



Sketch Planning Tool for Sustainable and Resilient Urban Goods Distribution

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Project Objective

This work aims to create a sketch-planning tool tailored to assist local authorities in strategic planning of goods distribution systems using micro-hubs, collection-points, and zero-emission vehicles, for a sustainable and resilient urban freight.

Problem Statement

The urban goods distribution system is a critical component of modern society. However, the COVID-19 pandemic exposed significant vulnerabilities in this system as it struggled to cope with an unforeseen surge in demand. This crisis highlighted the urgent necessity of developing a resilient and sustainable urban goods distribution system capable of efficiently recovering from high-severity disruptions. Our research team previously developed a novel analytical model, the Robustness, Redundancy, Resourcefulness, and Rapidity - Last-Mile Distribution - Resilience Triangle (R4-LMD-RT) framework to address this challenge. Based on the R4-LMD-RT model, this work aims to create a sketch-planning tool tailored to assist local authorities in strategic planning of goods distribution systems using micro-hubs, collection-points, and zero-emission vehicles, for a sustainable and resilient urban freight. The research outcome paves the way for more sustainable and resilient urban goods distribution systems in the post-pandemic world.

Research Methodology

Considering the role of e-commerce last-mile distributions in ensuring the supply of essential goods, it is pertinent to assess the resilience of last-mile distribution operations in terms of retailers' ability to maintain and efficiently restore the level of service in the event of such low-probability, high-severity disruptions. To this end, the authors previously developed Robustness, Redundancy, Resourcefulness, and Rapidity (R4) - Last Mile Distribution - Resilience Triangle (R4-LMD-RT) framework that can 1) model e-retailer's last-mile distribution operations using Continuous Approximation (C.A.) techniques, 2) develop the retailer's operational, tactical, and strategic decision-making to model its behavior pre-, peri-, and post- disruption and 3) evaluate its response to disruptions through. Based on this novel performance-based qualitative-cum-quantitative domain-agnostic resilience assessment framework, this project seeks to develop a specialized sketch-planning tool to assist local governments in strategic planning of goods distribution systems using micro-hubs, collection-points, and zero-emission vehicles, for a sustainable and resilient urban freight.

Results

Traditionally dominated by brick-and-mortar stores, the retail sector has witnessed an increasing presence of e-commerce in the past few years. Yet, despite the ease of online shopping, the wide range of product availability online, and the lucrative offers on e-commerce platforms, traditional in-store shopping continued to be the dominant channel for daily purchases until the COVID-19 pandemic enforced a sudden and significant shift in consumer shopping behaviors.

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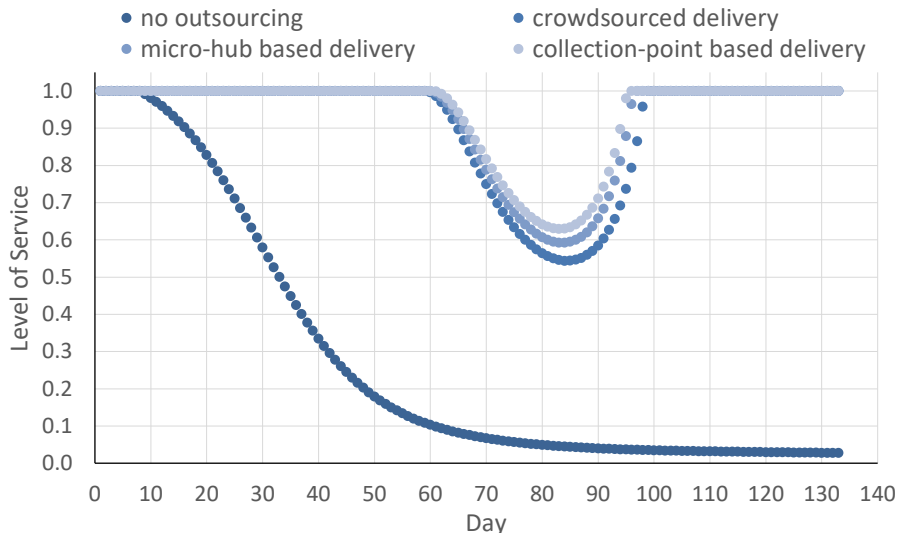


Figure 1. Last-mile distribution service disruption across different outsourcing channels

On March 11, 2020, the World Health Organization (WHO) declared the novel coronavirus (SARSCoV2) outbreak causing the coronavirus disease (COVID-19) as a global pandemic. A level of panic ensued among buyers; the local brick-and-mortar stores witnessed opportunistic purchase behaviors resulting in long queues and hoarding of daily essentials. Governments worldwide enforced aggressive virus containment measures to build the capacity to test, trace, and treat the infected. Consequently, the e-retailers, particularly those selling essential goods, daily consumables, groceries, medications, and healthcare products, witnessed an unprecedented surge in demand. The disruption thus instigated a lower level of services, which had negative implications for the efficiency of the distribution system with delayed deliveries or total lack of access to those deliveries, thereby exposing vulnerable and disadvantaged communities to increased risk.

This is particularly evident as the case study here (Figure 1) establishes this loss in level of service for a reasonably large-sized e-retailer with a market share of about 30%, serving the city of Los Angeles, a 475 sq. mi. service region with about 100k pre-disruption daily online customers. In particular, the e-retailer observes an average delay of 473k packages per day owing to the disruption, resulting in a total loss of \$298m. Thus, it is pertinent that the e-retailer outsources last-mile service to maintain and restore its service when exposed to disruption. In particular, an e-retailer offering rush delivery could employ a fleet of crowdsourced drivers, considering the flexible and on-demand nature of crowdshipping. Yet, another e-retailer may want to mitigate the monetary loss from the disruption and could, therefore, plan for the deployment of collection-points for customer pickup. On the other hand, a more traditional retailer may want to ensure reliability and could consequently outsource part of its last-mile distribution via a (or multiple) logistics service provider(s) distributing through micro-hubs.

Nonetheless, the e-retailer must consider equity implications for its staff, workers, and drivers to ensure a safe working environment and prevent any job hazard under business-as-usual conditions, but with unique protocols for each phase of the disruption. Further, collection-points must be sufficiently located throughout the service region, ensuring accessibility for disadvantaged and vulnerable groups.

Moreover, since logistics clusters with micro-hubs are located close to disadvantaged communities owing to lower property rates, such communities have a higher exposure to traffic emissions and accidents. Thus, it is pertinent that the regulatory bodies consider the general equity implications of home-based accessibility to last-mile delivery services and last-mile distribution in terms of exposure to freight-related externalities.