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Advancing Sustainable City Logistics through Energy-Efficient Transportation

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Abstract

The logistics sector has grown significantly in recent decades due to rapid industrialization, urbanization, and the expansion of the e-commerce industry. This growth has caused logistics to be one of the primary contributors to environmental pollution, mainly due to fossil fuel usage across various transportation modes. As cities expand and logistical demands increase, sustainable methods within global and urban logistics have become essential to reduce this ecological impact. In this line, the concept introduced as sustainable city logistics has emerged specifically to address the environmental impact of urban transportation. As electric vehicles continue to gain popularity, they are becoming a fundamental solution for reducing emissions, particularly in densely populated urban areas where air quality is a serious concern. In addition, implementing multi-echelon, or multi-tier, distribution systems is emerging as another key sustainability practice in logistics. At each stage of such systems, goods are consolidated at intermediate facilities, often referred to as transshipment hubs or 'satellites,' before being transferred to different vehicles for the next delivery phase. Adopting eco-friendly vehicles, especially for last-mile delivery, along with multi-echelon distribution systems, provides numerous benefits. These include reduced traffic congestion, lower pollution levels, and minimized transportation costs. However, the success of these strategies depends on optimized transportation planning and the efficient allocation of resources. Advanced decision-making approaches from operations research and artificial intelligence are critical in addressing problem-specific complexities, such as limited battery range, en-route recharging requirements of electric vehicles, and the complex structure of the multi-echelon distribution networks. This study presents a holistic approach to sustainable city logistics, focusing on energy-efficient transportation through multi-echelon distribution, eco-friendly vehicles, and advanced route optimization.

Keywords: sustainability; logistics; multi-echelon distribution; electric vehicles; energy efficient transportation