A Greener Last Mile for Hong Kong

Multi-Modal Hyperlocal Delivery System — A Public Research Summary

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Abstract

Urban last-mile delivery in Hong Kong is dominated by point-to-point dispatch, in which a dedicated vehicle serves nearly every order. This model scales linearly: each additional parcel adds road usage, carbon and congestion. This paper summarises a research project, funded under the Government's Smart Traffic Fund, that designed, built and field-validated a multi-modal hyperlocal delivery network combining neighbourhood sorting hubs, shared vans and on-foot couriers, coordinated by four planning algorithms and a smart routing-and-forecasting engine. The system was developed on more than a year of real, anonymised operational data and validated in live road trials across a fifteen-hub network spanning Hong Kong Island, Kowloon and the New Territories. Measured against the conventional baseline on the same deliveries, the network reduced vehicle road usage, distance travelled and carbon emissions each by approximately 73%, while raising fleet capacity utilisation roughly four-fold and forecasting next-day demand within target accuracy. We present the methodology and the indicator framework, and discuss the potential public benefit for Hong Kong's environment, congestion and communities. All figures are reported as relative or indexed quantities; no commercially sensitive operational data is disclosed.

Keywords: *last-mile logistics · multi-modal delivery · consolidation network · route optimisation · demand forecasting · carbon reduction · smart mobility · Hong Kong*

1. Introduction: One Van Per Parcel Is Choking the City

Conventional point-to-point (P2P) delivery dispatches a dedicated vehicle for nearly every order. It is operationally simple, but structurally inefficient, and the damage compounds as e-commerce volumes rise. Four effects reinforce one another:

- **More vehicles —** the fleet grows in lockstep with order volume rather than scaling efficiently;
- **More carbon —** each extra vehicle is another engine on the road, so emissions track deliveries one-for-one;
- **More congestion —** vehicles repeat the same congested corridors, frequently running far below cargo capacity;
- **Stalled efficiency —** cost and capacity utilisation per delivery never improve with growth — the model does not scale.

The harder truth is that, under this model, every additional order makes road usage, carbon and congestion worse rather than better. For a dense, fast-growing city such as Hong Kong, that trajectory is unsustainable. This research asks whether a different network design can break the link between delivery growth and environmental harm.

2. System Architecture: A Coordinated Multi-Modal Network

The proposed network replaces the single-vehicle trip with a coordinated three-part system — walkers, neighbourhood sorting hubs and shared vans — orchestrated end-to-end by software so that each mode does what it does best. Walkers handle the short local legs on foot at both ends of the journey — collecting and pooling orders into a neighbourhood hub, and later completing the final hand-off to the doorstep; shared vans carry the consolidated load hub-to-hub in between, at high utilisation; and neighbourhood hubs act as the compact consolidation points where the on-foot and van legs meet. Removing the engine from the densest, most congested local stretches at both ends is central to the design. A van can itself act as a temporary “hub on wheels”, trunking parcels into a district and parking as a mobile consolidation point from which walkers collect. Any neighbourhood can therefore be served simply by routing a van to it, making the network asset-light and quick to extend.

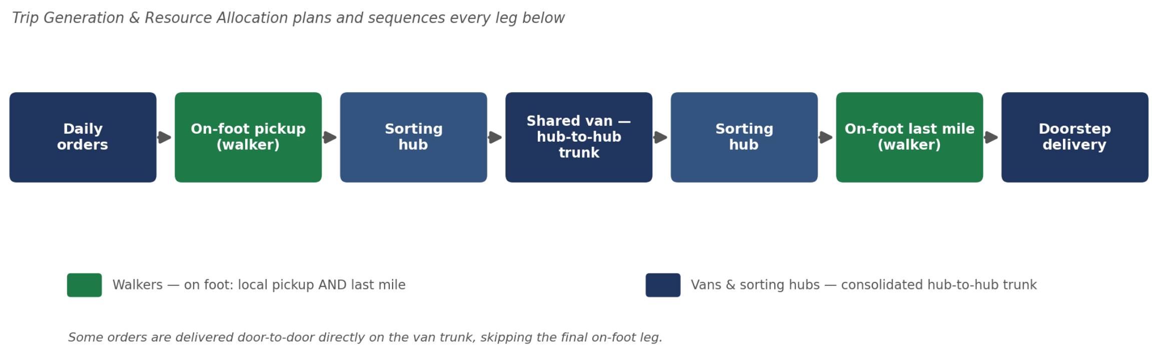

Figure 1. Multi-modal fulfilment flow. Walkers handle the local on-foot legs at both ends — collecting and pooling orders into a neighbourhood hub, and completing the final hand-off to the doorstep — while shared vans carry the consolidated load hub-to-hub in between. Some orders are delivered door-to-door directly on the van trunk, skipping the final on-foot leg.

2.1 Four research algorithms

- **Location Analysis —** identifies high-density delivery areas from historical orders and geocoded addresses.
- **Consolidation Points —** places sorting hubs to maximise on-foot coverage with the minimum number of hubs.
- **Trip Generation —** converts each day's orders into executable walker and driver trip legs across the network.
- **Resource Allocation —** computes the minimum staffed walkers and drivers needed for the day's workload.

2.2 Real-time operation

A dynamic route-planning engine continuously optimises trunk routes, hub activation and walker assignments against live orders, vehicle capacity and travel times, re-planning the moment conditions change. It integrates Hong Kong open-government data — including real-time parking-vacancy and traffic speed information published on data.gov.hk — to improve on-road decisions. A companion model forecasts next-day demand at each consolidation point so that vehicles and staff are positioned ahead of demand rather than reacting to it.

3. How We Measured the Difference

We compared the new network against the usual one-van-per-parcel method on the very same deliveries, and measured six things. The formulas below are written in plain words on purpose — each one is just everyday arithmetic: dividing, adding, and working out a percentage. To keep commercial details private we do not print the real numbers we put into them (such as how much a van holds, or what fuel costs); we only show how each measure is worked out, and we report the results as percentages or as “how many times better”. The six measures are listed in Table 1.

Table 1. The six things we measured

What we measured	In plain words
Time on the road	How many hours, in total, the vans spend driving to deliver a day's parcels
Distance driven	The total number of kilometres the vans cover
Carbon given off	The carbon dioxide produced by the fuel those vans burn
How full the vans are	Whether vans travel packed or half-empty
Cost for each parcel	What it costs to deliver one parcel
Forecast accuracy	How close our guesses of tomorrow's demand are to what really happens

3.1 Time on the road, and the distance driven

The time the fleet spends driving is simply how far it travels divided by how fast it goes, added up across all the vans. To show the improvement we compare the new total with the old one and turn the difference into a percentage saved. The total distance driven is worked out the same way.

$$\text{Time on the road} = \text{Distance} \div \text{Speed}$$
$$\text{Saving} = (\text{Before} - \text{After}) \div \text{Before} \quad \text{(shown as a percentage)} \qquad (1)$$

3.2 How full the vans are

This measures whether the vans run packed or half-empty. For one van it is the cargo it actually carries divided by the cargo space it has — a full van scores high, a nearly-empty one scores low. When we add up across the fleet we let the vans that drive the longest distances count for more, so a long, fully-loaded trip is credited properly and is not cancelled out by a short, near-empty one.

$$\text{How full a van is} = \text{Cargo carried} \div \text{Cargo space it has} \qquad (2)$$

3.3 Carbon given off

The carbon a van gives off depends on how much fuel it burns, and the fuel it burns depends on how far it drives. So the chain is simple: less distance means less fuel, and less fuel means less carbon. Because of this, when the network drives about three-quarters less, it also gives off about three-quarters less carbon — the carbon saving follows the distance saving in §3.1.

$$\text{Fuel used} = \text{Distance} \div \text{Distance the van travels per litre of fuel}$$
$$\text{Carbon given off} = \text{Fuel used} \times \text{Carbon per litre of fuel} \qquad (3)$$

3.4 Cost for each parcel — and why scale matters

The cost of each parcel has two parts: a small cost to actually carry that one parcel, plus a share of the fixed daily cost of running the hubs. That fixed cost is split between all the parcels handled that day — so the more parcels the network carries, the smaller each parcel's share becomes, and the cheaper every delivery gets. Figure 3 shows this: when there are only a few parcels the cost per parcel is high, but it falls as the number of parcels grows, and eventually matches the cost of ordinary delivery. The important point is that the environmental savings above happen at every level — whether the network is small or large.

Cost for each parcel = Cost to carry one parcel + (Fixed daily cost ÷ Number of parcels that day) (4)

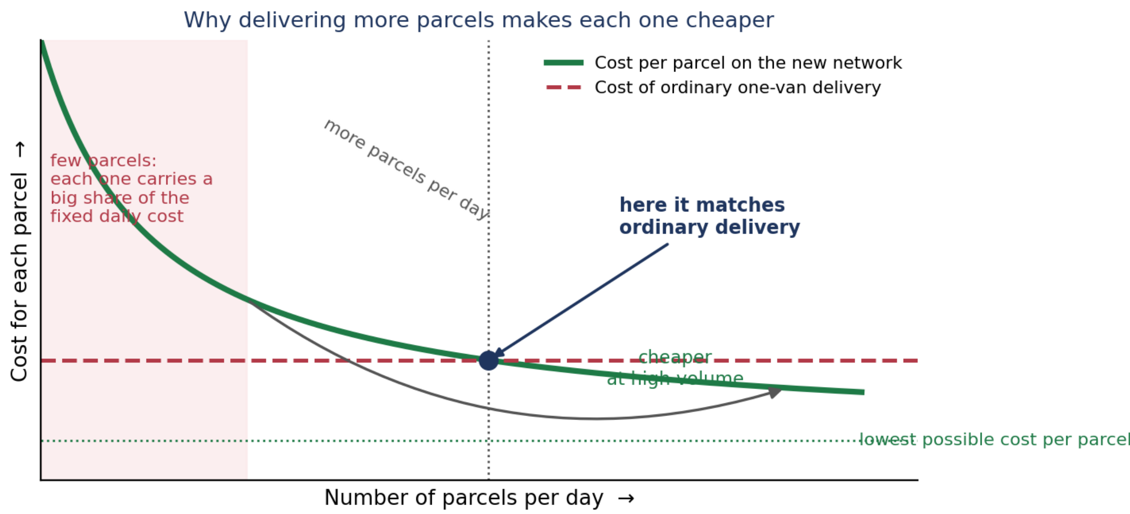

Figure 3. Why scale matters (a drawing, with no real numbers). When only a few parcels are delivered, the fixed daily cost is shared between very few of them, so each parcel costs a lot. As the number of parcels grows, that cost is shared more widely, the cost per parcel falls, and it eventually matches the cost of ordinary delivery.

3.5 Guessing tomorrow's demand

To put vans and couriers in the right place before the orders arrive, the system predicts how busy each neighbourhood will be the next day. The prediction is mostly the average of that neighbourhood's recent days, with two sensible tweaks: the most recent days count for a little more (because they show the latest trend), and one-off spikes are smoothed out so a single odd day does not throw off the plan. Each neighbourhood is predicted on its own, because some districts are far busier than others. We then check how good the guess was by measuring the average gap between what we predicted and what actually happened, written as a percentage, and we aim to keep that gap below our accuracy target.

Tomorrow's demand ≈ average of the recent days (recent days count for a little more)

How far off we were = average gap between guess and actual (kept below our target) (5)

In the trials, the predictions for the busy neighbourhoods stayed comfortably within target — confirming that the network can be set up ahead of demand rather than scrambling to react to it.

4. Field Validation

The network was developed on more than a year of real, anonymised Hong Kong delivery data and then proven in live operational road trials across all fifteen sorting-hub districts, spanning Hong Kong Island, Kowloon and the New Territories. The trials were designed to answer questions that simulation alone cannot:

- **Routes are executable —** the system's computer-generated routes worked under real traffic, real buildings and real walking distances;
- **Packages are handleable —** the assigned parcels were realistic to carry and deliver by weight and size;
- **Multi-modal hand-off works —** the on-foot pickup, the van trunk and the on-foot final delivery handed off cleanly end-to-end across every hub;
- **Asset-light & scalable —** any district could be activated simply by routing a van, with clear room to consolidate more volume per trip.

In short, the trials confirmed that the model generates effective, realistic routes and assignments in the real world — a strong foundation for operating this optimised hyperlocal logistics model at scale.

5. Results

Measured on the same deliveries, the multi-modal network substantially outperformed the conventional one-van-per-order baseline on every environmental and efficiency indicator (Figure 2):

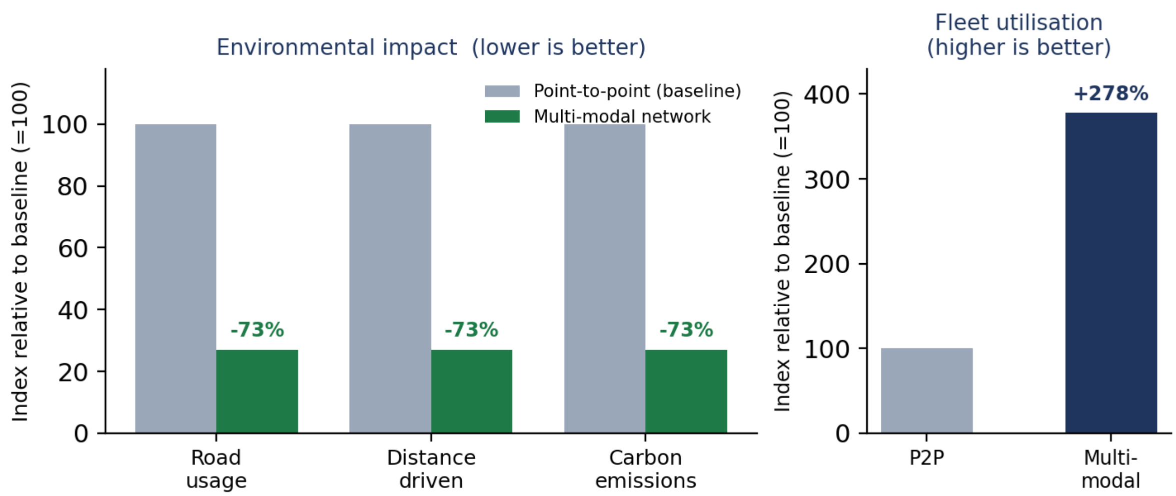

Figure 2. Indexed performance versus the point-to-point baseline (=100). Left: vehicle road usage, distance and carbon each fall by about 73% (lower is better). Right: fleet capacity utilisation rises roughly four-fold, an increase of about 278% (higher is better).

- **Road usage — about 73% lower.** the fleet spent roughly three-quarters less time on the road to serve the same orders;
- **Distance driven — about 73% lower.** total vehicle kilometres fell by roughly three-quarters.
- **Carbon footprint — about 73% lower.** vehicle carbon emissions dropped in step with the distance saved.
- **Fleet utilisation — up about 278%.** each vehicle trip carried several times more cargo, lifting utilisation roughly four-fold.
- **Demand prediction — within target.** next-day demand at busy hubs was forecast comfortably within target, enabling demand-ahead positioning.

Together these results demonstrate the central breakthrough: under this model, growth and sustainability pull in the same direction. The more the network consolidates, the more efficient — and the cleaner — each delivery becomes.

6. Discussion: Impact for Hong Kong

The potential public benefit of moving last-mile delivery onto a network of this kind is substantial, and it touches several of Hong Kong's most pressing priorities at once.

6.1 Cleaner air and progress toward carbon neutrality

Transport is one of Hong Kong's largest sources of roadside emissions. Cutting the vehicle distance needed to deliver the same parcels by roughly three-quarters means a proportional cut in delivery-related carbon and roadside pollutants. Applied across the city's large and growing parcel volumes, the model offers a concrete, scalable contribution to Hong Kong's goal of carbon neutrality before 2050 and to cleaner air in the dense neighbourhoods where people live and work.

6.2 Less congestion and safer, more livable streets

Fewer delivery vehicles repeating the same congested corridors means less traffic, less competition for kerb space and loading bays, and calmer streets. Shifting the densest local legs of delivery onto foot — at both pickup and drop-off — removes vehicles from exactly the crowded residential and commercial cores where they cause the most disruption and risk — directly serving the Smart Traffic Fund's mission of smarter, smoother and safer road use.

6.3 Local jobs and inclusive employment

The walker last-mile layer creates flexible, neighbourhood-based courier work that requires neither a vehicle nor a driving licence, lowering the barrier to entry and keeping delivery employment local to the communities being served.

6.4 Built-in sustainability reporting for business

Because the network plans and measures every route, it can attribute the carbon saved to each delivery. That gives retailers and logistics partners credible, per-order environmental data for their own sustainability and ESG disclosures, turning greener delivery into a measurable business advantage and encouraging wider adoption.

6.5 A model that improves as it grows

Unlike conventional delivery, where every additional order adds another vehicle, this network shares its consolidation infrastructure across all the orders flowing through it (§3.4). The environmental and congestion benefits hold at every scale, while the economics steadily improve as everyday delivery volumes grow — so the public benefit compounds precisely as the city leans on delivery more heavily.

7. Conclusion and Outlook

This project delivered a complete, working system — neighbourhood hubs, walker-and-van orchestration, dynamic routing and demand prediction — measured against real operational data and proven on Hong Kong streets across all fifteen hubs. The environmental and efficiency gains are not theoretical: they were observed in the field, with road usage, distance and carbon each reduced by roughly three-quarters and fleet utilisation raised several-fold on the same deliveries.

The clear next step is scale. As daily delivery volume on the network grows toward everyday commercial levels, the shared consolidation model becomes increasingly cost-competitive with conventional delivery while continuing to deliver its full environmental dividend. Offered as a shared hyperlocal tier that delivery partners across the city can plug into, the network is positioned to turn a single research project into a lasting public benefit for Hong Kong's streets, its air and its people.

Data Sources and References

- Smart Traffic Fund, Transport Department, Government of the HKSAR — Project CS/66/2305/RA.
- DATA.GOV.HK — Real-time car-park vacancy data and Traffic Data Analysis System (TDAS) traffic-speed data, Transport Department, Government of the HKSAR.
- Hong Kong's Climate Action Plan 2050, Environment Bureau, Government of the HKSAR — carbon-neutrality commitment.
- Hong Kong Smart City Blueprint, Office of the Government Chief Information Officer, Government of the HKSAR.
- Project final report and Key Performance Indicator reports, GoGo Tech Limited, 2026 (methodology basis for the indicators in §3; underlying operational figures are confidential).