FORECASTING AND PLANNING URBAN FREIGHT IN THE CONTEXT OF E-COMMERCE GROWTH

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Introduction and Background

The rise of e-commerce requires a new approach to socially responsible city logistics, as European cities face increasing congestion, emissions, and pressure on public space. The study proposes a predictive engineering and mathematical framework for forecasting urban freight growth. Our specific objective is to develop a robust modeling approach to forecast urban freight volume growth to support the creation of adaptive and sustainable urban master plans. Recent data from the European Commission (EC) show that the volume of low-value e-commerce shipments entering the European Union has surged dramatically. In 2024, approximately 4.6 billion low-value parcels (valued under €150) were imported into the EU. This represents a steep increase compared with 2023 and 2022: the recorded number more than doubled between 2023 and 2024 (from ~2.4 billion to 4.6 billion) and tripled since 2022 (from ~1.4 billion). Moreover, in 2024, roughly 91% of these low-value e-commerce shipments originated from China. In the Republic of Moldova, national postal service data reflect similar growth trends. In 2024, Moldova's postal market revenues grew by 35%, reaching 633 million lei. Around 10 million parcels were imported into Moldova that year. There has been a massive rise in cross-border parcel shipments from China to the EU and neighboring countries such as Moldova. This trend significantly increases the load on urban delivery and logistics networks, thereby elevating the volume of freight that urban planning and city logistics must now accommodate. Given such rapid growth, the proposed predictive framework becomes essential. Engineering and mathematical modeling—calibrated with empirical e-commerce flow data—will be critical for forecasting future urban freight loads, designing sustainable infrastructure and buffer zones, implementing efficient flow-control mechanisms, and preventing congestion, environmental degradation, and conflicts over public-space use.

Methodology

We employ an integrated approach utilizing time series analysis and stochastic differential equations to project last-mile delivery growth. The analysis uses granular traffic-flow and logistics data from Chișinău (Republic of Moldova), including official records showing that freight volumes increased by 12.5% in the last two years, alongside comparative data from EU urban centers. The core risk—curb-space competition—is quantified using a model that correlates delivery-stop frequency with variance in parking-search time, which directly affects CO_2 and NO_2 emissions.

Results

The SDE model reveals a nonlinear, high-volatility growth trajectory for parcel deliveries, projecting that volumes will exceed linear forecasts by approximately 18% over a five-year horizon. The analysis shows that the current rate of e-commerce expansion will lead to a 35% increase in peak-hour curb-space demand in central areas. Critically, this demand is correlated with a statistically significant 15% rise in emissions due to increased friction and time spent cruising for parking. However, the modeled adaptive master-plan framework—incorporating dynamic routing and consolidation strategies—demonstrates the potential to reduce CO_2 emissions by up to 25% by stabilizing operational turbulence.

Conclusions and Implications

The findings underscore that proactive, data-driven interventions are essential for urban freight stability. The proposed adaptive planning framework provides a vital decision-support tool for municipalities seeking to implement dynamic management systems that balance logistical efficiency with environmental and sustainability goals. The research offers a scalable template for cities, particularly in emerging markets such as Chișinău, aiming to harmonize logistics growth with European sustainability standards.

Keywords: *city logistics, curb-space competition, e-commerce, stochastic modeling, sustainable freight*