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Cargo cycles for local delivery in New York City: Performance and impacts

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ABSTRACT

This study aimed to evaluate the operating performance of human-powered cargo cycles compared to motorized delivery vehicles for local delivery in Manhattan, New York City (NYC) in the United States of America (USA). While many recent studies have more broadly examined cost and impact tradeoffs in the use of cargo cycles for last-mile parcel delivery, the primary focus of this study was to understand how human-powered cargo cycle moving and parking behaviors differ from those of motorized vehicles in NYC. The study employed spatial and statistical analysis methods to directly estimate traffic performance measures using GPS data collected from two local operators. Traffic operating characteristics - including corridor travel speeds, trip delays, delivery times, and travel distances were examined to compare goods movements and parking behaviors for each vehicle type. Street and parking space, CO_2, and particulate matter emissions savings were also estimated for alternate urban delivery vehicle replacement scenarios for one of the participating operators. Overall, results from this study suggest that cargo cycles can provide environmental benefits and offer a competitive last-mile delivery option for some local operators in very congested cities like NYC.

1. Introduction and background

1.1. Study introduction

This study developed and implemented a method to compare the traffic performance, space consumption, and emissions impacts for freight delivery by cargo cycle and motorized vehicle in Manhattan, New York City (NYC), United States of America (USA). Sections 1.2–1.4 describe the context for urban freight operations in NYC and previous literature on cargo cycles, the use of GPS to estimate traffic performance measures, and traffic and environmental impacts of urban freight. Chapter 2 describes the study methodology. Data was collected from six equipped vehicles: four total cargo cycles operated by two local operators, and two trucks also operated by one of the cargo cycle companies (Section 2.1). The data was processed (Section 2.2) and analyzed to estimate three traffic performance measures for each operator and vehicle type: speed, stopped-time delay: travel time ratio, and delivery or pick-up time (Section 2.3). Traffic performance results and observed differences between operators and between modes are discussed in Section 3.1. Finally, a hypothetical vehicle replacement scenario for one operator was evaluated using the estimated traffic performance measures as inputs for footprint estimation and vehicle emissions modeling; the methodology for this analysis is described in Section 2.4, and results are discussed in Section 3.2. Finally, Chapter 4 summarizes the major findings from this work, and the implications for freight operators and infrastructure managers.

1.2. Conditions for commercial vehicle operations in New York City

In New York City (NYC) in the United States of America, like in many large cities, demand for last-mile goods movement is growing as the population continues to increase and as both residents and businesses demand frequent on-demand or just-in-time deliveries. At the same time, public policies seek to limit the negative externalities of motor vehicle travel, including both greenhouse gas and air pollutant emissions and collisions that pose a threat to non-motorized travelers. The current mayoral administration's long-range plan for the city, OneNYC, aims to increase the city's share of non-drivers by expanding dedicated infrastructure for bicycles, pedestrians, and transit. The plan also aims to reduce the impact of last-mile goods movements on the city (City of New York, 2015). Simultaneously achieving these two goals is difficult. Shrinking capacities for motor vehicle movements without inducing a significant passenger mode shift may increase congestion for all motorized travelers, exacerbating already extreme delays faced by

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commercial vehicle operators. The Texas A & M Transportation Institute's 2015 Urban Mobility Scorecard estimated that in 2014, trucks operating in the NYC metropolitan area faced close to $2.8 billion in excess costs for wasted time and fuel due to traffic congestion (Schrank, Eisele, Lomax, & Bak, 2015). These delays result in worsening impacts for the city, as trucks operating in congestion produce higher emissions from inefficient engine operations and occupy limited available road space for longer periods of time.

Similarly, streets designed primarily for pedestrian safety may be difficult for large vehicles to navigate and may further constrain already inadequate capacities for parking and loading/unloading. In comparing demand for freight trips with available parking spaces for commercial vehicles, Jaller, Holguin-Veras, and Hodge (2013) concluded that in a number of Manhattan zip codes, demand for truck parking already exceeds the number of available spaces. This lack of available space frequently leads to illegal parking, which again has implications both for the operator and for the urban area. Holguin-Veras et al. (2011) estimated that commercial operators accrue parking fines averaging $500 to $1000 per truck per month for deliveries made in Manhattan during business hours. Illegally parked vehicles can also present both a new source of congestion (and associated externalities) and a safety challenge to multimodal travelers when they obstruct motor vehicle or bicycle travel lanes or pedestrian crossings.

1.3. Cargo cycles for urban delivery

One potential strategy to limit externalities from freight in a multimodal urban environment is to implement city logistics solutions that employ smaller, more environmentally friendly vehicles for local and last-mile movements; one such vehicle is the cargo cycle. Cargo cycles are two- and three-wheeled vehicles with cargo carrying capacity that are primarily powered by human energy. Some cargo cycles are also equipped with an electrical assist motor that provides supplemental power to improve performance in hilly conditions or while carrying a heavy load. With cities worldwide struggling to balance growing freight demands with increasing passenger multimodality and broad sustainability goals, cargo cycles have seen increasing application in recent years, both for local movements and for last-mile movements from urban consolidation centers. Table 1 provides a summary of recently published cargo cycle research. In addition to these studies, a number of projects are currently ongoing in Europe, including Germany's “Ich ersetze ein Auto” project, which aims to test the use of 40 cargo cycles for daily courier operations in nine German cities and the EU-funded LAMILO project, which is evaluating a multimodal supply chain using cargo cycles for last-mile delivery of goods moving into Paris by barge.

Results from these studies have identified both benefits and challenges for cargo cycle operators and potential impacts for the cities in which they operate. Cargo cycles are generally less expensive than motor vehicles to purchase, maintain, insure, fuel, and park; however, as their capacities are limited by the vehicle size, human limitations of the operator, and (where applicable) electric-assist battery autonomy, to move large volumes of goods they require more operators and/or vehicles than traditional truck or van services. When implemented as a last mile solution, cargo cycle operations also require space for transloading. To operate efficiently, cargo cycles must serve a dense market within a confined service radius (Dablanc, 2011); the required density is generally found in central business districts where space is both limited and expensive. Where regulations allow, cargo cycles can operate flexibly on motor-vehicle, bicycle, or even pedestrian infrastructure, but this flexibility may be constrained depending on the local vehicle classification regulations; for example, in the London case study, due to the use of an electric-assist motor, cargo cycles were classified as motor vehicles and permitted to operate and park only on motor-vehicle infrastructure (Browne et al., 2011). With the exception of the case study in London where operating costs were about even for cargo cycle and motorized operations, cargo cycle operations have not been found to be cost-competitive as a direct replacement for van and truck operations; however, they are more competitive where local policies such as hourly restrictions or low emissions zones limit or increase the cost of motor vehicle operations or where pedestrian and bicycle friendly infrastructure designs are difficult to navigate with large vehicles (Tipagornwong & Figliozzi, 2013).

The unique contributions of this study to the growing body of cargo cycle research are threefold. First, while a number of previous studies have noted that operating speeds of cargo cycles are generally competitive to motorized modes in dense urban areas, none have directly monitored or analyzed in depth the comparative vehicle traffic performance. This study proposes a simple methodology for comparing cargo cycle and motor vehicle traffic performance for urban delivery using GPS data. While a number of previous studies have examined the environmental and traffic impacts expected from city logistics solutions at a macro scale, few have evaluated micro-level space and environmental impacts from vehicle replacement. This study uses estimated traffic performance measures as inputs for a micro-scale analysis of space, air pollution, and CO_2 emissions savings. Finally, as noted above, modal competitiveness can vary considerably based on local regulations. By directly monitoring performance in NYC, this study will enable local operators to better understand the benefits and challenges for operating this mode under the city's existing regulations and infrastructure conditions.

1.4. GPS data for traffic performance measurement

While no previous study has employed GPS data to understand the

Table 1
Recent cargo cycle research.

Study	Focus
Transport for London (2009)	Outlined existing and potential future applications for cargo cycles in London, UK
Dablanc (2011)	Monitored the operations of La Petite Reine, a cargo cycle company performing deliveries from a consolidation platform in central Paris, France
Browne, Allen, and Leonardi (2011)	Conducted a before and after analysis of an office supply company replacing van deliveries with cargo cycle operations from a micro-consolidation center in central London, UK
Verlinde, Macharis, Milan, and Kin (2014)	Conducted a before and after analysis of a major parcel company implementing a mobile depot utilizing cargo cycles to replace motor vehicles for last-mile delivery in Brussels
Gruber, Kihm, and Lenz (2014)	As part of ongoing “Ich ersetze ein Auto” project, studied the market potential for replacing motorized (car and van) courier operations with cargo cycle operations in Germany
Tipagornwong and Figliozzi (2013)	Modeled the cost competitiveness of cargo cycle vs. motor vehicle delivery operations in Portland, OR, USA
Koning and Conway (2015)	Quantified the externality savings from growing cargo cycle operations in Paris, France between 2001 and 2014
Schliwa, Armitage, Aziz, Evans, and Rhoades (2015)	Developed a typology for cycle logistics and examined the influence of customer perception, urban geography and public policy on cargo cycle market penetration.
Saenz, Figliozzi, and Faulin (2016)	Modeled the greenhouse gas emissions savings for last-mile delivery by cargo tricycle compared to diesel van in Portland, OR, USA.