State of TRANSPORTATION PLANNING 2020
Moving People Over Cars: Mobility for Healthy Communities
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Creating Great Communities for All
City Tech Solution:
Delivery Congestion Reduction

Summary

The explosion of e-commerce has led to faster, more frequent, and more abundant delivery services, resulting in increased congestion in cities, disruptions to supply chains, and increased costs for delivery providers.

To address this need, City Tech Collaborative partnered with HERE Technologies, Accenture, UPS, and Microsoft to develop new data tools to create flexibility for last-mile package deliveries, with the potential to reduce traffic congestion.

Using a known congested area in Chicago as a testbed, the team analyzed UPS vehicle data to understand routes, delivery performance, and the impact on congestion. By merging traffic data and delivery activities, the pilot demonstrated opportunities for efficient, cost-effective, and congestion-reducing road-sharing for both delivery carriers and consumers.

The effort showed how multiple stakeholders can benefit from integrating delivery data and traffic mapping to understand exactly where delivery services are causing friction in cities. With this information, cities, retailers, and shippers can target specific populations and offer incentives at scale to increase delivery flexibility and reduce congestion and associated costs. In addition, cities could make data on traffic congestion and mitigation efforts easily accessible to third parties.

Deliveries: Disrupting Traffic and Supply Chain in Cities

Same-day deliveries and expanded online shopping options are becoming part of consumers’ everyday lives. Although convenient, the increased demand for fast deliveries contributes to road congestion in cities globally.
Increased traffic congestion is not only a nuisance, but it is also dangerous to all who share the road – from drivers to bikers to pedestrians – as well as takes an additional toll on the environment.

Consumer demand has encouraged last-mile urban logistics to increase delivery services and frequency, even in constrained geographies. These demands increase costs for delivery providers as well as disrupt supply chains across industries.

Understanding the impact of deliveries in cities can help shippers, retailers, and cities become more efficient with their logistics and decrease traffic congestion.

**A Collaborative Approach to Solution Development**

Delivery services and the resulting traffic congestion affect cities, public and private businesses, and residents. Unique collaboration among delivery service providers and data analytics organizations can determine the extent to which delivery services are causing road congestion and the areas where their impact is the highest. Using these tools, retailers and deliverers can determine flexible delivery options for consumers, thus reducing traffic congestion and lowering delivery costs.

The Delivery Congestion Reduction pilot resulted from a workshop hosted by City Tech in September 2017 to explore opportunities to develop innovative demand management methods for last-mile deliveries and to reduce congestion in cities. By collaborating with and understanding end-users and their real-world challenges, the workshop identified solutions that can be designed, developed, and deployed to more effectively manage urban logistics.

City Tech’s solutions focus on the intersections of physical infrastructure, data and digital infrastructure, and public and private services.

Delivery congestion impacts all three of these areas, thus calling for collaboration across sectors.

**City Tech Collaborative**

City Tech Collaborative (CityTech.org) is an urban solutions accelerator that tackles problems too big for any single sector or organization to solve alone. City Tech’s work uses IoT sensing networks, advanced analytics, and urban design to create scalable, market-ready solutions. Current initiatives address mobility, healthy cities, connected construction, and emerging innovation opportunities. City Tech was born and raised in Chicago, and every city is a potential partner.

As a member-driven consortium, City Tech combines the best tools and thinking from leading corporations, local governments, startups, civic and academic institutions, residents, and community organizations. From identifying and developing the initial problem statement to implementing a solution, City Tech’s solution development methodology accelerates impact-driven innovation and collaboration, as well as enables multiple parties to come together to work on a single solution.

**Here Technologies**

Lead sponsor of the solution, HERE Technologies (Here.com) builds open solutions for the future and redefines the digital map and the future of location technology. As creators of three-dimensional maps packed with layers of information and insights, HERE’s data science team led the traffic congestion analysis at a highly granular, road segment level and developed the solution to determine the relationship between delivery stops and their effect on traffic delays.
Accenture

Accenture (Accenture.com) drives innovation by partnering with clients to transform and grow organizations. The Accenture team provided key project management to focus the solution and meet the pilot’s goals.

UPS

UPS (UPS.com) is the world’s largest package delivery company and a leading global provider of specialized transportation and logistics services. UPS supplied vehicle trajectory and delivery stops data and insights on Chicago routes for analysis.

Microsoft

Microsoft (Microsoft.com) enables digital transformation for the era of an intelligent cloud and an intelligent edge. Microsoft was essential in orchestrating the design of the approach, model, and analysis of the solution.

Pilot

The team analyzed congested areas in Chicago as a testbed as well as examined UPS delivery route data. With the goals of reducing traffic congestion from UPS delivery vehicles, the pilot set out to:

- Demonstrate capabilities to validate routing and scheduling models
- Identify specific locations to target with interventions
- Identify characteristics of high congestion/cost areas for last-mile delivery

Pilot Design

HERE provided and analyzed traffic congestion data at the road segment level in highly granular and aggregated time frames to determine the testbed area.

UPS supplied vehicle trajectory and stops data on seven Chicago routes from October 9, 2018 to November 7, 2018 to understand delivery
and congestion patterns. The data included information on:
- 7 routes
- 23 vehicles
- 288,000 GPS points
- 152 trajectories
- 12,612 stops

Using this known congested area in Chicago, HERE conducted analysis using UPS data to determine the correlation and identify potential areas where flexibility in time or location of deliveries could reduce costs and ease congestion. The pilot demonstrated opportunities to merge data and delivery activities into efficient, cost-effective, and congestion-reducing road-sharing techniques for both delivery carriers and consumers.

**Analysis: Identify Stops & Speeds Related To Deliveries**

**Analysis:**

Delivery stops were identified in UPS’s trip log records based on when “ignition off” was listed in the data. These stops were mapped to match HERE’s map segments with traffic speed data.

HERE matched each UPS stop to the appropriate road segment, then used the weighted average
traffic speed at that location to assess the time leading up to, during, and after the delivery. The traffic analysis was accomplished using processed, archived GPS probe data matched to the HERE map segments, averaged in five-minute intervals. HERE then tested whether there were statistically significant differences between traffic speeds during the stop and before/after the stop.

**Results:**

Using UPS data, HERE Technologies’ data science team compared the data to understand where traffic patterns and congestion differed to determine the impact on congestion. The team found no significant difference between speeds before, during, or after UPS stops, and a larger sample size is needed to fully draw correlation between deliveries and road congestion. However, qualitative data suggests that there must be some impact on road congestion from deliveries.

**Analysis: Stops And Packages Per Road Segment**

**Analysis:**

The team analyzed the number of stops per road segment as well as the number of packages delivered per road segment to determine delivery demand in specific geographies.

The team aligned the stop time as defined in GPS data (engine off) with package delivery data contained in UPS’s data file (Orion), then determined the number of packages delivered per stop and total time spent delivering each package.

From this, the team found the following general statistics:

- Total number of stops = 10,197 (There are 12,611 stops identified from GPS files, out of which the team was able to match 10,197 with the Orion stop files)
- Median stop duration = 162 seconds
• Median number of packages delivered per stop = 2

• Median package delivery rate (i.e., number of packages delivered per minute of stop duration) = 0.8

**Results:**

Analysis found that UPS balanced the number of packages delivered on a route with the level of difficulty (amount of time required) quite well, with a similar median rate for per-package delivery across all seven analyzed routes.

Although the overall per package rate was relatively consistent across routes, variances in time per stop and time per package existed. Routes with a high number of packages and a high number of stops tended to occur on commercial or mixed-use roads. Park West tended to have longer stops and more packages delivered per stop than other routes (see charts above for median duration and median number of packages per stop for each route). The analysis found an inverse correlation between the number of stops and the stop duration.
For most routes, the longest stops occurred at 10 a.m. and 11 a.m., with Park West being the outlier and experiencing the longest stops at 4 p.m. (see charts below for stop duration over time of day for example routes).
Circled areas on the maps of Park West (left) and West Loop (below) show routes with many delivery stops that take a long time to deliver. Mixed-use/commercial streets such as these would benefit from testing incentives to maximize delivery efficiency and minimize traffic congestion.
Analysis: Pain Points and Opportunities

Following the analysis of packages per route, the team identified pain points for delivery drivers, focusing on where deliveries were taking comparatively longer and where costs were higher. Conversely, the team also analyzed where deliveries were particularly efficient, allowing drivers to deliver a large quantity in a short amount of time.

Low Rate Deliveries Results:

Peak time for low rate deliveries (few packages delivered over a long duration) was 2 p.m.

The team assumes that larger, more difficult deliveries are deliberately scheduled for mid-day.

These low rate deliveries were most concentrated in Wrigleyville and West Loop.

Bridgeport and Armour Square had higher overall number of packages than other routes (potentially due to more residential deliveries).

High Rate Deliveries Results:

Peak time for high rate deliveries (many packages delivered over a short duration) was right after and right before rush hours (10 a.m., 3 p.m. to 4 p.m.).

West Loop was unique for having both the highest rate and the lowest rate deliveries, potentially due to the diverse route. Bridgeport and Armour Square both had higher overall numbers of packages and higher rates of delivery, potentially due to the areas being more residential.

The figure shows the spatial distribution of deviations. White ellipses highlight the road sections where actual deliveries tend to be earlier than Orion ETAs. Black ellipses highlight the road sections where actual deliveries tend to be later than Orion ETAs.
Analysis: Scheduled vs. Actual Delivery

Using the Wrigleyville route, the team compared behavior of drivers to what was actually scheduled on the Orion delivery scheduler. Drivers delivered heavily between 10 a.m. and 3 p.m., perhaps to avoid rush hour traffic. The Orion schedule, on the other hand, assigned many deliveries at 9 a.m., 4 p.m., and 6 p.m. On average, the actual delivery was 1.3 hours earlier than the Orion scheduler ETA, and some deliveries were as many as eight hours earlier or later than scheduled. When looking at overall delivery time (first delivery to last delivery of the day), drivers typically beat what was scheduled.

Results

The Delivery Congestion Reduction pilot:

• Demonstrated capabilities to validate routing and scheduling models

• Identified specific locations to target with interventions

• Identified characteristics of high congestion/cost areas for last-mile delivery

The team determined:

• New Opportunity: It is possible to merge traffic data and delivery activities into more efficient road-sharing techniques to optimize traffic conditions and decrease delivery costs.

Comparison of actual route time spent for delivery per day vs. what was scheduled. The overall delivery time is defined to be the length of the time period starting from the first delivery of a day until the last delivery of the day.
• **Cost Optimization**: Identification of peak delivery cost times and locations can help inform the creation of delivery routes and optimization of delivery windows to minimize delays.

• **Scheduling Efficiency**: Differences between driver preferences and behavior and routing software recommendations show the potential for using more optimal routing to improve efficiencies and reduce costs for carriers and consumers.

• **Congestion Reduction**: Although it is most likely that deliveries are contributing to traffic congestion, a larger data sample, covering both a longer time frame and a larger geographical area, would lead to more statistically significant results. With this information, delivery service providers can make decisions around timing and frequency of deliveries to reduce congestion and cost.

### Impact and Recommendations

Certain streets are inherently more difficult for deliveries – commercial and mixed-use streets proved to take the most time to make deliveries. Other factors, including bike lanes, pedestrian paths, availability of loading zones, street width, and street parking, may influence efficiency of deliveries and impact traffic congestion.

With the success of the pilot, City Tech, HERE Technologies, Accenture, UPS, and Microsoft demonstrated that it is possible for shippers to merge their data with third-party traffic data to understand impacts on congestion. Not only is this information beneficial for shippers, but retailers and even cities can use quantifiable data to focus on locations where interventions will have the most impact on reducing traffic congestion and the associated costs.

Through this analysis, the team identified locations in Chicago, and the underlying characteristics of those street locations, that would benefit from testing incentives. Retailers and shippers can offer incentives at scale at target locations to increase delivery flexibility. Through collaboration, incentives could include retailers and shippers suggesting alternate delivery windows for specific locations at a lower cost to the consumer. Retailers could offer consumers a points-based reward system to only deliver on certain days, or shippers could target customers by zip code or street to suggest alternate pick-up locations that may be more efficient for deliverers. By shifting behaviors and grouping/limiting deliveries, traffic congestion could be reduced, and shippers/retailers could save time and money that may be needlessly spent. Using this methodology, the pilot can be scaled to other cities.

To fully test the pilot’s impact, the Delivery Congestion Reduction team recommends the testing of data-driven alternative delivery models in areas that may benefit most from the effort. To successfully deploy such traffic- and cost-reducing measures, the team also recommends that cities make data on traffic congestion and mitigation efforts easily accessible.
About the Authors

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As the Director of City Solutions at City Tech, David facilitates cross-sector collaboration among universities, government, and industry partners to drive innovative solutions to complex urban challenges. Prior to joining City Tech in 2015, David was Program Manager for the Chicago Department of Transportation Streetscape and Sustainable Design Program, where he directed nearly $100 million of policy, planning, and construction projects ranging from pocket parks and public markets to streetscapes and master plans. He is a former lecturer at the University of Illinois, Chicago and currently serves on the board of Foresight Design, a nonprofit that provides education and community building for sustainable transformation in the Midwest.

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Managing solution development at City Tech, George works with teams made up of experts from the public, private, and nonprofit sectors, along with startups and universities, to execute pilots and implement technologies to benefit city residents across the world. Prior to joining City Tech, George was the Senior Policy Analyst at Get IN Chicago, where he managed the lifecycle of grantmaking for programs serving at-risk youth and analyzed grant performance, outcomes, and compliance. George previously worked as a policy analyst in the Illinois Governor’s Office where he performed analysis and project management, including managing the implementation of initiatives such as the GetCoveredIllinois healthcare marketplace website and the Illinois Pathways public-private education partnership; George also served in the United States Army as an intelligence analyst.

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Adam J. Hecktman is Director of Corporate Affairs in Microsoft Philanthropies. In this capacity, he works to advance the company’s mission by making the opportunities of our rapidly evolving digital economy accessible to all people, particularly those most at risk of being left behind; Microsoft believes technology is a force for social and economic inclusion, and Adam works to create a future where everyone has access to the benefits it provides and the opportunities it creates. With Microsoft in Chicago since 1991, Adam previously worked in Microsoft’s Technology and Corporate Responsibility Team, and prior to that was the Director of the Microsoft Technology Center – Chicago. Adam received a Bachelor of Science in Commerce and Business Administration from the University of Illinois at Urbana-Champaign and is currently pursuing his Master of Data Science at DePaul University. Adam has served his community in various capacities and appointments at non-profit, civic, and professional organizations.