



Rebuilding the Last Mile:

From Fragmented Delivery to Shared, Circular Infrastructure.



Last-mile delivery has long been treated as an operational challenge to be optimised. It is a structural constraint on e-commerce's future. As costs continue to rise, emissions intensify, and customer expectations accelerate, incremental improvements are no longer sufficient.

What is emerging instead is a fundamental redesign of the delivery ecosystem, one built on shared infrastructure, reusable assets, and real-time data visibility. This article explores how a circular model for last-mile logistics is moving from concept to commercial reality, and why it represents one of the most important strategic shifts for supply chains globally.

Last-mile delivery has a problem that everyone in the industry acknowledges, and almost no one has fundamentally fixed. It is the most expensive stretch of the e-commerce supply chain, the most carbon-intensive, and despite years of operational tinkering, the one that still looks essentially the same as it did a decade ago. In major urban markets, it accounts for more than half of total logistics costs. Multiple carriers, multiple vehicles, multiple failed doorstep attempts, each operating in isolation, often serving the same building on the same day.

The pressures driving this are not easing. E-commerce keeps reshaping retail, and consumer expectations around speed and convenience continue to rise. The industry has reached the point where incremental efficiency gains, better routing algorithms, lighter vans, and optimised load factors are no longer enough. The question is not whether the current model is sustainable. It is not. The question is what replaces it, and who has the courage to build it.

The argument here is that three converging shifts, shared physical infrastructure, reusable packaging systems, and digital asset tracking together make a genuinely circular approach to last-mile logistics both operationally viable and commercially compelling. Not in theory. Now.

The Structural Problem

The last-mile ecosystem is fragmented by design. Carriers compete for doorstep access, each maintaining proprietary fleets, independent routing systems, and their own parcel locker networks, none of which talk to one another. The result is low vehicle utilisation, duplicated infrastructure, and a delivery experience that frequently fails the customer it is meant to serve.

Research on a 299-unit apartment building found an average of more than 1.5 parcels delivered per day to the same address by multiple carriers, minimal coordination, and no shared load planning (Perrier, Choudhry and Qian, 2024¹). That is not an outlier. It is standard operating procedure in dense urban environments.

Packaging compounds the damage. Single-use cardboard and plastic remain the industry norm, generating waste at a scale that efficiency programmes alone cannot address. Amazon's 2024 sustainability reporting shows genuine progress 12% of shipments now ship without additional packaging, and approximately 4.2 million metric tons of single-use packaging have been avoided since 2015². These are real numbers. But optimising within a linear system has limits. The more consequential opportunity is to replace the system itself.

A Different Architecture

The alternative rests on three interdependent components.

Shared locker networks

Rather than each carrier deploying its own proprietary locker infrastructure, which is underutilised, incompatible, and inconvenient, a shared alliance model allows all participating carriers to access common collection and drop-off points. Parcels are consolidated at urban micro-hubs and delivered once to a shared locker, replacing multiple vehicle trips to individual addresses.

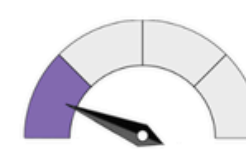
Research by the Hellenic Institute of Transport under the URBANE EU programme found that this collective model can reduce last-mile emissions by up to 89%³. That figure does not reflect marginal efficiency gains. It reflects a fundamental redesign of how delivery networks operate.

A shared locker alliance is not a convenience feature. It is an infrastructure decision with material implications for cost, carbon, and customer experience alike.

Thessaloniki smart mobility LL

Impact Assessment Results towards various business models

	Baseline	500-600 Lockers ILN	350-420 Lockers ALN	270-320 Lockers UCCLN
CO2 Emissions Reduction	-	-49.6%	-61.7%	-89.6%
Kilometers per Delivery	-	-52.3%	-63.5%	-82%
Deliveries per Trip	-	+13.5%	+21.6%	+43.2%
First-Attempt Deliveries	-	+3.7%	+10.5%	+16.1%
Freight Vehicles	-	-42.4%	-60.3%	-73.8%



Baseline Scenario
Describes the current situation.



Individual Locker Network
Outperforms baseline scenario.



Alliance Locker Network
Shows significant improvements.



Full Collaborative Model
Under UCC can reduce emissions by up to 90%.

Reusable tote systems

Reusable plastic totes have long been standard within warehouse and supply chain operations. The opportunity now is to extend them to the last mile by consolidating parcels from multiple carriers into standardised totes, delivering to shared locker hubs, and recovering them through the same infrastructure.

When integrated with smart lockers, totes enable genuinely closed-loop operations: delivered, deposited, collected, and returned through the same physical node. This dissolves the reverse logistics complexity that has historically made reusable packaging difficult to scale in consumer-facing environments.

The conceptual shift matters as much as the operational one. Packaging is no longer a cost to minimise or a waste problem to manage. It becomes a durable, reusable asset, one that circulates through the network, retains value, and generates data at every stage.

RFID-enabled asset tracking

Reusability at scale requires visibility. RFID tagging provides real-time monitoring of tote location, condition, and circulation rate, enabling accurate inventory management, reducing asset loss, and supporting quality control across a distributed network. Recent research on RFID-based logistics systems confirms that embedded intelligence in reusable assets significantly improves recovery rates and operational accuracy (Zhang et al., 2025⁴).

In practice, a tote can be tracked from fulfilment through delivery, locker deposit, collection, and network return, generating data at each stage that informs routing, demand planning, and asset utilisation decisions. The tote ceases to be packaging. It becomes an intelligent node in a digitally connected logistics network.

Why This Matters for the GCC

The GCC e-commerce market is expanding at a pace driven by high smartphone penetration, young and digitally active demographics, and government-backed investment in digital economic infrastructure. Last-mile logistics is a recognised bottleneck. Urban density, extreme heat, and the region's particular geography create operational conditions that make the existing model especially costly and difficult to sustain.

Saudi Arabia's Vision 2030 framework places supply chain modernisation and sustainability at the centre of economic transformation. The logistics sector is both a target for investment and a focus of regulatory reform. The shift toward circular, shared, and digitally enabled delivery infrastructure is not a long-range prospect here. It is an active area of policy interest and commercial development.

For businesses operating across the region, retailers, logistics providers, real estate developers, and technology companies, the strategic question is straightforward: how do you position relative to this transition? Early movers in shared locker infrastructure, reusable packaging systems, and RFID-enabled asset management will establish network advantages that are genuinely difficult to replicate once scale takes hold.



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Sofia Raptopoulou is a supply chain and logistics leader with over 20 years of experience driving operational excellence, digital transformation, and innovation across global industries. She has led award-winning last-mile delivery platforms, spearheaded large-scale digital initiatives in ports and logistics, and delivered automation, IoT, AI-driven optimisation, and advanced fulfilment solutions.

With deep expertise spanning strategy, sustainability, and execution, Sofia brings a distinctive combination of strategic insight and hands-on leadership to help organisations build resilient, high-performing supply chains fit for the future.

Making It Work

Several structural challenges require deliberate management:

- Carrier standardisation. Reusable totes and shared lockers only generate network value if participating carriers adopt common specifications. That requires industry-level coordination, and in some markets, active regulatory facilitation.
- Locker interoperability. The commercial logic of a shared alliance depends on genuine interoperability, so that any carrier's parcel can be deposited in any locker, accessible to any customer. Proprietary systems undermine this logic and constrain scale.
- Asset recovery. Tote recovery rates are the operational foundation of a circular model. Locker hubs function as natural return points, but the process requires clear accountability, structured incentives, and real-time tracking to maintain network integrity over time.
- Customer behaviour. Moving customers from doorstep delivery to locker collection requires convenience, clear communication, and demonstrable reliability. The design of the network, its density, accessibility, and operating hours matter as much as the technology underpinning it.

None of these is insurmountable. But they are system-level problems that require system-level thinking. Organisations that treat circular logistics as a collection of discrete pilots, a locker trial here, a packaging experiment there, will not capture the value of the model. The value lies in integration.

The Bigger Picture

What the circular last-mile model ultimately represents is a move from competitive fragmentation to collaborative infrastructure. The delivery networks of the next decade will not be built by a single carrier or a single platform. They will be built through shared assets, common standards, and digital connectivity to manage them at scale.

This is not a long-range prediction. The components exist. The economics are established. The policy environment, particularly in markets like Saudi Arabia, is increasingly aligned. What remains is execution, and the willingness to treat last-mile logistics not as a cost centre to be incrementally optimised, but as a strategic platform to be deliberately designed.

The next competitive frontier in e-commerce is not faster delivery. It is a smarter infrastructure.

At Aldar Audit Bureau, Grant Thornton, we support organisations in rethinking and redesigning their supply chains, from operating model transformation and infrastructure strategy to regulatory alignment and digital enablement, ensuring they are positioned not just to adapt to this shift, but to lead it

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