there are currently no guidelines to assist LGAs in the UK with their policies and planning related to urban freight, with local transport planning tending to prioritise movement of people over goods. Given the expected increases in e-commerce (Statista forecasts a doubling of 2019 levels by 2029[1]) and freight volumes and the detrimental effects of last-mile deliveries, there is an urgent requirement to support LGA policymakers in developing local plans and making informed decisions aimed at implementing interventions that mitigate these effects (Paddeu, 2025).

### *2.5. Review summary*

MCCs are one option, among numerous possible freight interventions (e.g., low emission zones, delivery time windows, traffic restrictions, financial subsidies, local publicity campaigns), that municipal LGAs should consider as a way to improve freight logistics operations in urban areas. However, site selection for MCCs is difficult, especially in densely populated urban environments where land is scarce, and particularly for LGAs within the constraints of their limited human and financial resources.

[1] Statista United Kingdom (UK): retail e-commerce revenue forecast from 2017 to 2029 https://www.statista.com/forecasts/477091/e-commerce-revenue-forecast-in-the-united-kingdom

The novel contribution of this paper is to distil and combine the relevant findings from previous literature to produce a novel methodology that is practical for municipal LGAs to use, and to test that methodology through application in a case study urban area, providing insights into the challenges and barriers that could be encountered as a result.

## 3. Methodology

### *3.1. Overview of methodology*

The MCC site selection methodology developed in this research is summarised in Figure 1, with further details provided in subsequent sections. A brief overview of the methodology is as follows. The first step is to create a working group of experts to oversee, manage, and perform the application of the methodology (Section 3.2), which is followed by identification and organisation of the site selection criteria (Section 3.3). A 'long list' of sites for potential consideration is drafted collaboratively based on the expert local knowledge available from members of the working group (Section 3.4), which is then filtered down to a 'short list' via a RAG (red/amber/green) rating process (Section 3.5). The final step is to assign a rank value to each site using the newly developed site selection software tool (Section 3.6).

### *3.2. Creation of working group*

The initial step in the methodology is to create a 'micro-consolidation working group' to oversee, manage, and perform all the activities involved. The working group should consist of the necessary personnel such as project managers, freight logistics industry consultants, academic researchers, and LGA officers from transport, planning, economic development, communications, and legal departments. From the perspective of an equity obligation, LGAs

cannot be seen to be favouring one freight operator or user group over another. For this reason, LGAs may require a neutral intermediary (e.g., university research team) to engage with potential users of a MCC.

### *3.3. Site selection criteria identification*

Based on the professional expertise within the working group and insights gained from a review of the relevant literature, site selection criteria are identified and organised into groups. The proposed site selection criteria should then be presented to LGA officers, providing the opportunity to raise any concerns or questions about the criteria or about any other criteria they think might also be relevant. Some examples of site selection criteria are shown in Table 1.

### *3.4. Long-listing exercise*

Local knowledge of the study area from within the working group (in particular from LGA officers) is used to draft a 'long list' of sites for potential consideration as a MCC. At this stage, sites are identified regardless of their status with respect to normally critical issues such as ownership, availability, leasing terms, and costs. The exercise is not intended to be fully objective or comprehensive but, rather, a 'first pass' to obtain a list of sites having a wide range of locations, conditions, and land uses. The exercise is designed to raise important questions about site feasibility through selecting sites that are likely to vary in how well they would meet the criteria.

### *3.5. Short-listing process*

To reduce the number of sites further, a 'RAG (red/amber/green) rating' process is conducted by

the LGA officers in the working group. 'Red' (rejected) sites are considered to be unsuitable for a particular reason (e.g., subject to ongoing or soon-to-be-submitted planning applications for major redevelopment, being a car park that is well used, or being a car park where parking passes have already been purchased). It might be questioned why a site would have made the long list only to be immediately rejected, however, it is only the exercise of making the long list that prompts site investigations in the necessary detail.

'Amber' sites are considered to require more time for internal discussions across LGA departments before confirming the likely suitability for short-listing (e.g., due to the need to await other planning decisions for sites). These sites are only revisited should there not be sufficient site potential drawn from the 'green' sites. 'Green' sites are those that the LGA officers have most confidence in as being potentially suitable for MCCs, and are subject to further assessment through site visits by members of the working group.

### *3.6. Development of a site selection software tool*

After a review of MCDMA methods (Section 2.3), a site selection software tool was developed based on criteria scoring, ranking, and weighting methods. The tool allows users readily to compare different sites based on their opinions about the suitability of each site, when scored for each sub-criterion, and allows them to assign weights to the sub-criteria, according to perceived importance, and priority rankings to the criteria groups. Specifically, the tool enables the user to assign:

(1) a score, $S_{[site,\ sub]}$ to each site for each sub-criterion using a scaled rating from 0 to 1;

(2) a weight, $W_{sub}$, from 1 (least important) to 5 (most important), to each sub-criterion;

(3) a rank, $R_{group}$, from 1 (highest priority) to 5 (lowest priority), to each criteria group.

Some illustrative examples of what might be considered when deciding how to score a site for different sub-criteria are shown in Table 2. Such a table could be provided for user guidance, if desired, but was not available to users (LGA officers) in this study. If weighting of sub-criteria or ranking of criteria groups is not desired by the user, then the tool uses a default value of 1 for the weights or ranks. The tool allows the same rank value to be given to two or more criteria groups and not all rank values need be used.

The tool calculates a score out of 10 for each site, $S_{[site]}$, using equation (1):

$$S_{[site]} = 10 \times \frac{\sum_{group} \frac{(6 - R_{group})}{N_{group}} \sum_{sub \in group} S_{[site,sub]} W_{sub}}{\sum_{group} \frac{(6 - R_{group})}{N_{group}} \sum_{sub \in group} W_{sub}} \quad (1)$$

where $N_{group}$ is the number of sub-criteria within a criteria group, 'sub' refers to sub-criteria, and 'group' refers to criteria groups. This calculation involves:

(1) Multiplying by (6 - $R_{[group]}$) to convert ranks to weights (e.g., rank 1 has weight 5).
(2) Dividing by $N_{group}$ to ensure that the number of sub-criteria within a group does not influence the score.
(3) Comparing the site-related values (in the numerator) with those of a 'perfect site' (in the denominator) where the $S_{[site,sub]}$ values are replaced with maximum scores of 1 across all the sub-criteria.
(4) Multiplying by 10 to convert to a score in the range 0 to 10.

## 4. Results

### *4.1. Description of case study area*

Selection of the case study urban area for testing the new methodology (Portsmouth) was dictated by the availability of a municipal LGA willing to provide the cooperation necessary to complete the research. PCC was one of the LGAs collaborating in the Solent Transport FTZ project and were therefore offering this cooperation. Portsmouth may be particularly well-suited to micro-consolidation as it is one of the UK's most densely populated cities, with a mid-2022 estimated population of 208,400 people living in a 40 $km^2$ area (PCC, 2024). An estimated 42,000 parcels are delivered each day into Portsmouth using over 650 delivery personnel, based on a projection of parcel delivery data obtained from a major carrier, so there would appear to be great scope and potential benefit from implementing one or more MCCs in the city.

PCC's interest in micro-consolidation relates to the significant growth in e-commerce and its associated challenges in making deliveries more efficiently. Related issues include high first-time delivery failure rates, high proportions of single-parcel deliveries, frequent product returns, and express deliveries. In common with the rest of the UK, van traffic is the fastest growing area of traffic demand. Portsmouth also has some locally unique delivery conditions relating to its geography, with its city centre effectively being on an island with only three road connections to the mainland (Figure 2).

Portsmouth has increasingly decentralised and polycentric land use patterns with significant development in edge-of-city areas, exacerbated by a recent history of such development being designed predominantly around driving (though the emphasis in development design is now shifting more towards ensuring accessibility to active and public transport in many

cases). This results in significant traffic congestion, economic impacts, low productivity, and air quality issues. With the proposed implementation of an MCC, PCC aims to provide stakeholders with an opportunity to explore and demonstrate new ways of making urban logistics more sustainable, and to provide practical evidence of the extent to which MCCs can reduce the transport footprint of last-mile parcel delivery if widely adopted

### *4.2. Creation of working group*

The working group created for the application of the novel methodology to Portsmouth consisted of representatives from the different fields of expertise necessary (Section 3.2), and was active between July 2022 and February 2023, with an overview of the group activities shown in Figure 3. To avoid any appearance of PCC favouring one freight operator over another, the academic researchers (rather than LGA officers) on the working group had informal meetings with potential MCC users such as national parcel carriers and local independent couriers located in different areas of the UK, including those using cargo cycles, to gauge their level of interest in and requirements for a MCC.

### *4.3. Site selection criteria identification*

Site selection criteria for Portsmouth were identified and grouped, before being presented to PCC officers for review and the addition of any other criteria thought relevant. On this occasion, no additional criteria were suggested by the PCC officers. Portsmouth is densely populated, and therefore all candidate MCC locations would be close to residential delivery areas, so proximity to delivery area is likely not a key concern, but was included for completeness, along with proximity to industry. The selected criteria groups and sub-criteria within each group for Portsmouth were those shown in Table 1.

### *4.4. Long-listing exercise*

A ‘long list’ of sites for potential consideration as a MCC in Portsmouth was drafted. The identified sites included kerbside locations, car parks, community buildings, retail units, shopping centres, and business centres. Upon reviews by the working group, some sites originally included in the long list were removed where they were known by PCC to have development plans in progress, while other sites not previously suggested, were added. The final long list included 32 potential sites. Figure 4 shows the long list prepared by the academic researchers, which was presented to PCC and informed the collaboratively generated official long list of 32 sites.

### *4.5. Short-listing process*

The ‘RAG (red/amber/green) rating’ short-listing process was conducted for the 32 sites (Figure 5). This produced 18 ‘red’ (rejected) sites, which included vacant department stores and high street retail units, active multi-storey and surface level public car parks, business centres, and closed amenity sites such as a former public swimming pool and a fire station.

Six ‘amber’ sites were identified, along with eight ‘green’ sites. Site visits were made to the eight ‘green’ sites (Figure 5) by ten members of the working group, including LGA officers from the transport and planning departments. The assessment of each site included careful consideration of the full list of site selection criteria (Table 1) for a fair and objective comparison across the sites. A summary of the site visit findings is given in Table 3.

The tour of sites also provided an opportunity to identify any other sites along the way that were not previously considered. Four such sites were observed and added to the ‘green’ list, including vacant retail units and a car park which had shipping containers on site but appeared to

have unoccupied space and good site access. Two of the 'amber' sites (Tipner Park & Ride and Bridge Shopping Centre) were also subsequently moved to the 'green' list after further consideration following the site tour, due to a change in their status. The Tipner Park & Ride site move to 'green' was partly due to a milestone being achieved in a separate PCC project which now made the site more suitable for a MCC. Meanwhile, the Bridge Shopping Centre became a beneficiary of national government funding (GOV.UK, 2023) which enabled the council to purchase the site and begin work on its regeneration. Between 2010 and 2019, most retail units had been vacant, with an increase in occupancy from 2020. The funding came with a requirement to fill the vacant retail units with occupants that would increase footfall, provide diversity and innovation in the range of activities available. With these additions, the 'green' list comprised 14 sites.

### *4.6. Application of the site selection software tool*

These 'green' sites were compared using the MCDMA site selection software tool (Figure 6), which identified two preferred (i.e., highest ranked) locations.

The input scores in the site selection tool assigned to each site for each sub-criterion were decided by the academic researchers based on the site visits and discussions with the working group. Criteria group priority rankings (Table 4) were provided by LGA planning officers, where site availability, social impacts, and environmental impacts were their main priorities. Default weight values of 1 were used for the sub-criteria as the LGA officers had limited time available or preferred not to consider this level of detail. Based on these inputs, the two highest scoring and thus preferred sites were 'Cascades Shopping Centre' (score of 8.8) and 'Bridge Shopping Centre' (score of 8.4).

Brief details of the final preferred sites are as follows. The Cascades Shopping Centre is a privately owned indoor mall located within the city's central commercial area, and is typical of many malls in the UK in being conveniently accessible from the road network and in having vacant retail and storage units available. The Bridge Shopping Centre is also in the central commercial area, about 1km east of the Cascades Shopping Centre, with good accessibility for road vehicles, and is currently owned by the LGA. A summary comparison of the two preferred sites is shown in Table 5.

## 5. Discussion

This paper has developed and demonstrated a systematic methodology to identify preferred sites for locating MCCs within urban areas. The proposed methodology is likely to be practical for municipal LGAs to use within their constrained resources in promoting or supporting the implementation of MCCs within their districts as one way to address the detrimental effects of urban freight operations. The methodology has been tested through being employed by an LGA in the real-world, where it successfully identified two preferred sites in the case study urban area of Portsmouth. The two sites were confirmed as being good options for locating MCCs in the opinions of LGA officers with expert knowledge of, and familiarity with, the requirements and characteristics of the case study area. The development of the methodology contributes to providing LGAs with guidance to assist with policies and planning related to urban freight, and with support in making informed decisions; areas within the sector identified as currently lacking and urgently needed in the UK.

Through using the methodology, LGA officers were successfully able to present the two preferred site options to cabinet members (i.e., elected LGA decision makers) for information

and approval. Cabinet approval to proceed was given, including allowing delegated authority for the selection of which site to move forward. This indicated that the LGA decision makers (i.e., cabinet members) had confidence in the methodology, judging it to have been suitably informed and trustworthy. The decision to proceed has allowed the next steps to be taken towards real-world MCC pilot trials in Portsmouth, and assessing the effects of siting a MCC in a particular location is suggested as an area for future research, involving investigation, both pre- and post-intervention, of factors such as road traffic congestion, air quality issues, greenhouse gas emissions, costs, noise pollution, and accidents. For the Solent FTZ, this will be undertaken through analyses including routing optimisation and calculating potential economic, social and environmental cost savings resulting from the trials.

The results of applying the methodology to the case study urban area are necessarily Portsmouth-specific. However, the experience of applying the methodology offers valuable insights of interest to a broad audience (e.g., other LGAs or researchers), with the methodology designed to be transferable to other urban areas with similar local government structures, transport infrastructure, and parcel delivery systems. Key insights from the Portsmouth application included: the practical challenges inherent in setting-up and running a working group consisting of a disparate assembly of busy people with multiple demands on their limited time resources; and the need to balance competing stakeholder interests equitably, including the requirement for the LGA not to be seen to be favouring any particular freight operators as prospective MCC users. The transferability of the methodology needs to be confirmed through further research assessing the application of the novel methodology to other case study urban areas, particularly as Portsmouth has several atypical characteristics related to its geography (Section 4.1).

Another area suggested for further research is performing sensitivity testing on the methodology to ensure robust solutions are produced, including application to other case study areas both within and outside the UK. In addition, refinement of the site selection software tool could be undertaken to check for and remove any unintended effects when comparing sites. This would help identify the best solution and other good alternatives amongst the site options. It would also be useful to gain the involvement of more stakeholders than was possible in this study, especially from potential site users (e.g., commercial parcel carriers), who are likely to have different views and priorities regarding MCCs than those of LGA officers. This could reveal if the same or different sites would have emerged as preferred sites, according to the different ranking and weights applied to the criteria groups and sub-criteria.

Some of the key issues and challenges of using the new methodology from the perspective of the intended users (i.e., LGAs) were captured through informal interviews with LGA officers (n=2) post application of the site selection methodology to the case study area. In general, applying the methodology was seen as an important factor in allowing the LGA to act as an enabler to incentivise freight transport operators to use MCC facilities by undertaking much of the work involved with identifying suitable sites, and then obtaining a site and preparing it for development. In this way, sites that would otherwise be considered unattractive by a freight operator (e.g., involving too much work to implement) become more desirable. For example, a freight operator would likely opt for a site that is already viable for logistics (e.g., easily accessible for logistics vehicles) and has planning permission in-place for development. Support from dedicated LGA officers, who effectively acted as champions for micro-consolidation, was found to be important in the successful application of the methodology, keeping the necessary momentum going by reminding others when actions were needed.

The main barriers to the successful application of the methodology were identified by the LGA officers' feedback, which included the following:

1) reluctance from LGA decision-makers about permitting the use of LGA-owned sites for MCCs in case a more attractive use opportunity were to arise in the future;
2) multiple LGA departments needed to be involved, and they do not necessarily communicate effectively with each other;
3) LGA officers tended to be busy, overstretched, and meeting averse. This was especially the case for the legal department, and obtaining necessary procurement documents was particularly challenging (e.g., delays in progressing the signing of a lease contributed to a site owner leasing their available space to another user);
4) freight operators needed to be convinced of the merits of switching from their BAU operations to using MCCs instead.

Regarding the last barrier in the list, freight operators' specific concerns included issues such as: does their delivery density in the area warrant micro-consolidation; what would be the impacts on their overall supply chain; is there sufficient local workforce available; and is there a Clean Air Zone (Low Emissions Zone) in the vicinity. However, taking the first step (i.e., a shift in mind-set to engage with the possibility of using MCCs) was seen by the LGA officers as perhaps being the biggest challenge for freight operators to overcome, and use of the methodology by the LGA to identify preferred sites that are attractive to prospective freight operators was seen as a good way to incentivise taking that first step.

Input from prospective freight operators who might use particular MCC sites was seen as beneficial in determining the finer details of what would be required and what was less important

(e.g., entry points, access through doors, height restrictions). However, in obtaining this input, it was important for the LGA to find the difficult balance between obtaining the input, whilst not being seen to favour particular operators.

## 6. Conclusions

LGAs can act as enablers to incentivise and promote the use of MCCs by commercial freight operators through identifying preferred sites that are attractive. To that end, the research presented here has developed a practical, systematic methodology for MCC site selection in urban areas. The methodology has been demonstrated through application in practice by a municipal LGA (PCC) to identify two preferred sites from an initial long list of 32 potential sites. With these preferred sites identified, LGA officers were armed with an informed, collaborative assessment to present to senior managers and cabinet members (i.e., elected LGA decision makers) for approval, providing the basis for the LGA to proceed with real-world micro-consolidation trials.

The research contributes to the existing literature through distilling and combining findings from previous research in the domain to show how a structured methodology can work with imperfect real-world data, offering a practical approach for LGAs to identify preferred sites for MCCs. Beyond Portsmouth, the methodology was designed to be transferrable to other urban areas both within and outside the UK, and can contribute to providing municipal LGAs in these areas with guidance to assist with policies and planning, and with support to make informed decisions. Application of the methodology to the case study area has identified insights into the challenges and barriers affecting its utility in other urban areas, such as maintaining equity between the varied stakeholders and engaging a working group consisting of personnel whose

time resources are scarce. The transferability of the methodology has not been tested yet, though, which is an area for future research that would enable the methodology to be applied with confidence more widely, contributing to the mitigation of the detrimental effects of urban freight.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## References


1. Aljohani, Khalid, and Russell G. Thompson. 2020. "A multi-criteria spatial evaluation framework to optimise the siting of freight consolidation facilities in inner-city areas." *Transportation Research Part A: Policy and Practice* 138:51-69. https://doi.org/10.1016/j.tra.2020.05.020.

2. Assmann, Tom, Florian Müller, Sebastian Bobeth, and Leonard Baum. 2019. "Planning of cargo bike hubs." Otto-von-Guericke-Universität Magdeburg. https://www.akademiemobility.cz/download/1171/Hub%20Planning%20Brochure_EN_Web_final.pdf.

3. Bajec, Patricija, Danijela Tuljak-Suban, and Veronika Slapnik. 2023. "Micro-depots site selection for last-mile delivery, considering the needs of post-pandemic parcel recipients." *Transportation Research Procedia* 69:496-503. https://doi.org/10.1016/j.trpro.2023.02.200.

4. BEHALA. n.d. "The future of urban logistics." Berliner Hafen- und Lagerhausgesellschaft mbH. Accessed January 31, 2024. https://www.behala.de/en/new-microdepot-berlin-westhafen/

5. Buldeo Rai, Heleen, Sanggyun Kang, Takanori Sakai, Carla Tejada, Quan Yuan, Alison Conway, and Laetitia Dablanc. 2022. "'Proximity logistics': Characterizing the development of logistics facilities in dense, mixed-use urban areas around the world." *Transportation Research Part A: Policy and Practice* 166:41-61. https://doi.org/10.1016/j.tra.2022.10.007.

6. Cross-River Partnership and Steer. 2020. "The potential for urban logistics hubs in central London." Cross-River Partnership. Accessed June 17, 2024. https://crossriverpartnership.org/wp-content/uploads/2021/01/Central-London-Hubs_Final-report.pdf.

7. Dablanc, Laetitia, and Michael Browne. 2020. "Introduction to special section on logistics sprawl." *Journal of Transport Geography* 88:102390. https://doi.org/10.1016/j.jtrangeo.2019.01.010.

8. Dablanc, Laetitia. 2023. "Chapter 12: Land-use planning for a more sustainable urban freight". In *Handbook on City Logistics and Urban Freight*, 246-266. Cheltenham, UK: Edward Elgar Publishing.

9. DiMoG (Digital Mobility in Freight Transport). 2023. "German research on cargo bikes: DiMoG." CityLogistics. Accessed June 17, 2024. http://www.citylogistics.info/research/german-research-on-cargo-bikes-dimog/.

10. Fried, Travis, and Anne Goodchild. 2023. "E-commerce and logistics sprawl: A spatial exploration of last-mile logistics platforms." *Journal of Transport Geography* 112:103692. https://doi.org/10.1016/j.jtrangeo.2023.103692.

11. Garus, Ada, Maria Alonso Raposo, Andromachi Mourtzouchou, and Biagio Ciuffo. 2023. "Living lab conceptual framework: co-creation and impact assessment of an

automated last-mile delivery service." *Transportation Research Procedia* 72:3601-3608. https://doi.org/10.1016/j.trpro.2023.11.562.

12. GOV.UK. 2022. "E-cargo bikes: grant funding." HMG. Accessed January 31, 2024. https://www.gov.uk/government/publications/e-cargo-bikes-grant-funding.

13. GOV.UK. 2023. "£20 million Levelling Up transformation for North Portsmouth." HMG. Accessed January 31, 2024. https://www.gov.uk/government/case-studies/20-million-levelling-up-transformation-for-north-portsmouth.

14. Grote, Matt, Tom Cherrett, Gary Whittle and Neil Tuck. 2021. "Environmental benefits from shared-fleet logistics: lessons from a public-private sector collaboration." *International Journal of Logistics Research and Applications* 1-27. https://doi.org/10.1080/13675567.2021.1942441.

15. Gunes, Seyma, Travis Fried, and Anne Goodchild. 2024. "Seattle microhub delivery pilot: Evaluating emission impacts and stakeholder engagement." *Case Studies on Transport Policy* 15:101119. https://doi.org/10.1016/j.cstp.2023.101119.

16. Janjevic, Milena, and Alassane Ballé Ndiaye. 2014. "Development and Application of a Transferability Framework for Micro-consolidation Schemes in Urban Freight Transport." *Procedia - Social and Behavioral Sciences* 125:284-296. https://doi.org/10.1016/j.sbspro.2014.01.1474.

17. Janjevic, Milena, and Alassane Ndiaye. 2017. "Investigating the financial viability of urban consolidation centre projects." *Research in Transportation Business & Management* 24:101-113. https://doi.org/10.1016/j.rtbm.2017.05.001.

18. Katsela, Konstantina, Şeyma Güneş, Travis Fried, Anne Goodchild, and Michael Browne. 2022. "Defining Urban Freight Microhubs: A Case Study Analysis." *Sustainability* 14 (1). https://doi.org/10.3390/su14010532.

19. Lenz, Barbara, and Johannes Gruber. 2021. "Bicycles for Urban Freight." In *International Encyclopedia of Transportation*, edited by Roger Vickerman, 488-494. Oxford: Elsevier.

20. Macharis, Cathy, Laurence Turcksin, and Kenneth Lebeau. 2012. "Multi actor multi criteria analysis (MAMCA) as a tool to support sustainable decisions: State of use." *Decision Support Systems* 54 (1):610-620. https://doi.org/10.1016/j.dss.2012.08.008.

21. Mpogas, Konstantinos, Eftihia Nathanail and Ioannis Karakikes. 2020. "Location Planning of Small Consolidation Centers in the City of Volos." 5th Conference on Sustainable Urban Mobility (CSUM2020), 17-19 June 2020, Skiathos, Greece. 853-867. https://doi.org/10.1007/978-3-030-61075-3_83.

22. Novotná, M, L Švadlenka, S Jovčić, and V Simić. 2022. "Micro-hub location selection for sustainable last-mile delivery." *PloS One* 17 (7). https://doi.org/10.1371/journal.pone.0270926.

23. Paddeu, Daniela. 2025. "Decarbonising last-mile deliveries: When the national strategy fails to meet local needs and expectations." *Transportation Research Part A: Policy and Practice* 195. https://doi.org/10.1016/j.tra.2025.104435.

24. PCC. 2024. "Portsmouth demography – JSNA report." Portsmouth City Council. Accessed January 31, 2024. https://www.portsmouth.gov.uk/services/health-and-care/health/joint-strategic-needs-assessment/portsmouth-demography.

25. Ringsberg, Henrik, Alena Brettmo, and Michael Browne. 2023. "Exploring Swedish urban freight stakeholders' interests in public spaces." *Cities* 133:104131. https://doi.org/10.1016/j.cities.2022.104131.

26. Rosenberg, Leonardo N., Noemie Balouka, Yale T. Herer, Eglantina Dani, Paco Gasparin, Kerstin Dobers, David Rüdiger, Pete Pättiniemi, Peter Portheine, and Sonja van Uden. 2021. "Introducing the Shared Micro-Depot Network for Last-Mile Logistics." *Sustainability* 13 (4). https://doi.org/10.3390/su13042067.

27. Rudolph, Christian, Alexis Nsamzinshuti, Samuel Bonsu, Alassane Ballé Ndiaye, and Nicolas Rigo. 2022. "Localization of Relevant Urban Micro-Consolidation Centers for Last-Mile Cargo Bike Delivery Based on Real Demand Data and City Characteristics." *Transportation Research Record* 2676 (1):365-375. https://doi.org/10.1177/03611981211036351.

28. Sahoo, Sushil Kumar, and Shankha Shubhra Goswami. 2023. "A Comprehensive Review of Multiple Criteria Decision-Making (MCDM) Methods: Advancements, Applications, and Future Directions." *Decision Making Advances* 1 (1):25-48. https://doi.org/10.31181/dma1120237.

# Tables

Table 1. Micro-consolidation site selection criteria.

| Criteria group | Sub-criteria |
|---|---|
| Availability | 1) Likely short-term availability (1-2yrs)<br>2) Likely medium-term availability (3-5yrs)<br>3) Ability to expand operation in future (more space/land available in the site to extend larger operation on) |
| Social/environmental impacts | 1) Social impact (local residents, labour, local infrastructure etc.)<br>2) Environmental impact (air pollution, water pollution, noise pollution) |
| Parking | 1) Parking spaces (peak utilisation) |
| External access | 1) Existing site access conditions<br>2) Height barrier<br>3) Step-free site access for vehicles |
| Highway capacity | 1) Surrounding road network (congestion)<br>2) Surrounding cycle infrastructure |
| Payment/hours | 1) Payment system<br>2) Opening hours |
| Internal operations | 1) Working or storage space availability,<br>2) Shelter<br>3) Internal working height<br>4) Bare min 8m x 4m available for internal space for cargo bike storage<br>5) Turning circles access for vehicles (e.g. for vans), unobstructed internal turning circles (pillars), building access (cycles min. 0.7m x 2.94m, turning corners can be an issue), step-free building access for bikes/people |
| Utilities | 5) Lighting supply<br>6) Water supply<br>7) Electricity supply |
| Security | 1) CCTV<br>2) Site perimeter (gates and fencing)<br>3) Building (doors/windows)<br>4) Secure cycle storage (assume ‘yes’ if building existing space)<br>5) Multi-user site |
| Visibility | 1) Visibility to public (for marketing/awareness) |
| Proximity | 1) Proximity to deliveries, proximity to industry/suppliers |

Table 2. Examples of scoring considerations for different sub-criteria.

| | Score | | | |
|---|---|---|---|---|
| **Sub-criteria** | **0** | **0.33** | **0.66** | **1** |
| Short-term availability | About to be purchased and occupied for other use | Planning permission for another use given, start date to be confirmed | Undergoing review, may be advertised for sale/planning but unconfirmed | Available for the next 2 years |
| Social impact | Vans need to enter quiet residential roads to reach the site<br><br>No available local labour<br><br>Unsuitable roads and other infrastructure | Brief use of residential roads<br><br>Some available local labour<br><br>Roads and other infrastructure may need minor improvements | Close to but not entering residential roads<br><br>Good local labour availability<br><br>Roads and other infrastructure already adequate | Only main roads need to be entered to reach the site - not close to residential areas<br><br>Good local labour availability<br><br>Good local roads and infrastructure |
| Peak parking utilisation | 100% full | Only a few parking spaces available in the busiest times | Several spaces always available | Many spaces always available |
| Height barrier | Barrier in place and too low for van clearance | Barrier in place and low enough to restrict vans but possible to open | Barrier in place but high enough for vans/rarely in use | No barrier in place, no restrictions for van access |
| Surrounding road network | Heavily congested at peak times and across the day | Some congestion at peak times but not across the day | Congestion is rare | Free of congestion |
| Opening hours | Open for access sporadically with no set pattern | Limited to a small time period during the day | Open across the week for traditional working hours | Open for access 24/7 |
| Shelter | No shelter | Shelter in parts but temporary and much of site exposed to outside | Most of site under permanent shelter | Permanent shelter in place across all of site |
| Electricity supply | No infrastructure in place | Infrastructure in place but not been used for a number of years | Infrastructure in place and used by last occupant in the last year | Infrastructure in place and in use currently |

| | | | | |
|---|---|---|---|---|
| Multi-user site | No other users to support surveillance/security of site | Multiple users but high turnover and no interaction | Multiple users but little interaction | Multiple users and cooperative in nature |
| Visibility to public | In a location not seen by anyone whether business or public | Location away from businesses and residents but occasionally passed by either | In industrial estate generally away from the public but within sight of nearby businesses | In location that is well observed by businesses and the local public |

Table 3. Site visit findings summary in relation to the MCC criteria.

| | 1000 Lakeside car park | Cascades 1st Floor Car Park | Clarence Street | Landport View | Pye Street | Sainsbury Car Park | Technopole car park | Tipner Firing Range |
|---|---|---|---|---|---|---|---|---|
| **Availability** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Social / Env impacts** | Low | Low | Low | Low | Low | Low | Low | Low |
| **Parking Spaces** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **External Access** | Good | Good | Good | Good | Good | Good | Good | Good |
| **Highway capacity** | Good | Fair | Fair | Fair | Fair | Fair | Good | Good |
| **Payment/ Hours** | Good | Good | Fair | Good | Good | Good | Good | Good |
| **Internal Operations** | Good | Good | Fair | Fair | Fair | Good | Good | Good |
| **Utilities** | Good | Good | Good | Poor | Poor | Poor | Good | Good |
| **Security** | Good | Good | Fair | Poor | Poor | Good | Fair | Good |
| **Visibility** | Fair | Good | Good | Good | Good | Fair | Fair | Low |
| **Density** | Fair | Good | Good | Good | Good | Good | Good | Fair |

Table 4. Local authority planning officers' criteria priority ranking.

| **Criteria** | **Priority Rank** |
|---|---|
| Availability | 1 |
| Social / Environmental impacts | 1 |
| Parking Spaces | 3 |
| External Access | 3 |
| Highway capacity | 3 |
| Payment/ Hours | 4 |
| Internal Operations | 4 |
| Utilities | 4 |
| Security | 5 |
| Visibility | 4 |
| Density | 4 |

Table 5. Preferred sites profile comparisons.

| Name | Cascades | Bridge Centre |
|---|---|---|
| Type of facility | Shopping centre | Shopping centre |
| Ownership | Private | Public |
| Clean Air Zone (CAZ) | Inside | On the boundary but with direct freight vehicle access on one side of the site available without entering CAZ boundary (see note) |
| Area | City's main commercial area with some residential land use in the vicinity | Dense mixed-use area including retail and residential |
| Availability | A number of unoccupied units available at varying sizes and rates | Limited spaces available with increasing interest from potential occupants |
| External access | Dedicated freight access point with sufficient space for turning | Dedicated freight access point with sufficient space for turning |
| Internal access | Door access to internal buildings slightly restrictive | Door access to internal buildings slightly restrictive |

Note: As of August 2024, the Portsmouth CAZ only applies to older Heavy Goods Vehicles (including some larger motorhomes), buses and coaches, taxis and private hire vehicles.

## Figures

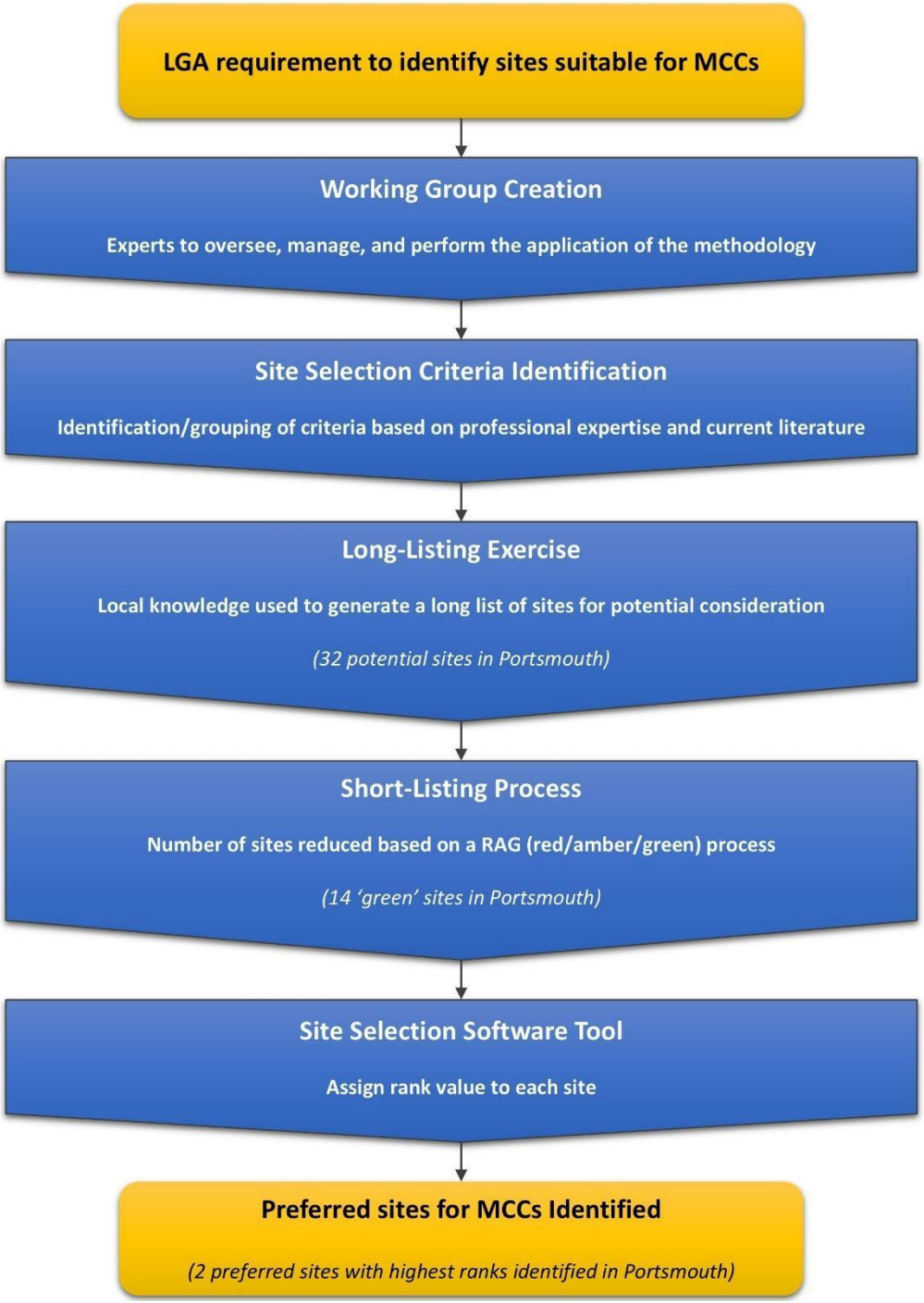


Figure 1. Flowchart of the methodology used to identify locations for MCCs.

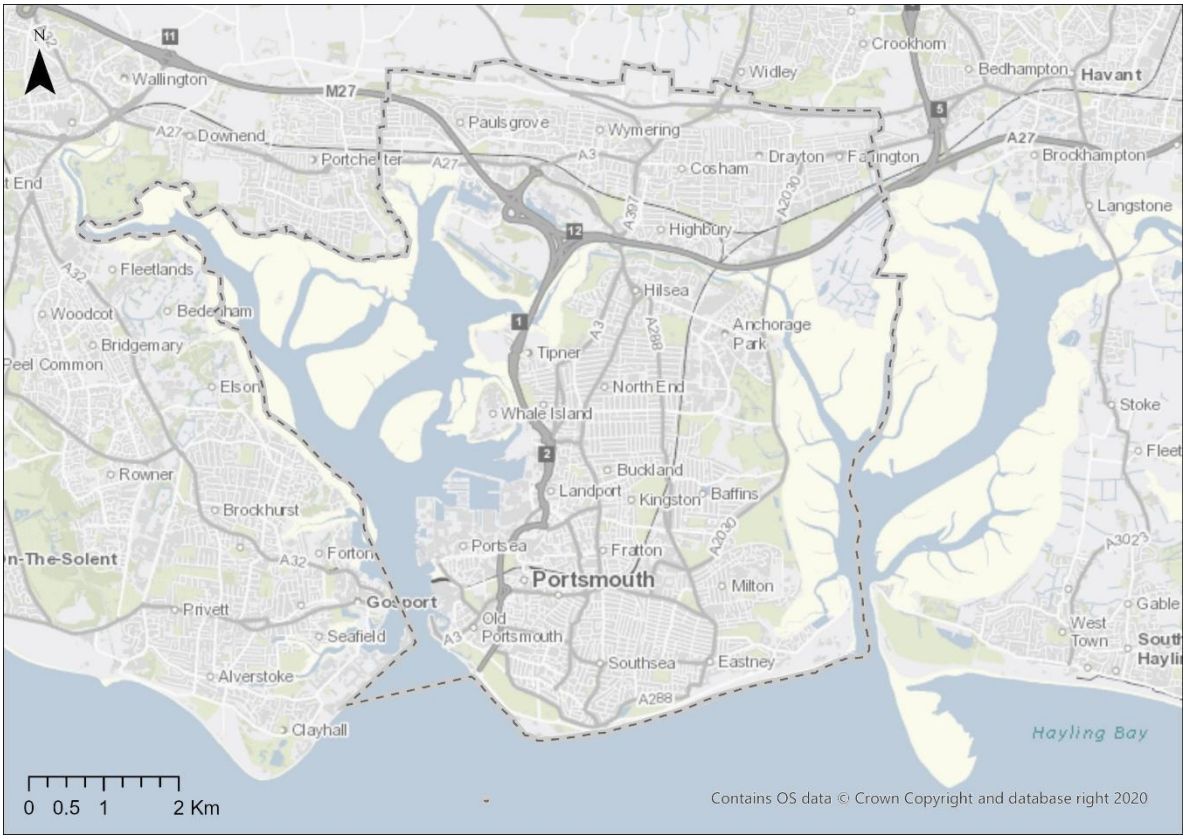


Figure 2. Map of the case study urban area. Dashed line indicates extent of Portsmouth City Council district.

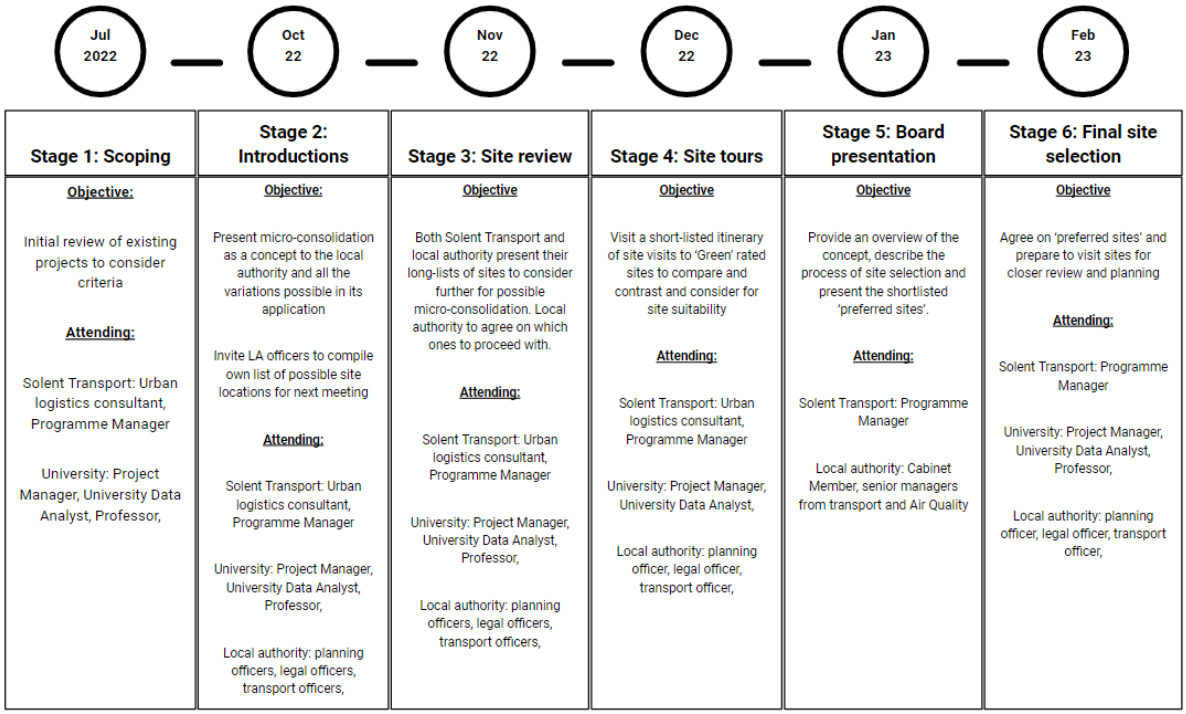


Figure 3. Micro-consolidation working group overview of activities.

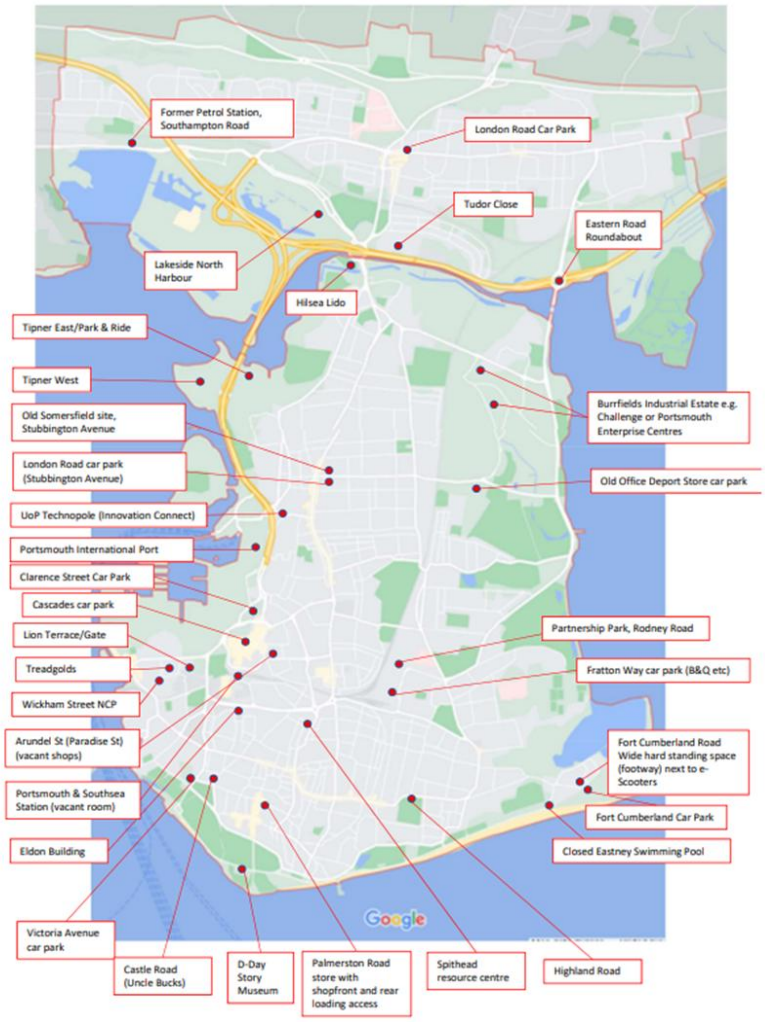


Figure 4. Micro-consolidation site selection long list (suggested sites presented by the university researchers to PCC prior to agreeing collaboratively generated official long list).


Figure 5. Red/amber/green rated sites.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5 | 5 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | |
| Locations | Grouped & Weighted Score | Address | Availability | Social/Environmental Impact | Parking Spaces | External Access | Highway Capacity | Payment/hours | Internal Operation | Utilities | Security | Visibilty | Proximity | Total |
| Best Example | 10.0 | | 15.00 | 10.00 | 3.00 | 9.00 | 4.00 | 8.00 | 14.00 | 6.00 | 7.00 | 2.00 | 4.00 | 82.00 |
| Cascades 1st Floor (accessed from rear of NCP) | 8.8 | Charlotte Street | 13.30 | 8.30 | 2.00 | 9.00 | 1.65 | 8.00 | 14.00 | 6.00 | 4.00 | 2.00 | 4.00 | 72.25 |
| Bridge Centre Fratton Road | 8.4 | Garnier Street | 13.30 | 6.60 | 2.00 | 9.00 | 1.65 | 6.00 | 14.00 | 6.00 | 4.00 | 2.00 | 4.00 | 68.55 |
| Unit 20 Hilsea Industrial Estate | 8.3 | Limberline Spur | 11.60 | 6.65 | 3.00 | 9.00 | 2.31 | 8.00 | 14.00 | 6.00 | 4.00 | 0.67 | 2.64 | 67.87 |
| Lakeside, North Harbour car park | 8.1 | North Harbour | 15.00 | 8.30 | 2.00 | 9.00 | 3.66 | 7.33 | 10.00 | 4.00 | 4.00 | 0.67 | 2.66 | 66.62 |
| Cash 4 Clothes | 7.5 | Clarence Street | 8.25 | 6.65 | 3.00 | 7.98 | 1.32 | 8.00 | 14.00 | 4.00 | 4.00 | 0.67 | 3.32 | 61.19 |
| Park & Ride (Tipner East) | 7.3 | Tipner Lane | 15.00 | 8.30 | 1.00 | 9.00 | 1.65 | 4.67 | 10.00 | 6.00 | 1.00 | 1.33 | 1.98 | 59.93 |
| Sainsburys Car Park | 7.1 | Fitzherbert Street | 10.00 | 6.65 | 3.00 | 7.98 | 1.32 | 8.00 | 10.00 | 4.00 | 3.00 | 1.33 | 3.32 | 58.60 |
| Waterlooville Model Centre | 6.9 | Commercial Road | 6.60 | 6.65 | 0.00 | 7.98 | 1.32 | 8.00 | 12.00 | 6.00 | 4.00 | 1.33 | 2.64 | 56.52 |
| The Admiral Drake Pub Car Park (for Technopole) | 6.7 | Kingston Close | 11.65 | 4.95 | 2.00 | 9.00 | 1.65 | 7.33 | 10.00 | 4.00 | 0.00 | 0.67 | 3.32 | 54.57 |
| Ponden House | 6.7 | Charlotte Street | 3.30 | 8.30 | 0.00 | 7.98 | 1.65 | 8.00 | 12.00 | 6.00 | 4.00 | 1.33 | 2.64 | 55.20 |
| Tipner Firing Range | 6.7 | Firing Range car park | 11.60 | 6.60 | 2.00 | 7.98 | 1.65 | 8.00 | 10.00 | 4.00 | 1.00 | 0.00 | 1.98 | 54.81 |
| Pye Street Car Park | 6.4 | Charlotte Street | 10.00 | 6.65 | 0.00 | 7.98 | 1.32 | 7.33 | 10.00 | 4.00 | 0.00 | 2.00 | 3.32 | 52.60 |
| Clarence Street (Hope St. Car Park) | 6.1 | 73 Clarence Street | 10.00 | 6.65 | 2.00 | 4.98 | 1.32 | 4.67 | 10.00 | 4.00 | 2.00 | 1.33 | 3.32 | 50.27 |
| Market Way Car Park (north east corner) | 5.1 | Charlotte St | 4.95 | 4.95 | 0.00 | 6.00 | 1.32 | 4.67 | 10.00 | 4.00 | 1.00 | 1.33 | 3.32 | 41.54 |

Figure 6. Scoring of 14 short-listed micro-consolidation pilot sites using MCDMA tool.

**Figure Captions**

Figure 1. Flowchart of the methodology used to identify locations for MCCs.

Figure 2. Map of the case study urban area. Dashed line indicates extent of Portsmouth City Council district.

Figure 3. Micro-consolidation working group overview of activities.

Figure 4. Micro-consolidation site selection long list.

Figure 5. Red/amber/green rated sites.

Figure 6. Scoring of 14 short-listed micro-consolidation pilot sites using MCDMA tool.