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Foreword

George Mason University’s Transportation Policy, Operations, and Logistics (TPOL) Master of Arts program requires students to complete a capstone course known as a practicum. The students have a variety of real-world experience in the transportation industry and the practicum affords them the opportunity to apply their knowledge and expertise to address existing transportation problems. The following report is the result of a semester-long study in which the practicum team of ten students, along with the guidance of their professor Dr. Jonathan Gifford and their client Mobility Lab, researched the opportunities for improving information systems to support passenger and freight transportation in Arlington County, VA. Through a combination of literature review and fieldwork, the team developed recommendations that will establish Arlington as a Connected City in passenger and freight transportation services.
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Executive Summary

Purpose of Research

In order to meet the demands of a growing population, Arlington County must continue to improve its transportation systems. Arlington County offers a variety of passenger and freight transportation choices to residents, businesses, and commuters. However, these choices lack connections within and between the choices, which conflicts with the county’s vision, defined in its Master Transportation Plan, of a multimodal transportation system that provides equity of access for all users.

Transit choices are spread across multiple information platforms. Efficient route utilization and ridership cannot be maintained due to high operating costs and insufficient revenue from Arlington’s bus and Americans with Disabilities Act (ADA)\(^1\) complementary paratransit services. Service gaps exist in connecting passengers to transit within the “first and last mile” of their trip origins or destinations. The current community feedback platform does not successfully encourage community dialogue. Community engagement strategies should keep pace with an increasingly mobile population so that the public is aware of the services being offered.

Shortfalls also exist with freight delivery in Arlington County. The county’s current curb space management policies and freight carriers’ most efficient unloading practices are not aligned. Arlington County’s Master Transportation Plan does not account for the needs of freight stakeholders and freight data is limited at the local level. These gaps in planning and data-sharing must be addressed in order for Arlington County to accommodate increasing freight delivery demands as the county’s population continues to grow.

Method of Data Gathering and Analysis

Due to the current independent nature of passenger and freight transportation systems, we approached each service separately, using a range of methods for data gathering and analysis. For both services, a review of literature was performed to identify gaps and common solutions that address those gaps. Arlington County’s passenger services are featured prominently within local transportation plans and planning documents, whereas freight services were scarcely mentioned. This led us to conduct fieldwork involving on-site observations and stakeholder interviews in order to supplement the lack of freight data. We also analyzed the Virginia Department of Transportation’s Commodity Flow Survey to develop an understanding of freight throughput in Arlington County.

\(^{1}\) The Americans with Disabilities Act requires fixed route transit service providers to supplement their services with paratransit (non-fixed route) services.
Overview of Findings: Passenger Service

In order for Arlington County planners to provide improved connectivity for passenger transportation, gaps in service, data, and community engagement must be addressed.

Like most fixed-route transit options, ART faces service gaps in areas of Arlington County that are the least densely populated. For areas that have a higher population, buses often experience overcrowding. Passenger fares only contribute just over a quarter of the funds needed for operations and maintenance which adds to ART’s inability to maintain efficient route utilization and ridership. Another common challenge for riders in Arlington County is the first and last mile of their commute. The difficulty in reaching the transit service itself can influence passenger’s mode of travel choice. Other cities across the U.S. have partnered with transportation network company (TNC) services, such as Uber and Lyft, in order to bridge the gaps in first and last mile travel. In Arlington County, bike-sharing and car-sharing programs also provide options that connect passengers with transit.

Increasing transit utilization and efficiency is also reliant on the way in which data is presented to the user. Mobile networks play a vital role in day-to-day life and real-time tracking of services has become a necessity for busy commuters. Current smartphone applications are constrained by variations in technology platforms and do not allow real-time tracking for all of Arlington County’s transit services. TNC services are also not integrated with these platforms. Mobility Lab’s web-based service, CarFreeAtoZ, has worked toward integration by providing travelers with a comprehensive multimodal trip planning tool. Developing this tool as a mobile application would create greater convenience for commuters.

Data sharing could be further facilitated through community engagement initiatives. Users of the “My Arlington” and ArlingtonVA Service Request apps can provide feedback and report non-emergency issues, but these outlets are not sufficient means of generating meaningful community engagement. Arlington will need to use additional methods to engage the public, such as intercept surveys at transit stops and marketing events at popular local venues.
Overview of Findings: Freight Service

In order for Arlington County planners to provide improved connectivity for freight transportation, gaps in planning and data-sharing must be addressed.

A review of the literature indicated that the most common challenge faced by freight carriers is dealing with the complexity of urban areas. However, the literature did not present an idea of common freight carrier practices in dealing with the challenges presented by urban environments. A field study was conducted to compensate for this lack of data and assess the common delivery practices of freight carriers in Arlington County. 102 delivery events were observed over the course of two weeks in Arlington County’s urban areas. Curb-space management and use of proper loading zones proved to be problematic, with 72.5% of vehicles observed in no parking zones. Freight vehicles were also observed blocking travel lanes, bicycle travel lanes, crosswalks, and fire hydrants.

These unsafe and often unlawful delivery practices suggest that there are deficiencies in the coordination between planners and freight stakeholders. Interviews with freight carriers and their customers supported this finding. Freight carriers indicated that while they faced challenges while delivering in urban areas, they currently have no way to voice their concerns to Arlington County planners. While less perceptible than the challenges faced by freight carriers, customers did note that, when available, alleys and off-street loading zones were less frequently used to make deliveries. Many customers also noted congestion as a common issue caused by double-parked freight vehicles.

The gaps identified in planning are indicative of the gaps in the availability of freight data. Much of the data collected by freight carriers is proprietary; in many cases it offers them a competitive advantage, which presents little incentive to share. However, freight data has the potential to help identify planning needs. Coordination between planners and freight carriers could lead to accurate forecasting of freight demands and urban design that is conducive to both passenger and freight movement.
**Recommendations**

The following recommendations address ways to approach Arlington County’s passenger and freight transportation challenges:

**Recommendation 1: Reduce or replace underused ART and Specialized Transit for Arlington Residents (STAR) routes with TNC services**
Arlington County should consult the case studies in this report to determine the feasibility of supplementing these services with TNC partnerships.

**Recommendation 2: Provide first and last mile service options for public transit**
TNC partnerships would improve transit service in Arlington County and could potentially reduce transit operations and maintenance costs.

**Recommendation 3: Improve existing real-time transit information and develop strategies for community engagement**
Arlington County should develop and promote mobile technologies that provide real-time tracking of service providers and improve community engagement.

**Recommendation 4: Identify delivery challenges and solve them within a test neighborhood**
Arlington County should conduct interviews with freight carriers and customers within a test neighborhood to identify common practices, problems, and ideas. The findings from these interviews should guide the creation of a comprehensive freight plan.

**Recommendation 5: Charter an Urban Freight Cooperative (UFC) within a test neighborhood**
A working group should be developed to foster continued collaboration between Arlington County planners and freight stakeholders. The UFC should promote data-sharing and the development of policies that take into account freight delivery best practices and transportation management principles.

**Recommendation 6: Integrate freight data with other transportation system data**
Arlington County should develop a data-sharing system for freight information obtained by the UFC. This data can be used to more accurately forecast freight movements and volume, improving accuracy of land use developments and parking management plans.
Arlington County, a Collection of Urban Villages

Serving as an “Urban Village”\(^2\) where most human conveniences and necessities are at walking distance within any neighborhood, Arlington County is widely-viewed as a leader in transit-oriented development and passenger movement (Arlington County 2017d). It has taken an innovative and progressive approach towards fostering communities that optimize land use to provide a variety of transportation and housing choices near jobs, shops, services and schools.

Arlington County offers a broad range of multimodal transportation options for its residents, boasting nearly 100 percent transit-coverage within half a mile to its entire population. Modes of transit include: Metrorail, Metrobus, Arlington Transit (ART), Capital Bikeshare, and numerous TNCs such as Uber and Lyft. It also provides ADA complementary paratransit services\(^3\) under the STAR service. Furthermore, Arlington County is also home to Ronald Reagan National Airport (DCA) and the Crystal City Virginia Railway Express (VRE) station.

In addition to embracing service avenues for passenger movement, Arlington County is now beginning to explore the next steps it will need to take in supporting freight movement. Urban freight delivery has become abundant through the growth of e-commerce and an ever-increasing demand from customers. For many in Arlington County, urban freight serves as a substitution for transportation. Rather than determining how to get from “Point A” to “Point B” in order to reach goods or receive services, individuals are using freight resources to bring the goods or services straight to “Point A” without having to use personal transportation or public transportation.

Future Arlington County policies and planning must include freight requirements alongside those of pedestrians, bicyclists, and other transportation services.

Despite its success to create distinctive, attractive urban villages with a strong sense of place and growth potential, to push its growth from a smart city to a connected city\(^4\), Arlington County must overcome several challenges. It is a rich county by national standards, with an estimated 2015 per capita income of $63,570, compared to the United States $56,430 (U.S. Census Bureau 2017), but its budget is stretched in trying to update and maintain existing transportation modes while new modes and services are generating additional financial requirements (Arlington County 2017c1, 10, 25). Financial and land availability constraints contribute to the County’s reluctance to pursue major transit and roadway transportation improvements for its future (Arlington County 2017c1, 25).

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\(^2\) The term urban village illustrates Arlington County’s dedication to plans focused on developments at the neighborhood level, which combine to form a comprehensive plan for the county (Arlington County 2017c1, 1).

\(^3\) Section 12143 of the Americans with Disabilities Act (ADA) requires fixed route transit service providers to supplement their services with paratransit (non-fixed route) services.

\(^4\) A connected city uses information technology systems, predominantly web-based, in conjunction with one another to manage transportation networks, housing demands, and business development (Martin 2014).
Additionally, stakeholders have not incorporated freight movement considerations into Arlington County’s Master Transportation Plan. Competition for resources between freight and passenger movement is already demonstrated through high traffic congestion in Arlington County’s densely populated areas. This results from the limited availability of parking spaces, constrained space on roads, and the lack of convenient off-street loading zones (docks) for businesses receiving freight. Non-existent or extremely limited, fragmented data on freight movement throughout the county further hinders Arlington County in building a transportation plan that comprehensively predicts needed resources for passenger and freight movement.

Arlington County’s growing population will accentuate its current challenges to meet demands for passenger and freight movement, particularly as it further fills the county’s already densely populated 26 square miles. Already exhibiting a population density of 8,814 people per square mile (Arlington 2011 Arlington 2017a), as shown in figure 1.1., Arlington County’s population is anticipated to grow by 50,000 residents by 2040, bringing that density to 10,737 per square mile.

Figure 1.1. Arlington County population history and prediction (Arlington 2011 Arlington 2017a).
By 2040, mirroring this population growth, freight movement in Arlington County is also predicted to drastically increase, nearly tripling its amount of imported items since 2012, and more than doubling its exports (figure 1.2.).

This combined rise in population and freight movement, with little room to expand infrastructure, provides the county its impetus to embrace “big ideas to expand the system and accommodate the next wave of growth” within a “disciplined investment strategy” (Arlington County 2017c1, 26). Arlington County, if it were to embrace advances in information technology and extend its history of community engagement even further, could implement cost-effective yet innovative transportation solutions in its neighborhoods. Although transportation is just one facet of a truly connected city, implementation of the passenger and freight movement recommendations provided in this Blueprint would provide systems ready to plug into other connected city innovations. As technology progresses, its population grows, and its neighborhood streets become vulnerable to overcapacity, Arlington’s vision of transportation as a “system that provides equity and access to all users” will ensure that it is ready to adapt to these changes (Arlington County 2017c2, 2). This Blueprint provides the guidelines for the County to identify positive and negative aspects of existing passenger and freight services, during a time when demand and technology outpace the capacity of county officials and planners.

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2025</th>
<th>2040</th>
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</thead>
<tbody>
<tr>
<td>Import</td>
<td>2,101,117.60</td>
<td>3,981,297.65</td>
<td>6,242,520.96</td>
</tr>
<tr>
<td>Internal</td>
<td>1,110,287.52</td>
<td>2,037,582.59</td>
<td>3,208,923.21</td>
</tr>
<tr>
<td>Export</td>
<td>322,807.37</td>
<td>494,081.11</td>
<td>866,216.53</td>
</tr>
</tbody>
</table>

Figure 1.2. Forecasted tons of freight imported, exported, and moved internally in Arlington County (VDOT 2017).
Research Methodology

Our research methodology sought to identify gaps\(^5\) in Arlington County passenger and freight transportation through extensive review of literature, including local transportation plans and planning documents and case studies, internal and external to Arlington County. We chose to research and analyze performance and policy gaps for passenger and freight transportation, separately, due to the current independent nature of each service’s transportation processes; identifying a passenger and freight section, respectively, within the final report. In addition to the literature review, for freight movement, we conducted fieldwork involving interviews and on-site observations involving Arlington County freight stakeholders, further detailed in the respective freight section. Using data from the Virginia Department of Transportation (VDOT) Commodity Flow Survey, we also identified freight throughput in terms of exports, imports and internal movement within Arlington County. Comprehensively, for passenger and freight transportation, once best practices were identified, we benchmarked existing practices in Arlington County against them and proposed strategies to advance Arlington County towards establishing a more Connected City. Our research was conducted without a budget and further limited by the strict schedules of the research team students and involved stakeholder parties.

\(^5\) A gap identifies the difference between the desired or expected outcome of a policy or action and its actual outcome — where does it “fall short” in either its implementation or adequacy to address the identified problems it was created to solve.
Arlington’s Passenger Transportation

Arlington County offers multiple transit options to its residents and visitors ranging from walking and biking to bus and metro. Over the years, Arlington leadership has gone to great lengths to offer convenient and economic friendly modes of public transit (Arlington County 2017d). Their investments in infrastructure and transit service demonstrate that they are committed to achieving and sustaining a connected city for the people of Arlington County.

According to Paul Mackie at Mobility Lab, "Building a platform that brings together all the different modes of transportation, integrates them, and makes them work seamlessly together” creates “seamless mobility”. Mackie added that the goal of Arlington County should be to provide a single mobile device application that displays all of the available transit options to riders: bus, rail, and TNCs.” (Connor et al. 2017).

The County provides extensive sidewalks, walking trails, and bicycle routes throughout the county (figures 3.1 and 3.2).

Figure 3.1. Sidewalks and walking trails coverage (Arlington County 2017b, GIS Mapping Center 2017).
Capital Bikeshare has provided residents and tourists of Arlington the opportunity to make the first and last mile more achievable. Currently, there are over 80 Capital Bikeshare stations in Arlington, strategically placed for riders to make trips more convenient. These stations accommodate a large bicycle infrastructure network that includes 50 miles of shared-use street trails, 40 miles that is a mix of bike lanes and sharrows, and 80 miles of on-street bike routes throughout the county (BikeArlington, 2016).
Although Arlington County has continued to improve its passenger transportation system, Mobility Lab’s vision for a connected city, mentioned above, could be made a reality if the county addresses several performance shortfalls. These shortfalls include: numerous transit choices spread across equally numerous but disjointed information platforms; high operating costs and insufficient revenue offsets at ART and STAR; FM/LM transit service gaps; and the lack of a single, user-friendly social outreach platform to market the county’s transit services. Essentially, to better connect passengers with the wide range of transportation options in the county, Arlington’s planners must address:

**Service gaps:** Enhance or replace underutilized ART routes and specialized transit services & provide first and last mile service options to public transit; and

**Data gaps:** Improve real-time information on available transit modes; and

**Community engagement opportunities:** Create avenues for passenger transportation feedback.
Gaps in Passenger Transportation Service

Arlington Transit (ART)

ART provides 16 bus service routes that operate extensively throughout the County. Two Primary Transit Networks (PTN) offer high-quality, high-frequency transit service along Arlington’s primary development corridors: 41 and 55 (Arlington County 2016c). ART 41 runs along the Columbia Pike to Courthouse, servicing Glebe Road along the route, and ART 55 operates from East Falls Church to Rosslyn North of the main Ballston – Rosslyn corridor. ART 41, the most utilized ART route, recorded 961,134 riders in FY2015, which was over 34% of all ART trips that year. Over one-third of ART ridership used one route. ART also consists of 14 Secondary Transit Network (STN). These routes “serve moderate to low- density portions of Arlington and adjacent communities with a focus on providing connections to Metrorail stations and other PTN service transfer points” (Arlington County 2016c). These remaining 14 routes and ART 55 served a combined 1,849,318 riders in FY2015 (66% of trips).

ART is a fixed route transit system. “Fixed routes in a transit system provide clarity and regularity to the transit service, and it is known to work very well for densely populated cities” (Nourbakhsh and Ouyang 2012). However, ART like many bus transit services, acknowledges its obligation to service more than just the densely populated areas of the county. Arlington County’s FY 2017-2026 Transit Development Plan identified four challenges:

1. Because of ART’s fixed route system, many bus routes fail to meet productivity and cost efficiency standards.

Figure 3.4. ART routes (red lines) in comparison to zoning: commercial (yellow), residential (white), special (green), service (red) (Arlington County 2017b, GIS Mapping Center 2017).
2. Many neighborhoods and local communities feel they need more transit service and/or desire stronger connections to other areas of the County (service gap).
3. Unnecessary delays from riders having to add funds to payment cards.
4. Highly utilized bus routes experience overcrowding.

One of the fundamental challenges with fixed bus routes is the inability to maintain efficient utilization/ridership. ART is no different. **Figure 3.5.** illustrates that passenger fares contribute only a small portion of ART's income needed for operations and maintenance. At only 26%, ART relies on 74% of its funding to come from state and local funds.

Additionally, **figure 3.8.** shows the cost recovery rate – operating costs covered by riders’ fares – of each ART route. Of the total $9,764,282 operating costs in FY2015, only $2,962,792 was recovered through rider fares. ART 41 consistently performs the strongest, recovering 53% of operating costs from riders in FY15. ART 53, 62, 74 and 92 have substantially lower cost recovery rate compared to the other routes.

![Figure 3.5. Transit operations and maintenance funding by source (Arlington County 2016).](image-url)
Figure 3.6. Density of average weekday bus boarding by stop (Arlington 2016 3-44).
Due to the fixed nature of the bus there are many communities that are outside of ART’s footprint. “Service gaps are defined as areas where there are people that will likely use transit, yet there is little to no transit available within a comfortable walking distance (a quarter-mile)” (Arlington County 2016). **Figure 3.7.** shows the current known service gaps in Arlington County. However, this is not a comprehensive list of gaps. Ultimately, any neighborhood or community that doesn’t live within a quarter-mile of a fixed route transit provider, by definition, is gapped.

**ART Unrecovered Costs**

<table>
<thead>
<tr>
<th>ART Route</th>
<th>Annual Operating Costs (FY15)</th>
<th>Cost Recovery (FY15)</th>
<th>Unrecovered Costs (FY15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>$1,830,337</td>
<td>53%</td>
<td>$860,258</td>
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<tr>
<td>51</td>
<td>$833,037</td>
<td>17%</td>
<td>$691,421</td>
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<tr>
<td>87</td>
<td>$981,082</td>
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<td>$686,757</td>
</tr>
<tr>
<td>77</td>
<td>$882,083</td>
<td>26%</td>
<td>$652,741</td>
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<tr>
<td>75</td>
<td>$827,495</td>
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<td>$645,446</td>
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<td>45</td>
<td>$895,649</td>
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<td>53</td>
<td>$559,014</td>
<td>11%</td>
<td>$497,522</td>
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<tr>
<td>42</td>
<td>$830,592</td>
<td>45%</td>
<td>$456,826</td>
</tr>
<tr>
<td>52</td>
<td>$505,722</td>
<td>23%</td>
<td>$389,406</td>
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<td>92</td>
<td>$321,342</td>
<td>1%</td>
<td>$318,129</td>
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<td>61</td>
<td>$320,827</td>
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<td>$275,911</td>
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<tr>
<td>84</td>
<td>$301,158</td>
<td>21%</td>
<td>$237,915</td>
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<tr>
<td>43</td>
<td>$291,403</td>
<td>28%</td>
<td>$209,810</td>
</tr>
<tr>
<td>62</td>
<td>$231,015</td>
<td>15%</td>
<td>$196,363</td>
</tr>
<tr>
<td>74</td>
<td>$153,526</td>
<td>11%</td>
<td>$136,638</td>
</tr>
</tbody>
</table>

**Figure 3.8.** ART unrecovered costs.
ART’s efficiency is also adversely affected by the many riders who do not have sufficient funds on their payment cards at the origin of their trip. This requires the rider to add funds to their payment cards before the bus can depart the bus station, further delaying that bus trip. Arlington County determined that ART routes were delayed “400 minutes per weekday due to riders adding value to SmartTrip® cards” at bus stops (Arlington County 2016). Off-Board Fare Payment can eliminate lines of people waiting to pay while boarding the bus. Paying bus fare at the stop before getting on the bus could help save time and reduce delays.

As a consequence of the above challenges, ART routes 53, 62, 74 and 92 fail to meet productivity and cost efficiency standards. In 2015, these four routes combined had an operating budget of $1,264,897 (13% of overall operating budget) and 131,397 rider (only 4.7% of total ridership). They recovered $116,245 (4%) of the $1,264,897 operating costs from riders’ fares in 2015.

**Specialized Transit for Arlington (STAR)**

Supplementing STAR with TNCs would remove inequity and improve transportation service to the disabled. STAR is Arlington County’s ADA complementary paratransit service. It supplements the Washington Metro Area Transit Authority (WMATA) paratransit service MetroAccess for trips that begin and/or end in Arlington. STAR was created so that Arlington County could have a more efficient and cost effective alternative to MetroAccess. Although MetroAccess is the fourth most ridden paratransit system in the country, it has struggled to contain costs in recent years. As a result, Arlington has encouraged its residents with disabilities to use STAR as an alternative for in-county services. According to STAR, “all rides are arranged in advance. STAR riders must pre-plan activities and schedule STAR trips in advance as same day service is generally not available (Arlington Transit 2017).” This rule puts the disabled at a disadvantage compared to those who can use public transit without advanced notice.

**First and Last Mile Service Gaps**

This section provides examples of public transit successfully partnering with private ride-share companies throughout the U.S. to resolve various transit inefficiencies. In Arlington County and other parts of the U.S., a variety of ride-sharing, bike-sharing, and car-sharing options currently resolve gaps in connectivity to passenger transit or serve as alternative choices. Ride-sharing companies such as Uber and Lyft are ubiquitous throughout Arlington County and offer riders with door-to-door service between residencies and destinations. Research reveals that today’s service gaps for public transportation are the first and last mile of a commute. The challenge for riders in Arlington County is getting to and from public transit, not necessarily the service itself.

*Uber Connecting to Public Transit*
Uber and Lyft have been striking agreements with transit agencies, mostly for "first-last mile" programs meant to shuttle commuters to bus or train stations (Woodman 2016). Since 2015, Uber has partnered with San Francisco, Atlanta, Philadelphia, Dallas, Cincinnati, and Pittsburgh, among other cities. Uber and Lyft have also provided public services for disabled and low-income residents. Last year Washington, DC transportation planners proposed Uber respond to some 911 calls for ambulances. City planners throughout the country are finding these companies to be a valuable option to supplementing or replacing their public transit systems.

One of the most successful examples of ride sharing partnerships is between Uber and City of Altamonte Springs Florida. Last spring, Altamonte Springs began a partnership with the on-demand ride service, Uber. The city picks up one-fifth of the cost of any Uber ride that begins and ends in Altamonte Springs (Simmons 2017). The subsidy jumps to 25 percent for any trip to or from the local train station. According to city planners, the yearlong pilot will cost taxpayers less than a hundred thousand dollars which is much less than establishing a bus system.

Supplementing Uber in Place of Costly Construction

Subsidizing on-demand travel is an alternative to costly transit construction, but this option may not feasible for heavily populated cities such as Arlington. For less densely populated cities such as Altamonte Springs, Florida and Summit, New Jersey, this is a cheaper option than developing and maintaining public transit. Summit has a partnership with Uber which allowed city officials to drop plans to build an additional underground commuter parking lot, a cost of $10 million (Condon 2017). The town plans to use $162,000 to supplement the cost of residents
using Uber traveling to and from the transit to free up parking spaces for shoppers in their downtown.

**Uber Replacing Underutilized Bus Routes**

Other parts of the U.S. use TNCs to supplement underutilized bus routes to solve the first and last mile challenges faced by the commuters that use public transit. Direct Connect, for example, allows commuters to take Uber, United Taxi or Wheelchair Transport to key bus stops and hop on a bus to their final destination (Direct Connect 2017). The service is used in Pinellas County, Florida where its transit authority partnered with Uber and United Taxi to improve access to bus stops within a 15 square mile radius. The county pays half of a commuter's Uber fare (Up to $3 per ride) if trips begin and end at designated stops, remain in zone, and occur between 7 a.m. to 7 p.m. Monday through Saturday. The subsidy is applied by entering a promo code in the Uber app. The United Taxi is used by those who do not have access to the smart phone apps needed for Uber rides. Their website shows that Lyft will be an option soon. Direct Connect replaces the East Lake Connector, an underperforming route that ran along Keystone and East Lake roads between Tarpon Mall and the Shoppes at Boot Ranch (Johnston, 2016). With an average weekday ridership of 26, the connector was one of the county's most underutilized route. While it cost $160,000 to operate the connector, Pinellas Suncoast Transit Authority (PSTA) forecasts costs for Direct Connect to be around $80,000.

**Uber Paying Public Transit to Advertise**

Chicago METRA agreed to advertise for Uber in exchange for $900,000 over the next three years. METRA riders will have the incentive of $10 off of their first Uber ride (Ecolane 2017). With Uber becoming the official ride-sharing partner of METRA, riders will be convinced to use the Uber app in order to get to and from the rail station. Chicago city officials claim that ridesharing will attract more riders to METRA given the social aspects of sharing rides with Uber and public transit.

*Figure 3.10. Chicago Uber METRA advertisement.*
**Chariot Connection to Public Transit**

Another option to improve public transit ridership is Chariot, recently purchased by Ford. Chariot occupies a space between UberPool and public transportation (Dellinger 2017). It uses vans to service fixed routes around cities and can be accessed using a smartphone app. The app shows users where the shuttle is and the route it is taking. Chariot's goal is to supplement underserved public transit bus routes. It currently operates in its home city of San Francisco and in Austin, TX, with a pilot project launched late last year in Lake Tahoe to supplement ski resort transportation. Chariot announced that it will be expanding to eight new cities throughout 2017.

*Figure 3.11. Chariot ride sharing (Ford Motor Co. 2017).*

**Scoop Ridesharing**

Another rideshare company quickly gaining fame throughout the U.S. is Scoop. From San Francisco to Charleston, Scoop is becoming a viable option for commuters. The difference from other rideshare companies mentioned is that users can choose either to ride or drive a route for each trip. According to their website, commutes are scheduled throughout the day and their algorithm matches users based on route, predicted traffic, past feedback, and more (Scoop 2017). Scoop’s model focuses on creating partnerships with employers and cities, tapping into existing geographic and work communities (Quinn 2017). Cisco was Scoop’s first San Jose partner. Now, the carpooling app is part of the tech firm’s new employee process, said Rob Sadow, CEO and co-founder of Scoop Technologies. “Using Scoop helps employees meet people inside Cisco faster,” he said. The average cost per ride is $5 to $6, with about 80 percent going to drivers (Pyments.com 2017). But if a company partners with Scoop to help their employees find rides, fees can be discounted to as little as $1 per ride.
Partnering with ride-share companies would, not only improve transit service in Arlington County, but could potentially reduce cost of their public transit programs. A meeting between Mobility Lab, applicable ride-share companies and public transit stakeholders could identify partnering requirements that would optimize benefits and service capabilities. To improve first and last mile service for a broader pool of Arlington commuters, car and bike share opportunities could be included in these meetings. Research reflects increased use of these options to reach public transit and other destinations throughout Arlington and the DC Metro area.

Car Sharing as a Connection to Transit or Its Own First-mile Last-mile Solution

According to research performed by Mobility Lab, car sharing “removes more cars from the road than they add” and “vehicle ownership is significantly lower in buildings with both car sharing nearby and unbundled parking” (McMahon 2013). Car sharing services create incentives for urban residents to elect not to own a car. Such services decrease the amount of time that drivers waste on searching for parking since car-sharing parking spots are reserved specifically for each shared car. Cities can reduce the total number of parking spaces available by converting more of them to car sharing spaces (RPWG 2017).

Prior to the development of car-sharing programs, people who required temporary car use were limited to rental car companies. Rental cars do not always provide the most convenient or cost effective method for short trips. Thanks to mobile network innovations the car rental industry is transitioning into a car-sharing sharing industry. The three key differences that distinguish car-sharing from traditional rental cars are (1) short-term rentals, (2) a decentralized, self-accessing network of vehicles, and (3) the bundling of gasoline and insurance into rates.
Millard-Ball 2005). The idea of car-sharing has turned car renting into an hourly occurrence and created a system that can replace car ownership.

One of the biggest benefits of car-sharing is the increased mobility to those individuals that are not able to own a car. Providing people who currently have no access to an automobile the ability to drive once or twice per week is likely to result in high value trips (Litman 2000). Car-sharing also creates added benefits to those who already own a car but may need a different utility than their car currently offers. Car-share members who own smaller cars are able to reserve a van or truck for only a few hours, instead of renting one for the whole day or a weekend.

One of the first markets that car-sharing programs entered was college and university campuses. “As of September 2007, more than 70 colleges and universities in the United States have partnered with car-sharing organizations, and this market segment is expected to continue growing” (Zheng et al. 2009). Car-sharing provides “college students, faculty, staff and local residents living on or near a college campus access to shared cars while helping universities maximize the use of its on-campus parking, reduce campus congestion and decrease their carbon footprint” (Zipcar 2014). In Arlington, Zipcar and Ford have partnered with Marymount University and George Mason University to offer discounted student memberships.

Car-sharing is looking to continually grow both geographically and technologically. Private businesses are now utilizing car-sharing services to “save money, meet environmental sustainability goals and reduce parking requirements” by providing their employees with access to cars for business meetings and more (Zipcar 2014). The initial success of car-sharing in private business has captured the attention of the residential housing industry. “Many building developers are now incorporating car-sharing into their developments as an added value to tenants” (Millard-Ball 2005).

Car-sharing programs have become more popular in Arlington County within the last year. Car2Go revealed that “membership in Arlington and D.C. has passed the 57,000 member mark, making it one of the largest in North America” (ARLnow 2016). Car2Go had limited success with its pilot program in Arlington in late 2015. However, since adding the ability to travel between Arlington and D.C. last year, the company has reported “a 540 percent increase in the average number of trips beginning or ending in Arlington, a 22 percent jump in overall Car2Go trips in the region, and a 63 percent increase in average weekly memberships” (ARLnow 2016). New companies are entering the market and traditional car rental services are beginning to adapt by creating car-sharing programs of their own. Initial car-sharing programs have been able to take an existing industry, rebrand it, and create a product that customers use on a daily basis. Given the current initiatives and the historic trends of car-sharing, it is likely car-sharing programs are going to continue to grow.
Gaps in Real-Time Tracking of Service Providers

Mobile devices are improving the way people navigate transportation selection in the United States. The Pew Research Center conducted a study on the U.S. Smartphone use in 2015 finding that among the Americans surveyed, “Smartphones help users navigate the world around them, from turn-by-turn driving directions to assistance with public transit. This is especially true for younger users.” These behaviors are common among smartphone owners between the ages of 18-29. 80 percent of smartphone owners between the ages 18-29 use their phone for turn-by-turn driving directions and 38 percent use smartphones for public transit information.

Real-time Tracking Gaps

Arlington has no plan to create its own mobile transit app for the county, partly due to its Open Data Initiative. This initiative provides ART schedule and route data for mobile and software application developers. The Transit App supports the Washington DC region that includes ART for real-time data and transit information. Promoting the Transit App at bus and metro stations throughout Arlington County could be a worthy solution to help county residents navigate and control their transportation choices. The Transit App uses open data provided by Arlington County and surrounding areas through the Open Data source for developers. Transit App Data Attribution feeds real-time transit information for Metrobus, Metrorail, DC Circulator, DC Streetcar, Fairfax Connector, and feeds transit information for Baltimore Metro, MARC, Maryland Transit Administration (MTA), Virginia Railway Express, DASH, CUE, PRTC, RTA, Charm City Circulator, and Prince George County Bus.
Arlington County has the capability to customize each transit display by adding the Transit App icon on all the liquid crystal display (LCD) screens in the County. Each display can be customized to provide the information most relevant to the target group for that location. According to Jake Sion, Chief Operations Officer at Transit App, when asked whether an organization or local government can display and promote this icon, he responded, “There is no cost. It is legal to use our app name and logo and promote it.” (Sion 2017). Since the LCD screen can be programed, we recommend adding the logo to the screens and a caption that reads, “For free personalized mobile real-time tracking, download Transit App.”

Using the mobile device and other technologies as a medium to communicate transportation options is becoming prevalent in Arlington County. However, the applications available are: limited to specific modes of transit; at times inaccurate due to external factors (weather, service delays, etc.); and constrained by variations in technology platforms. Arlington commuters could benefit from an application, accessible by a handheld device, that tracks all available Arlington County passenger transportation services, in real-time.
ART Commuter Page and WMATA BusETA

For Arlington County bus service, ART transit real-time data information is available on a computer or handheld device. The Arlington Commuter Page and ART Alerts webpage provides updated information on transit arrival times. On a handheld device, only a web-based application is offered, not an Arlington-specific mobile transit application. Assuming that the schedules and bus stops posted online are current, the application assists riders in choosing the best option available. The application does not account for traffic and weather conditions which continually affect the arrival times, leaving many commuters with knowing when the next bus will arrive. For those who are unable to access the mobile application or web page, Arlington offers a call-in service to provide information on ART routes and stops.

Additionally, WMATA currently uses BusETA that is a text message bus arrival information system. This application provides customers with real-time bus arrival information that is updated every 30 seconds and shows the actual time and distance for the bus next arrival. The message displayed shows the next three buses set to arrive at the stop.

Figure 3.14. ART real-time BusETA text message service.

Bus Stop and Metro Transit Screens

Arlington County offers 40 Redmon Group transit displays throughout county bus stops and metro stations. These displays disseminate real-time transit information using Light-Emitting Diode (LED), and LCD screens that are all programed and customized for the location they serve. Displays provide commuters with information including: route number, vehicle destination, and wait time (presented in a countdown format).
My Arlington Application

Arlington County also currently utilizes the “My Arlington” app which provides information such as; traffic disruptions, crime statistics and transit related alerts for WMATA and ART. The “My Arlington” application allows users to provide feedback under the Links section. However, the word Links is not easily identifiable when a user would like to report general feedback or report a malfunction within the application. Arlington also offers the ArlingtonVA Service Request app for users to report non-emergency issues related to the county such as bus stop damage, graffiti, litter/illegal dumping, parking meter issues, parking and traffic sign damage, broken streetlights, and potholes.

Transportation Network Companies (TNCs)

Existing TNC providers in Arlington County provide the commuter with service through the use of an application, accessible by web or personal device. Applications use GPS to identify the location of the commuter for pick-up, and the user provides an address for the final destination upon request for transportation. Applications provide the user with a price before he or she agrees to accept transportation; allow the user to see the route of the driver during the trip and enable the user to provide a rating for the services provided. TNC applications are not integrated into other modes of transportation, such as bus, metro or bikeshare. However, most TNC applications do provide a car sharing option which reduces the rate of service for individual users.
CarFreeAtoZ Comparison Tool

The CarFreeAtoZ website is one of the most comprehensive multimodal trip planning and comparison tools offered to Arlington County residents. It was developed by Arlington County Commuter Services and Mobility Lab to simplify transportation mode choice of commuters (CarFreeAtoZ 2017). According to David Emory of Mobility Lab, "CarFreeAtoZ currently allows for planning trips that combine public transit, walking, biking, and driving. Those modes will continue to be the primary focus, but there are more options that can be shown for them, such as information from additional third-party transportation providers (Emory 2015)." CarFreeAtoZ currently does not offer a specific mobile application and its website does not render on mobile devices particularly well. The current mobile browser rendering locks users into one screen section at a time, a disadvantage when compared to the side-by-side data comparison possible on PC and Mac (non-mobile) browsers.

Community Engagement Opportunities

Arlington County uses a number of venues for public outreach and information sharing when it comes to transit. From advertising in retail stores, to public websites, to the CarFreeAtoZ website, transit managers provide a full range of available transportation and the advantages of using each, to include biking and walking. Arlington County Commuter Services (ACCS) works with Arlington business managers and executives, property managers, and hotel managers who, in turn, work with their respective employees, tenants, and guests on advancing travel options such as public transit, biking, walking, and sharing the ride (ACCS 2015). However, to become a connected city, Arlington County will need to develop strategies to facilitate two way dialogue that encourages more public feedback on future transportation decisions.

ArlingtonVA Service Request App

The “My Arlington” app allows users to provide feedback under the Links section. However, the word Links is not easily identifiable when a user would like to report general feedback or report a malfunction within the application. Arlington also offers the ArlingtonVA Service Request app for users to report non-emergency issues related to the county such as bus stop damage, graffiti, litter/illegal dumping, parking meter issues, parking and traffic sign damage, broken streetlights, and potholes.

Arlington Transit Intercept Surveys

Community outreach starts at the grassroots level. Intercept Surveys or brief interviews can be conducted at Arlington transit stations in Crystal City, Shirlington, Rosslyn, Pentagon and Pentagon City. Surveys can be targeted towards user feedback, enhancement suggestions, and
new transit ideas the county is analyzing for future implementation. When the Metro was being developed in Arlington, county developers wanted to help the public understand the concept of the Metro car. According to an article written in Arlington Magazine, “Most people didn’t even know what the Metro cars looked like, so we brought one to the parking lot at the Kann’s department store in Virginia Square and let people go inside and experience it for themselves,” says Weihe (at 98, she now lives in the Goodwin House, a retirement community in Falls Church). “It was a popular event, and we handed out fliers with information about the routes (Craft 2014).”

The younger generation is most susceptible to riding transit, and for that the old methods of marketing can no longer work. Ideas such as bringing a bus to a Nationals game and having a place where people can write their ideas on an older bus could be beneficial to the younger community and bring about fresh transit planning ideas. Additionally, adding USB ports, monitors to watch the news, or having a mobile Wi-Fi for every bus will attract the younger crowd and give them an extra incentives to ride transit.
Arlington’s Freight

Arlington County planners have devoted significant resources to planning its future transportation system. However, the county has devoted comparatively little attention to how freight movements integrate into that system in a manner that can support the projected increase in those movements over the coming decades. The National Capital Region Transportation Planning Board (TPB) (2016) and the Virginia Department of Transportation (2013) drafted multimodal freight plans, although neither address the specific challenges of delivering freight in downtown areas. Similarly, Arlington County’s Master Transportation Plan does not directly address freight transportation outside of discouraging on-street delivery of goods — a policy that complicates deliveries and hinders a positive relationship between county government and the businesses supporting Arlington’s future.

No direct, comprehensive data exists regarding how Arlington County goods are delivered — what practices drivers used and how, specific to Arlington, those practices affect transit, bicyclists, pedestrians, or other drivers. Freight carriers, customers, and law enforcement officers have access to portions of a variety of data, but no consolidation has occurred. The lack of freight data presents promising prospects for connecting urban freight deliveries to the rest of Arlington County’s transportation initiatives. In order to move towards solidifying freight’s role in a future connected city, first, it is important to understand how and where freight moves in Arlington County and observe freight carrier interaction with Arlington’s neighborhoods, streets and people.

Truck, van, and postal deliveries are the most visible freight movements on Arlington’s streets, and are the focus of data presented here. Expressed in tons, Arlington County imported six times more freight by truck than it exported in 2012, the most recent year for which there is categorized Commodity Flow Survey data (figure 4.1.). Of that export, 62.6% (202,322 tons) was waste and scrap (figure 4.2.). Of all products moved (imported, exported, or within the county), imports of meat products, gravel, and building materials (worked stone, glass, ceramics) were the top three commodities by tons.

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6 Measures by tons permit a general understanding of both weight and volume of cargo moving in the streets of Arlington, more so than measures by unit of delivery — which varies between article — or dollar value.

7 For more information on the periodic survey of freight in the U.S. by the Bureau of Transportation Statistics and the Census Bureau, see https://www.census.gov/econ/cfs/.

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Figure 4.1. Ratio of imports to exports in Arlington County. 2012 (VDOT 2017).

Figure 4.2. Top 10 categories of freight, in tons, imported, exported and moved internally in Arlington County in 2012 (VDOT 2017).

Commodity Codes (1)

05  Meat, poultry, fish, seabed, & their preparations
06  Milled grain products and preparations, and bakery products
07  Other prepared foodstuffs, fats and oils
12  Gravel and crushed stone (excludes dolomite and slate)
17  Gasoline, aviation turbine fuel, and ethanol (includes kerosene, and fuel alcohols)
18  Fuel oils
19  Other coal and petroleum products
31  Glass, building stone, cement/concrete building items, china/ceramic/porcelain household items
35  Electronic and other electrical equipment and components, and office equipment
41  Waste and scrap (excludes agriculture or food)

(1) Source: BTS (2011)
Relevant to a general understanding of truck movement of these tons of freight, “dry vans” — parcel or panel trucks and semi-trailers — carried the most in Arlington in 2012, more than twice the tons of the even bulk carriers (Figure 4.3). Deliveries were either by full-truck loads (FTL) with a single carrier or by private, often consolidated load carriers (Figure 4.4).

Figure 4.3. Tons of freight transported in Arlington County in 2012, by vehicle type (VDOT 2017).

Figure 4.4. Tons of freight transported in Arlington County in 2012, by load type (VDOT 2017).
In 2012, movement of empty shipping containers were the county’s first, second and sixth largest numbers of units moved for any good in the county: 95,432 exported; 59,544 moved internally; 16,359 imported (Table 4.1.). This indicates a high ratio of imported goods to exported (large number of exported empty containers), and significant amount of one-way trade between destinations within the county (large number of empties moved internally).

<table>
<thead>
<tr>
<th>Total Units</th>
<th>Flow</th>
<th>Cargo</th>
</tr>
</thead>
<tbody>
<tr>
<td>95,432</td>
<td>Export</td>
<td>Empty shipping containers</td>
</tr>
<tr>
<td>59,544</td>
<td>Internal</td>
<td>Empty shipping containers</td>
</tr>
<tr>
<td>20,151</td>
<td>Import</td>
<td>Gravel &amp; crushed stone (excludes dolomite &amp; slate)</td>
</tr>
<tr>
<td>19,845</td>
<td>Internal</td>
<td>Meat, poultry, fish, seafood, &amp; their preparations</td>
</tr>
<tr>
<td>16,536</td>
<td>Import</td>
<td>Meat, poultry, fish, seafood, &amp; their preparations</td>
</tr>
<tr>
<td>16,359</td>
<td>Import</td>
<td>Empty shipping containers</td>
</tr>
<tr>
<td>14,279</td>
<td>Import</td>
<td>Glass; building stone; cement or concrete building items; china, ceramic, or porcelain household items</td>
</tr>
<tr>
<td>8,466</td>
<td>Internal</td>
<td>Glass; building stone; cement or concrete building items; china, ceramic, or porcelain household items</td>
</tr>
<tr>
<td>8,175</td>
<td>Export</td>
<td>Waste &amp; scrap (excludes agricultural or food)</td>
</tr>
<tr>
<td>7,330</td>
<td>Internal</td>
<td>Gravel and crushed stone (excludes dolomite and slate)</td>
</tr>
</tbody>
</table>

Table 4.1. Top 10 total units of freight imported, exported or moved internally in Arlington County in 2012 (VDOT 2017).

With the heavy urban freight footprint seen in Arlington County, we turned to seek out urban freight movement best practices found in literature from a breadth of sources. We then conducted two phases of field studies over a four-week period to obtain data not available in commodity flow survey results. The first phase of field study observed freight deliveries to customers in Arlington County. The second phase was interviews with freight carriers, customers, and Arlington County government officials. Both phases revealed that the majority of the observed deliveries to businesses and residents were food and parcels. Interviews with the government officials confirmed what policies currently addressed freight deliveries.

Although Arlington County’s complete streets vision has yielded improvements in car, bus, bicycle, and pedestrian movements in downtown neighborhoods, that vision is not yet complete. Freight deliveries are a vital economic activity and yet, within Arlington’s existing infrastructure, they occur either at the expense of their efficiency (if drivers comply with all parking ordinances) or at the expense of other street users’ safety and efficiency (if drivers do not). Essentially, to better integrate freight carriers and their customers with the county’s complete streets, Arlington’s planners must address:
Planning gaps: Arlington County’s existing provisions for freight loading and unloading do not match common, efficient delivery practices. Freight carriers’ trip planning and the county’s “complete streets” planning are disconnected and at odds.

Data-sharing gaps: Freight delivery data (volume, frequency, location) is limited and not shared among carriers or between carriers and Arlington County planners.

Review of Literature and Case Studies

Summary of Findings in the Selected Literature

Among numerous articles, books, and presentations offered on urban freight movement in the last decade, the literature presented in Appendix B offered the most detailed identifications of challenges and solutions regarding urban freight transportation.

Of the fifteen challenges, or gaps between desired and actual outcomes, mentioned throughout the reviewed literature, the six most frequently mentioned were:

- Complexity of urban areas, including mixed land use and road networks not suited to delivery vehicles (8 of 10 documents);
- Traffic congestion, both induced by cargo deliveries and not (7 of 10);
- Increasing urbanization, often displacing traditional centralized (downtown) freight distribution centers (6 of 10);
- Conflicts, accidents and parking issues between the diverse transportation modes present in urban areas (6 of 10); and
- Difficulty of driver operations at delivery, including poorly-adapted cargo access systems, lift-gates, and dollies, and associated driver stress (5 of 10);
- Difficulty in accessing and sharing freight data (10 of 10).

Of the 23 proposed solutions mentioned throughout the reviewed literature, the five most frequently proposed were:

- “In/out optimization” using regulated truck routes and dispersed, often smaller, freight depots (9 of 10 documents);
- Night or off-peak hours distribution and delivery (9 of 10);
- Integration of intelligent transportation systems (ITS) and road freight transportation management (RFTM) technologies (7 of 10);
- Adaptation of delivery vehicles to urban landscapes (smaller or more maneuverable vehicles; alternative vehicle loading systems) (6 of 10); and
- Development and enforcement of a parking reservation system (6 of 10).
To determine if new or similar or challenges to those identified in the literature and case studies existed, two phases of field studies were conducted over a four-week period. The first phase of field study observed freight deliveries to customers in Arlington County. The second phase was interviews with Arlington County freight stakeholders.

**Gaps in Planning — Phase I Field Study: Assessing Delivery Practices**

The first phase of field study observed freight deliveries to customers in Arlington County. The second phase was interviews with freight customers and Arlington County government officials. Both phases revealed that the majority of the observed deliveries to businesses and residents were food and parcels. Interviews with the government officials confirmed what policies currently addressed freight deliveries.

In order to compensate for the lack of county specific freight data, we conducted a series of observations in Arlington County’s urban areas. Our goal was to develop a better understanding of how freight carriers function in an urban environment. Several common practices are noted in our analysis, however the data is not intended to represent a complete quantitative study. While the evidence we present is purely anecdotal we believe there could be great value in conducting a more rigid and long-term experiment of this nature to more closely represent freight movement in the county.

**Types of Freight Carriers and Metrics Used**

For the purposes of our observations, freight carriers were any motorized vehicle providing delivery or pick-up services for all goods including, but not limited to, hospitality, food, and retail industries, grocery, and general e-commerce. Table 4.2 provides the fields (columns) used for field notes about each observed delivery.
Table 4.2. Field study observation forum.

For the purposes of our observations, freight carriers are defined as any motorized vehicle providing delivery or pick-up services for all goods including, but not limited to hospitality, food, and retail industries, grocery, and general e-commerce. We used vehicle and delivery type to provide a more accurate characterization.

Seven additional metrics were used to describe the parking situation observed for each vehicle, indicating the following:

- Bike lane present and whether or not it was blocked by the vehicle
- Travel lane blocked or clear
- Pedestrian crossing blocked or clear
- Parking zone, no parking zone, or loading zone
- Hydrant within fifteen feet
- Vehicle flashers on or off
- Cones used by freight carrier
The following service and delivery vehicles were excluded from our observations: all emergency and fire response vehicles, utility and service vehicles (i.e. plumbing, electric), meal delivery (i.e. pizza delivery, UberEATS), and waste management. While these vehicles play an important role in connecting people to goods and services, we felt it necessary to limit the scope of our research in order to address issues specific to freight and parcel delivery.

**Observation Locations and Times**

Our observations took place in three urban corridors within Arlington County; Rosslyn/Ballston (RB), Crystal City, and Columbia Pike. A majority of the observations were conducted in the Ballston/Rosslyn corridor due to its high density of office, residential, and retail space. With additional time and resources, it would be worthwhile to observe freight movements in the Shirlington, Pentagon City, Cherrydale, East Falls Church, and Nauck neighborhoods as Arlington County has begun to direct growth and active planning initiatives to these mixed use areas (Arlington 2016b). The following are descriptions of the general locations where observations were performed.

*Figure 4.5. Observation locations.*
The RB corridor is a three mile stretch that includes five metro stations; Ballston, Virginia Square, Clarendon, Courthouse, and Rosslyn. Wilson Blvd. and Clarendon Blvd. are two of the main roads that run through the corridor and they are both listed in Arlington County’s Master Transportation Plan as “complete streets” projects. Over 20% of Arlington County’s total population resides in the corridor (Arlington 2016b).

Figure 4.6. Ballston corridor.

- Ballston is the farthest west and has a mixture of high density office and residential space, as well as retail. Renovation of the Ballston mall is expected to bring even more business to the area. According to 2010 Census data, Ballston has a population of 12,616 with 7,170 total housing units and an occupancy rate of over 93.3%.

- Virginia Square is the next stop heading eastbound through the corridor and is home to the Federal Deposit Insurance Corp., George Mason University, and Arlington’s central public library. Virginia Square has approximately half as many residents and housing units as Ballston and the residential occupancy rate is comparable.

Figure 4.7. Clarendon.

- Clarendon has the smallest population in the corridor at 4,884 and is characterized by a vibrant nightlife and busy restaurants. There are a number of detached single-family homes in addition to the condos, apartments, and office buildings that line Clarendon and Wilson Blvd.

- The county government is located in the center of Courthouse and is surrounded by office buildings, detached homes, townhomes, and high-rise apartments, and condominiums. The total population is 12,479.
Rosslyn is the last metro stop on the orange line before Washington, D.C. and is made up of high density office, commercial, and residential developments. It contains over 20,000 employees and about 2,000 businesses and is currently undergoing extensive development of its main square in the hopes of attracting more business and residents (Arlington, 2016). As of 2010, the total population in Rosslyn is 10,813.

Crystal City is within close proximity to the Pentagon and the Washington National Airport and contains the Crystal City metro station and an underground mall. There are several defense industry contractors in Crystal City, a large number of hotels and restaurants, and many residential high rises. Total population in Crystal City is 10,550 and its residential occupancy rate is lower than the RB corridor at 82.6%.
Columbia Pike runs just over three miles from Arlington County’s western border to Arlington Cemetery and Fort Myer in the east. It contains over 17% of Arlington’s current population and is the busiest bus transit corridor in Virginia (Arlington, 2016).

We performed our observations at various times and days throughout the work week (Monday-Friday) and each observation session lasted from about half an hour to three hours. Total observation time for all days and locations was approximately 16 hours; 11 hours in the RB corridor, 3 hours in Columbia Pike, and 2 hours in Crystal City.

Analysis of Observation Data

Of the 102 observations of deliveries conducted over two weeks, 48% were parcels or mail delivery, 36% were food and beverages to restaurants and stores, 8% were service deliveries (uniforms, janitorial and office supplies) and the remaining 8% could not be identified, typically because the delivery vehicle was unmarked and the driver was not present during the period of the observation (figure 4.11).\(^8\)

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\(^8\) Observers speculated that the “unknown” vehicles were contractors for parcel delivery services, yet insufficient evidence existed to support the speculation. Thus, “unknown.”
Figure 4.11. Observed categories of deliveries (percentage of 102 total observations).

Further analysis of Commodity Flow Survey data revealed that the bulk of these food and beverage delivery services were, immediately prior to delivery, from locations within Arlington County (the majority) and other parts of the National Capital Region (figure 4.12.). Similar analysis was not possible for parcel deliveries, since they are of diverse commodities typically delivered by third party carriers.
Figure 4.12. Origins of food items in Arlington County in 2012, in tons from top 6 areas (VDOT 2017).

Table 4.3. Last location, prior to delivery, of food items in Arlington County, in tons from all areas provided in data (VDOT 2017).

<table>
<thead>
<tr>
<th>From</th>
<th>Grains</th>
<th>Fruits, Vegetables</th>
<th>Eggs, Honey, Animal Feed</th>
<th>Meat, Prepared Meats</th>
<th>Flours, Bakery Items</th>
<th>Prepared Foods</th>
<th>Alcohol</th>
<th>Totals</th>
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</thead>
<tbody>
<tr>
<td>Arlington County, VA</td>
<td>1,897.41</td>
<td>31,749.55</td>
<td>4,982.24</td>
<td>408,978.02</td>
<td>18,709.67</td>
<td>22,787.95</td>
<td>3,889.06</td>
<td>492503.90</td>
</tr>
<tr>
<td>District of Columbia, DC</td>
<td>9,430.22</td>
<td>8,223.93</td>
<td>8,376.85</td>
<td>155,082.68</td>
<td>34,952.97</td>
<td>59,448.71</td>
<td>5,989.65</td>
<td>281059.00</td>
</tr>
<tr>
<td>Montgomery County, MD</td>
<td>7,277.32</td>
<td>8,464.38</td>
<td>5,852.11</td>
<td>75,094.49</td>
<td>24,668.39</td>
<td>42,130.25</td>
<td>2,779.74</td>
<td>164247.49</td>
</tr>
<tr>
<td>Sullivan County, TN</td>
<td>35.21</td>
<td>3,123.13</td>
<td>253.30</td>
<td>44,270.08</td>
<td>2,987.67</td>
<td>4,112.78</td>
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<td>Northampton County, NC</td>
<td>1,480.34</td>
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<td>1,237.88</td>
<td>80,507.27</td>
<td>1,473.59</td>
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<td>Caswell County, NC</td>
<td>139.21</td>
<td>621.02</td>
<td>580.92</td>
<td>25,948.90</td>
<td>3,770.92</td>
<td>4,832.99</td>
<td>428.51</td>
<td>36322.47</td>
</tr>
<tr>
<td>Warren County, NC</td>
<td>27.27</td>
<td>167.47</td>
<td>487.00</td>
<td>10,615.16</td>
<td>401.66</td>
<td>2,261.50</td>
<td>13,960.7</td>
<td>13960.7</td>
</tr>
<tr>
<td>Surry County, NC</td>
<td>151.59</td>
<td>81.78</td>
<td>866.51</td>
<td>113.21</td>
<td>1,213.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jefferson County, WV</td>
<td>50.17</td>
<td>256.71</td>
<td>237.60</td>
<td>176.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gates County, NC</td>
<td>431.31</td>
<td>64.50</td>
<td>50.41</td>
<td>54.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardly County, WV</td>
<td>210.51</td>
<td>230.39</td>
<td>114.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alleghany County, NC</td>
<td>468.27</td>
<td>39.86</td>
<td>508.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hertford County, NC</td>
<td>17.16</td>
<td>399.70</td>
<td>72.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greenbrier County, WV</td>
<td>27.10</td>
<td>328.64</td>
<td>60.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camden County, NC</td>
<td>187.51</td>
<td>141.38</td>
<td>328.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Letcher County, KY</td>
<td>135.92</td>
<td>152.95</td>
<td>288.86</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hampshire County, WV</td>
<td>213.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pendleton County, WV</td>
<td>106.57</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pike County, KY</td>
<td></td>
<td>49.22</td>
<td>49.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>20,982.13</strong></td>
<td><strong>59,236.13</strong></td>
<td><strong>22,363.08</strong></td>
<td><strong>756,977.72</strong></td>
<td><strong>87,200.22</strong></td>
<td><strong>141,670.30</strong></td>
<td><strong>13,626.12</strong></td>
<td><strong>1,096,055.69</strong></td>
</tr>
</tbody>
</table>

Given that a significant portion of the observed deliveries were food and beverages, likely using short haul carriers from bases from inside or near Arlington County, and that food deliveries comprise the bulk of tonnage reported in the 2012 Commodity Flow Survey:

- Restaurants, grocery stores, convenience stores, and their freight carriers are significant stakeholders in freight delivery policies; and
- Changes to delivery policies, such as curb space management and loading zone enforcement, might have ripple effects in the hospitality and food provision industries, not just the freight industry.

Curb space management, in particular, appeared to have significant effect on the observed deliveries, most of which were to restaurants and convenience stores.

Arlington County’s current transportation policy discourages on-street delivery of freight, although it provides opportunity for specific parties to obtain permission (Arlington 2009, 25 & 28). As noted in the Parking and Curb Space Management Element of Arlington County’s Master Transportation Plan, on-street parking competes with other uses of roadways, including other curb uses, additional lanes for traffic flow, bike lanes, and wider sidewalks. Drivers
Searching for vacant parking spaces add to traffic volumes and can create street congestion. (Arlington 2009, 4).

Although the county has provided on- and off-street loading zones, for the observed parcel and food delivery vehicles, use of those zones appeared to be problematic. Freight vehicles typically parked in no parking zones (74 of 102, 72.5%). Of those observed in no parking zones, 37.8% did not use the vehicle’s warning signals (flashers), 13.5% parked within 15 feet of a fire hydrant, and 5.4% parked without warning signals within 15 feet of a hydrant (figure 4.13).

![Observed deliveries, curb space zone used (raw numbers)](image)

**Figure 4.13.** Observed freight drivers’ parking behavior, by curb-space zone.

For all observations (parked in any zone), vehicle lanes were partially or completely blocked 37% of the time and, when present, bike lanes were blocked 37% of the time. Crosswalks were partially or completely blocked in 39% of observations; this figure also included any time the view of the crosswalk signal was blocked (figure 4.14.).
Figure 4.14. Observed freight drivers’ parking behavior by vehicle lane access and (when present) bike lane and crosswalk access.

The photographs in figure 4.15. of vehicles in the Rosslyn-Ballston Corridor depict some of these practices. Vehicles commonly double-parked or blocked travel lanes, bicycle lanes, crosswalks, and fire hydrants.

Figure 4.15. Freight delivery practices observed in the Rosslyn-Ballston Corridor.
Such parking behavior is unsafe and illegal, or presents inconvenience to other street users. Section 14.2-2 of the Arlington County Code prohibits stopping, standing or parking any vehicle “unattended by the owner or operator, in such a manner as to constitute a hazard to traffic.” Section 14.2-33 prohibits parking in “no parking” zones. Section 14.2-38 prohibits stopping, standing, or parking within 15 feet of a fire hydrant, on a crosswalk, or double-parking.\(^9\) Section 14.2-38.3.C. prohibits commercial vehicles from parking for more than 30 minutes in a loading zone.

Yet it is unlikely that drivers, or the delivery companies, are willfully unlawful or disregard the safety of the delivery drivers and the other users of the streets. It is more reasonable to suppose that delivery drivers and customers, for whom timely, efficient delivery may mean the difference between employment and not, customer satisfaction or not, are merely seeking the most efficient means to move goods from the truck to the curb, the curb to the destination. Such behavior illustrates gaps between:

- Desired and available parking resources, or between proper and poor application of curb space management principles;
- Ordinances that prohibit and the cultural norms that accept the current delivery practices, both among law enforcement officers and among drivers; and
- Public sector fears of accidents and inefficient traffic flow and the reality of delivery vehicles’ impact on Arlington’s streets.

These gaps provide opportunity for a more connected relationship between freight carriers and policy-makers, to maximize efficient freight delivery within safe streets meeting Arlington’s complete streets principles. The literature previously summarized further illustrate these service gaps and what other organizations are doing to minimize the friction between timely delivery of freight and the need to govern urban transportation networks.

**Gaps in Planning —Phase II Field Study: Assessing Stakeholder Collaboration**

**Interviews with Freight Carriers, Customers, and County Officials**

During “Phase II” of our data collection, interviews were conducted with freight carriers, customers and several key freight stakeholders in Arlington County. The key objectives of this effort were to: identify challenges faced by freight carriers and customers; determine their current level of involvement in planning and policy processes; and evaluate the level of interest

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\(^9\) “On the roadway side of any vehicle stopped or parked at the edge of curb of a street” (Arlington County Code, § 14.2-38.A.7).
of the identified individuals to collaborate with other stakeholders to constructively contribute towards affecting the freight delivery processes.

Use of an interview guideline with defined questions ensured basic consistency of information collected among the freight carriers (figure 4.16). Interviews were brief, respecting the busy schedules kept by freight delivery managers.

<table>
<thead>
<tr>
<th>Interview Questions for Freight and Parcel Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How many times per week does your firm deliver to or pick up from commercial locations in Arlington County, VA? Approximately how many locations/businesses does your firm provide service to in Arlington County, VA?</td>
</tr>
<tr>
<td>2. Do your truck drivers utilize delivery allies or building loading docks/zones when they are available? What is the protocol for making deliveries when these are unavailable?</td>
</tr>
<tr>
<td>3. Have you been involved in any stakeholder meetings with county officials and do you have a way to voice your concerns to them should you have any?</td>
</tr>
<tr>
<td>4. What sort of challenges, if any, do you or your driver face when delivering to urban environments?</td>
</tr>
<tr>
<td>5. Would you be willing to participate in a collaborative data sharing effort with other freight stakeholders and county officials with the goal of improving freight space management and safety?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Additional Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What type of product or products does your firm deliver?</td>
</tr>
<tr>
<td>2. Do your drivers have preplanned company delivery routes or GPS assisted navigation to assist them in being the most efficient in serving all customers?</td>
</tr>
<tr>
<td>3. What type(s) of delivery vehicle(s) does your firm utilize?</td>
</tr>
<tr>
<td>a. Box Truck</td>
</tr>
<tr>
<td>b. Tractor Trailer</td>
</tr>
<tr>
<td>c. Van</td>
</tr>
<tr>
<td>d. Other type</td>
</tr>
<tr>
<td>4. Do your delivery trucks also pick up empty articles, such as beer kegs, plastic or cardboard bread or chip shipping racks from customers that they had previously delivered your firm’s product or products to?</td>
</tr>
<tr>
<td>5. How many miles does your delivery vehicle travel from its point of origin to customers in Arlington County, VA?</td>
</tr>
</tbody>
</table>

Each interview was informal; interviewers and interviewees had the opportunity to expand the discussion beyond these three questions. Interviewers corresponded via phone and/or e-mail to attempt contact with twenty-three different freight carriers. The freight carriers contacted were those observed during “Phase I” of the data collection, ensuring that they currently conducted freight delivery in the Ballston/Rosslyn corridor. Calls were attempted during regular business hours (between 9:00 a.m. and 5:00 p.m.). When attempting to make contact with the freight carriers, several obstacles were encountered, to include:

- **Freight carrier with no direct line**- Several of the vehicles observed had contact information displayed on the side of the vehicle. However, the information provided was often a toll free (1-800) number or the name of the carrier’s company website. Internet searches were
performed to identify the direct lines to freight, delivery, or transportation departments, but a majority of the companies pursued did not provide direct line information, online.

- **Unable to reach appropriate source** - The freight carrier company’s call operator did not forward the call to the appropriate department head. The contact information listed directed the interviewer to a sales representative who was not prepared to answer freight data inquiries. On one occasion, the call operator stated that the freight manager was not authorized to respond to requests for information.

- **Freight manager unavailable** - On several occasions the freight carrier company’s call operator directed the call to the appropriate department head, however due to unavailability, the call was routed to a voicemail inbox. Multiple efforts to reattempt contact were made, however, were unsuccessful.

- **Freight manager too busy** - On three occasions, the appropriate department head answered the call, but was too busy to answer the interview questions. On two occasions, a route manager answered while on a delivery route, and did not have time to be interviewed.

Of 24 requests to carriers for interviews, four granted a total of five interviews. Among 23 requests to customers in the Ballston area, 20 granted at least one interview, with several granting multiple. A summary of each interviewee’s answer to the three questions appears in Table 4.3.

<table>
<thead>
<tr>
<th>Stakeholder Name and Occupation Title</th>
<th>Route Manager, G&amp;K Services</th>
<th>Arlington On-Road Supervisor 1, UPS</th>
<th>Arlington On-Road Supervisor 2, UPS</th>
<th>President and Owner, ProFish</th>
<th>Transportation Manager, Saval Food</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interview Questions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Have you been involved in any stakeholder meetings with county officials?</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>* No for VA and MD. * Yes for DC.</td>
<td>No</td>
</tr>
<tr>
<td>What challenges do you or your drivers face when delivering to Arlington County, particularly in the Ballston/Rosslyn corridor?</td>
<td>* When people see a big truck, they think the worst. Some try to get out of the way, but others get in the way. * Parking can be tough getting in and out of tight spots.</td>
<td>* Lack of parking is a challenge, but generally, not many concerns. * Biggest concern is parking on streets without sidewalks, such as those in McLean.</td>
<td>Traffic patterns in Arlington, especially the parking situation with limited parking capacity.</td>
<td>Lack of proper loading zones, non-licensed vehicle use of designated space, ticketing.</td>
<td>* No complaints from Arlington drivers, though this is probably a product of their early delivery times. Driver leaves center at 2:30 AM and returns by 10:30 AM. * Generally speaking, the urban drivers are challenged by the lack of proper loading zones.</td>
</tr>
<tr>
<td>Would you be willing to participate in a collaborative forum with other freight stakeholders, customers, and county officials, with the goal of improving freight management?</td>
<td>Yes (“Absolutely! I would love to be a part of that.”)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Table 4.3. Phase II – Arlington County freight carrier interview responses.*

Among the freight carriers, all interviewed expressed interest in greater collaboration with Arlington County government and other carriers (table 4.2). ProFish offered to compile delivery metrics and customer satisfaction data should increased collaboration occur (Kutz 2017a). ProFish also noted that it had been involved in stakeholder meetings with public officials in Washington, D.C., but had not participated in such meetings in Maryland or Virginia, identifying both states as “unapproachable” (KutzCasten 2017a).
Similarly, the other freight carriers interviewed had not been involved in stakeholder meetings with Arlington County officials (KutzFreeman 2017b, Keenan 2017c, Wellman 2017d). When asked about involvement in Arlington County’s transportation planning process, UPS responded that the company had “never been asked to be a part of that process” (Kutzeenan 2017c).

All of the carriers interviewed indicated that freight delivery in Arlington’s downtown is challenging, chiefly due to the lack of parking (including adequately sized parking) and loading zones. These were the only challenges noted. (KutzCasten 2017a, Freeman 2017b, Keenan 2017c, Wellman 2017d).

In addition to interviews of freight carriers in Arlington County, numerous freight customers and County government officials were also interviewed to provide a comprehensive overview of the challenges faced by Arlington County freight stakeholders. Not following a standard format, interviews with selected customers in the Ballston–Rosslyn corridor were open-ended, primarily focused on the deliveries to the customers and challenges faced. Similarly, interviews conducted with key officials did not follow a standard format, simply seeking out additional perspectives concerning Arlington County freight delivery and data collection.

Customer interviews were conducted with managers of restaurants, bars, and specialty food shops such as pizza parlors and bakeries, located on two main roads, in the Ballston/Rosslyn corridor of Arlington County, VA. The establishments receive food, alcoholic and non-alcoholic beverages, and operating supplies, delivered to their doorstep from a variety of freight carriers, throughout the week. Out of 23 attempted interviews, 19 managers were available, willing to participate and knowledgeable regarding the establishment’s approximate weekly delivery truck throughput. The results appear in Table 4.4.
These interviews revealed that the businesses received a median of 10.5 and mode of 6 delivery trucks per week (table 4.3). Delivery volumes varied throughout the week, both among businesses and at single businesses depending on the day of the week. Although deliveries occurred daily at most businesses — with multiple per day at some — unlike freight carriers, restaurant managers could not identify any challenges with deliveries.

Despite customers’ stated lack of challenges, it is notable that few deliveries made use of alley or off-street loading zones, instead coming through the front door of the businesses from trucks parked immediately outside. Loading zones were present near only a few businesses, meaning that had drivers made use of a nearby zone, delivery turnaround time would have had to include the time needed to shuttle the goods from the truck to the business. Such shuttling of goods adversely impacts the efficiency of the delivery and increases the likelihood of spillage or damage while shuttling. Instead, drivers and customers minimized the distance (maximized the efficiency) between truck and door by expecting the delivery to occur immediately adjacent to the business.

<table>
<thead>
<tr>
<th>Business</th>
<th>Trucks Per Week</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakery</td>
<td>5</td>
<td>Food/food product (including product for baking in-house)</td>
</tr>
<tr>
<td>Bar</td>
<td>Undeclared</td>
<td>Manager Unavailable</td>
</tr>
<tr>
<td>Restaurant</td>
<td>15</td>
<td>Bread is sourced from a bakery next door. Food, non-alcoholic and alcoholic beverages (including keg delivery/empty keg pick-up)</td>
</tr>
<tr>
<td>Restaurant</td>
<td>24</td>
<td>Food, non-alcoholic and alcoholic beverages (including keg delivery/empty keg)</td>
</tr>
<tr>
<td>Restaurant</td>
<td>12 to 15</td>
<td>Food, non-alcoholic and alcoholic beverages (including keg delivery/empty keg pick-up)</td>
</tr>
<tr>
<td>Restaurant</td>
<td>8 or 9</td>
<td>Food, non-alcoholic and alcoholic beverages (including keg delivery/empty keg)</td>
</tr>
<tr>
<td>Restaurant</td>
<td>Undeclared</td>
<td>Manager Unavailable</td>
</tr>
<tr>
<td>Restaurant</td>
<td>6</td>
<td>Food, non-alcoholic and alcoholic beverages.</td>
</tr>
<tr>
<td>Restaurant</td>
<td>6</td>
<td>Food/food product, non-alcoholic and alcoholic beverages, (including product for baking in-house)</td>
</tr>
<tr>
<td>Restaurant</td>
<td>19</td>
<td>Food, non-alcoholic and alcoholic beverages (including keg delivery/empty keg pick-up)</td>
</tr>
<tr>
<td>Restaurant</td>
<td>Undeclared</td>
<td>Manager Unavailable</td>
</tr>
<tr>
<td>Restaurant</td>
<td>7</td>
<td>Food/food, non-alcoholic and alcoholic beverages, product (including product for baking in-house)</td>
</tr>
<tr>
<td>Restaurant</td>
<td>12</td>
<td>Food/food product, non-alcoholic and alcoholic beverages, (including product for baking in-house)</td>
</tr>
<tr>
<td>Restaurant</td>
<td>1</td>
<td>Food, non-alcoholic and alcoholic beverages.</td>
</tr>
<tr>
<td>Restaurant</td>
<td>18</td>
<td>Food, non-alcoholic and alcoholic beverages.</td>
</tr>
<tr>
<td>Restaurant</td>
<td>12</td>
<td>Food, non-alcoholic and alcoholic beverages (including keg delivery/empty keg pick-up)</td>
</tr>
<tr>
<td>Restaurant</td>
<td>Undeclared</td>
<td>Unwilling to Participate</td>
</tr>
<tr>
<td>Specialty Food</td>
<td>7</td>
<td>Food/food product (including product for baking in-house)</td>
</tr>
<tr>
<td>Specialty Food</td>
<td>3</td>
<td>Pizza dough only.</td>
</tr>
<tr>
<td>Specialty Food</td>
<td>28</td>
<td>Food, non-alcoholic and alcoholic beverages.</td>
</tr>
</tbody>
</table>

Table 4.4. Phase II – Arlington County freight customer interview responses.
The final category of interviewees were Arlington County government officials. These interviews confirmed existing county and state policies. All officials were civil employees in departments related to transit management, transportation management and planning, or site planning and development. Interviews included requests for an overview of freight delivery practices and freight delivery data in Arlington County.

According to those interviewed (Sternfeld 2017a, 2017b), county ordinances and policies mandate:

- Off-street deliveries.
- All new building sites must include loading docks in their plans.
- New, mixed-use buildings (e.g., combining commercial and residential) must have a loading dock for food delivery and one large enough for moving vans to park and load or off load residential items.

Additionally, county planning procedures require an assessment of the site’s curb-side loading zone needs, based on the frequency and duration of deliveries and the locations of potential customers (Sternfeld 2017a).

Data was not available for delivery volume and frequency within county neighborhoods, nor was a list of freight stakeholders available. Although such data exists during site development and street planning phases, the county has not maintained nor comprehensively analyzed freight information as a factor in traffic management or complete streets initiatives. However, all officials interviewed were anecdotally aware of the effect of freight on the downtown area, particularly traffic flow. A commonly noted issue was congestion resulting from double-parked delivery vehicles at established loading zones on Clarendon Boulevard, particularly during peak morning traffic count hours (between approximately 6 and 11 AM). Similarly, as one official noted, “Everybody needs to share” the street spaces, “because it is about managing limited roadways — bicycle lanes or travel lanes” (Sternfeld 2017b). As another official noted regarding the difficulty of meeting freight and other transportation needs, “In urban areas [traffic] overload needs change throughout the day” (Sternfeld 2017b).

Thus, Arlington County approaches the management of curb-space by balancing freight needs with other curb-space demands and an overarching view of what constitutes a pleasant, productive urban environment. Interview responses provided insight into the following planning gaps between:

- **Freight carriers and their customers:** Carriers noted difficulties with parking and downtown traffic congestion and customers did not. Additionally, just-in-time supply chain practices, resulting in numerous deliveries throughout the week, exacerbate the carriers’ difficulties (they must deliver frequently into a difficult area) without affecting customers (they do not have to devise the means to store the greater volume of goods per delivery should fewer deliveries occur).
Freight carriers and county officials: Drivers disobey county traffic and parking ordinances to maximize the efficiency of their deliveries.

County officials and freight carriers: Volume, category, and locations of concentrated deliveries within the county, accompanied by unfamiliarity with the specific challenges of delivering freight under existing policies and infrastructure.

County officials and freight customers: Awareness, beyond conceptual, why on-street deliveries present the most efficient means to receive goods and how current policies and infrastructure either negatively impact current businesses or hinder the adoption of other practices.

County planners, freight carriers, and customers: The locations of existing loading zones adversely impact delivery efficiency and customer expectations of timeliness and reliability, meaning that the zones are infrequently used (not used to their maximum design capacity). Effectively, these underused zones are a net loss to overall curb-space potential — parking, transit loading, or taxi and car-sharing use, for example.

County planners, freight carriers, and customers: Who each other are and what innovations each might contribute to Arlington’s initiatives to provide equity of access for all users.

Gaps in Data-Sharing: Assessing the Availability Of Freight Data

Many of the gaps identified in this field study are symptomatic of a scarcity of consolidated data among the stakeholders involved in urban freight deliveries. Conversely, lack of data is symptomatic of inferior communication between stakeholders. The two conditions exacerbate each other. If service gaps can be closed by communicating needs between stakeholders, freight data provides the measurement of those needs.

Much of this data is proprietary to the freight carriers and their customers, or it is government information that, if not shared equally, could be used to competitive advantage by businesses in the know — thus, the data is not shared. The research for this Blueprint was stifled by the lack of or unwillingness to provide that data, requiring use of the 2012 Commodity Flow Survey data from the Virginia Department of Transportation just to determine what commodities are present in the county. Unfortunately, the survey data is insufficiently granular to identify locations of high volumes of delivery, nor identify the daily or seasonal fluctuations in those deliveries. Consequently, the gap analysis discussed in the first field study began in an anecdotal survey of the city, identifications of its business districts, and “best-guess” determination of where to conduct observations, at what time of day, and on what days of the week.

The current system of insular data warehousing results in the practices noted in the literature review. The traffic congestion and difficulties with parking are fundamentally the following data-sharing gaps:
• Delivery managers and drivers do not really know — although experience helps them predict — what traffic or parking will be like at the delivery site, complicating the forecasting of:
  o Delivery times or turnaround;
  o Best locations to link in delivery chains (maximizing the efficiency of individual vehicles);
  o Ability or need to assign multiple vehicles to a single delivery area due to delivery volume compared to availability of parking or presence of road obstructions;
  o Whether the presence of other delivery vehicles will complicate the use of loading zones or impair drivers’ ability to maneuver their vehicles in spaces constrained by the presence of other vehicles.
• Users of other transportation modes, including transit, do not know if a delivery truck will be along their route, impairing their ability to avoid the vehicle.
• Site developers and road repair crews do not know if their activities will impair the delivery of goods, which impairs all parties’ abilities to reschedule activities to reduce conflict.
• County planners do not know whether freight demand is growing or shrinking, moving to other areas of concentrated demand, or impaired by current designations of loading zones, parking policies, or traffic calming and control systems.

While some publicly provided data on road repair plans and development projects can ease stakeholders’ difficulties, and crowd-sourced traffic mapping applications such as Waze are available, these services represent only the first step in a truly connected city. The Blueprint summarizes recommended solutions that lead to a more connected city through data-sharing.
The Blueprint

The recommendations offered in this section each address more than one way to approach the gaps noted Arlington’s passenger transportation and freight delivery practices. Each recommendation offers a framework for identifying how to approach the challenges — *approach* here indicating a type of incentive, idea, or stakeholder that facilitates solving a problem (PIARC 2012, 58-59). Although each recommendation may achieve results independent of the others, and the blueprint need not be adopted as a whole, in combination they form the recommended method for creating a more connected transportation system within Arlington County.

By implementing the six recommendations in this blueprint, Arlington County can maintain its status as a leader in transit development and become a pioneer in the integration of freight services into its transportation plans. Adoption of connected city technologies, including increased stakeholder collaboration, will give Arlington County a competitive advantage that will:

1. Provide a better quality of life for its residents and businesses; and
2. Allow county planners to keep pace with a growing population.

*1. Reduce or Replace Underused ART and STAR Routes with TNC Services*

**Recommendation:** Arlington County should explore one or a combination of the TNC case studies to determine feasibility of supplementing the county’s public transportation service; particularly, ART and STAR. Policy should require these partnerships replace underutilized bus routes with private ridesharing companies. It should also restrict service between origin, public transit access points, and destination. Similar to other cities, cost savings as a result of bus replacement could be used to subsidize travel of passengers, or to low-income households.

**Gaps Addressed:**
- ART, like many bus transit services, has an obligation to service more than just the densely populated areas of the county. Many neighborhoods and local communities feel they need more transit service and/or desire stronger connections to other areas of the County (service gap).
- One of the most fundamental challenges with fixed bus routes is the inability to maintain efficient utilization/ridership. ART is no different. Passenger fares contribute only a small portion of ART's income needed for operations and maintenance. At only 26%, ART relies on 74% of its funding to come from state and local funds.
- Highly utilized bus routes experience overcrowding.
2. Provide First and Last Mile Service Options for Public Transit

**Recommendation:** Arlington County partner with private ride-share companies to provide first and last mile service of public transit riders. According to research and case studies, these partnerships have been successful in other cities throughout the U.S. Similar to the ART route recommendation, policy should restrict service between origin, public transit access points, and destination.

**Gaps Addressed:**
- Ride-sharing companies such as Uber and Lyft are ubiquitous throughout Arlington County and offer riders with door-to-door service between residencies and destinations.
- Research reveals that today’s service gaps for public transportation are the first and last mile of a commute. The challenge for riders in Arlington County is getting to and from public transit, not necessarily the service itself.
- Partnering with ride-share companies would, not only improve transit service in Arlington County, but could potentially reduce cost of their public transit programs.

3. Improve Existing Real-Time Transit Information and Develop Strategies for Community Engagement.

**Recommendation:** Leverage and promote existing technologies to provide real-time information on available transit modes to connect mobility services and improve community engagement. Develop a single source real-time information platform to synchronize all transit modes and improve community engagement.

**Gaps Addressed:**
- Existing real-time information applications are: limited to specific modes of transit; at times, inaccurate due to external factors (weather, service delays, etc.); and constrained by variations in technology platforms. Arlington commuters would benefit from an application, accessible by a handheld device, that tracks all available Arlington County passenger transportation services, in real-time.
- TNC smart phone applications are not integrated into other modes of transportation, such as bus, metro or bike share.
- Unnecessary delays from riders having to add funds to payment cards.
- To become a connected city, Arlington County will need to develop strategies to facilitate two way dialogue that encourages more public feedback on future transportation decisions.
4. Identify Delivery Challenges and Solve Them within a Test Neighborhood

Figure 5.1. Recommended time period.

**Recommendation:** Over a period of 18 months, Arlington County should conduct small group interviews with freight customers and carriers doing business within a specific neighborhood.

**Gaps Addressed:**

- **Planning** —
  - Identifies and solves conflicts between current parking policies and the desired delivery practices among freight carriers and customers.
  - Tests effectiveness of proposals in a controlled location.
  - Assesses potential for broader application in the county.

- **Data-sharing** —
  - Compiles a list of freight carriers and customers.
  - Compiles a list of delivery practices and challenges.
  - Uses small-group interview principles to promote information exchange and to foster working relationships.

**Objectives**

1. Establish a goal-oriented working relationship between county officials and other freight stakeholders (carriers and customers) within that neighborhood.
2. Compile a list of stakeholders within that neighborhood — carriers and customers; county offices responsible for transportation infrastructure development, transit management, and transportation development management.
3. Solicit input from carriers and customers about:
   - What practices they use to deliver and receive goods;
   - What problems they have to overcome to deliver or receive goods; and
   - What ideas they have to mitigate or eliminate those problems.
4. Use combined stakeholder input (private and public sector) to compile a list of delivery practices and policies.
5. Solicit combined stakeholder assistance in completion of a gap analysis of current county policies compared to current delivery practices.
6. Design a pilot program urban freight plan for that neighborhood, which mitigates the identified gaps without adversely affecting other complete streets initiatives in the county.

7. Test the pilot urban freight plan for a period of at least one year, using periodically-collected performance metrics identified in the plan to provide evidence of success or failure.

8. Provide a controlled test of whether the interview and solution process can be applied successfully throughout the county.

Initial identifications of stakeholders and first small group interviews should occur within three months of the program start. Final assessment of the findings should occur within six months of start. Implementation of the solutions in accordance with the freight plan should occur within one year from the publication of the plan. The compressed timeframe restricts the complexity of the plan and increases the sense of purpose and value among stakeholders, who can report activities within common business performance cycles.

**Recommended neighborhood**

The size of the pilot neighborhood must be large enough to yield sufficiently varied data to be useful, yet not so large that data collection is difficult or cost-prohibitive. The neighborhood should also have a mixture of residential and commercial buildings in order to represent the typical urban environment.

The Clarendon neighborhood is an ideal target. The proposed boundaries are from Washington Boulevard in the west to North Danville Street in the east, up to one block north of Wilson Boulevard and one block south of Clarendon Boulevard.

The neighborhood contains a diverse mixture of restaurants, office buildings, and apartments within commercial zoning, and is surrounded by single- and small multi-family unit residential neighborhoods at varying real estate values. Several churches are present, as are schools and day-care. The area experiences a variety of traffic congestion, from very little on most weekends, to very congested during morning and afternoon rush hours. There are several Capital BikeShare stations. Multiple posted and suggested bike routes pass through the area. Multiple MetroBus and ART stations are present, as are several taxi stands. Metrorail’s Clarendon Station is also present.
Figure 5.2. Recommended test neighborhood in Clarendon, showing restaurants, businesses, schools, taxi stands, bikeshare stations, bus routes (yellow) and stops, WMATA Metro line (orange), and bike routes (green).

Recommended strategies for interviews

1. Neighborhood residents are not, under this recommendation, freight stakeholders — although later iterations of this program may see benefits to including them.
2. Initially, interview customers separately from carriers to prevent political or business conflicts between the groups.
3. Initially, interview groups from the same industry (restaurant, food delivery, parcel delivery) in order to compile generalized categories of challenges.
4. Because neighborhoods businesses receive the goods and have physical addresses, begin small group interviews with freight customers. These interviews should include inquiries about who they receive deliveries from and who they use to ship parcels and goods, if any. This will facilitate compiling a list of all freight carrier stakeholders in the neighborhood.
5. Conduct field observations similar to those detailed in the field study summaries to identify freight carriers doing business in the neighborhood.
6. Interview groups of no more than 10 stakeholders (including government officials present) in order to foster interaction between members and minimize the duration of meetings. Limited government presence will adhere to the Arlington Way and prevent misconceptions among stakeholders about the purpose of the interviews (soliciting information, not dictating policies). Interviewing such small groups likely also reduces the cost of hosting an interview room.
7. Interview durations should not exceed one hour in order to:
   o Minimize time conflicts with businesses ("time is money");
   o Enable supervisors to permit subordinates to attend without productivity losses; and
   o Encourage participation, both in attendance (short meetings may be hard to decline) and
during the meeting (limited time to get things done).
8. Conduct multiple interview with the same group if necessary.
9. Information received in the meetings should be non-attributional and not subject to law
   enforcement repercussions, regardless of potential traffic or parking violations identified.
10. The interview format detailed in the field section is a suitable template.
11. Use an off-the-shelf, open architecture information sharing system to compile and share the
    list of challenges and solutions.
12. Consider publishing media reports of findings once compiled.

Recommended strategies for gap analysis and solutions development

1. Include Arlington County Police in any plan development, including designing performance
   metrics. The following may be suitable: traffic accident reports; moving and parking
   violation reports; patrol car observations.
2. Restrict the number of policy changes to ease the complexity of performance measurements.
3. Aggressively limit infrastructure changes — the focus should be on use of information
   systems and enhancing delivery and traffic efficiencies, not generating development projects.
4. Consider soliciting input from organizations such as BikeArlington, WMATA, and Capital
   BikeShare during the solutions phase of the program.
5. Consider iterative field observations to:
   o Substantiate the presence and intensity of identified challenges; and
   o Provide policy performance measurements.
5. Charter an Urban Freight Cooperative (UFC) within a Test Neighborhood

**Recommendation:** Over a period of 18 months, Arlington County should create a freight stakeholder working group, the Urban Freight Cooperative (UFC), within a specific neighborhood. Although designed to perpetuate the relationships developed in recommendation 4, the UFC may be adopted independently of such a process. This is because the purposes of the UFC extend beyond cataloging and solving delivery challenges.

**Gaps Addressed:**
- **Planning** —
  - Designs a think-tank of public and private sector stakeholders to propose modifications to ordinances and policies.
  - Integrates stakeholders into the development process for policies that affect them.
  - Assesses potential for broader application in the county.
- **Data-sharing** —
  - Creates a representative forum that can design an information sharing platform.
  - Uses subject matter expertise for best data design and reporting initiatives.

**Objectives**

1. Maintain a goal-oriented working relationship between county officials and other freight stakeholders (carriers and customers) within that neighborhood.
2. Support continued, efficient growth of freight deliveries by promoting freight data sharing and developing policies that combine freight delivery best practices and transportation management principles.
3. Provide freight stakeholders a representative body that can participate in other development and planning forums that affect that neighborhood.

4. Facilitate the development of an urban freight plan for the neighborhood, described in recommendation 4 (if applicable).

5. Provide a controlled test of whether the stakeholder working group can be applied successfully throughout the county.

Because it is designed to facilitate recommendation 4, the chartering of the UFC should occur between three and six months after the start of that recommendation. If Arlington County does not adopt recommendation 4, the creation of the UFC can occur immediately. Notably, without adoption of recommendation 4, the UFC must design a process that facilitates mandate 2.

**Recommended neighborhood**

The Clarendon neighborhood is an ideal target, for the reasons provided in recommendation 4.

**Proposed Membership Eligibility**

The creation of an Urban Freight Cooperative, as with farming cooperatives, unites its members by making explicit how tightly interwoven their successes and failures in fact are — a relationship that is invisible under Arlington’s current *laissez-faire* approach to urban freight. Cooperatives are designed to maximize efficiencies, minimize costs and, above all, provide members the means to ensure that their concerns are heard and acted upon. Thus, to ensure that the UFC is a cooperative of freight stakeholders:

1. Arlington County government membership should be restricted to those offices directly involved with transportation and economic development planning and public safety. This reduces the potential for carriers to perceive the cooperative as just a governmental body, and for government officials to inadvertently steer the cooperative.

2. All businesses and organizations (private or public) within the test area who receive freight deliveries or contract freight pick-ups are eligible for membership.

3. All freight carriers delivering to or from the test area are eligible for membership.

4. Eventual liaison with the Fairfax County Economic Development Authority seems beneficial.

5. Neighborhood residents are not initially eligible, since the focus is on businesses and the public sector. Later refinement of this program may see benefits to including them.

6. are not eligible (not freight as defined in this blueprint).

7. Waste management companies, construction companies, and other service or utilities contractors are not eligible — they are not freight carriers, even if hauling materials.
**Recommended strategies for creating and maintaining the UFC**

1. Identify all businesses in the test neighborhood that receive or contract shipment of parcels or goods. Solicit from these businesses which freight carriers they use.
2. Invite stakeholders to a conference about freight innovations, during which the closing agenda item or event is the proposal to charter a UFC within the neighborhood. One of the conference booths could describe Seattle’s Urban Freight Lab (see Appendix B) or San Francisco’s Better Market Street (see literature review) as a primer for the UFC.
3. Create a charter working group to propose a charter to members within 3 months.
4. Consider creation of a steering committee with periodic, rotating membership and cabinet positions, to simplify coordination of UFC actions.
5. Consider modeling the UFC after city port authorities, such as New York, or the Metropolitan Washington Airports Authority. Although the UFC will not own facilities like such authorities, their coordinating activities may provide suitable models.
6. Consider promoting general topics such as:
   - Delivery driver safety;
   - Innovations in delivery vehicle technology;
   - A study about traffic patterns and best routes within the target neighborhood;
   - A public relations campaign that provides other transportation mode users tips on how to interact with delivery vehicles.
6. Integrate Freight Data with Other Transportation System Data

Recommendation: Arlington County, in cooperation with private sector freight stakeholders, should develop a data-sharing system for freight information and data.

Gaps Addressed:
- Planning — Improves transportation demand management planning by including freight movements in design scenarios. Permits forecasting of freight movements and volume, improving accuracy of land use developments and parking management plans.
- Data-sharing — Combines data that was formerly locked behind corporate and government firewalls.
Requirements

- A web-based information sharing platform that provides:
  - Information about the UFC (if adopted from recommendation 5), containing:
    - About (formation, missions, goals)
    - Current Members/Membership Information
    - Contact Information
    - Events Information/Calendar
  - The status of the freight initiatives carried out by the UFC (if adopted) or, at a minimum, Arlington County government;
  - Information on urban freight best practices, innovations, challenges and needs.
- A web- and mobile-based application to share and access freight data for Arlington County.

The development of this data-sharing system builds on the information collected in recommendation 4 and the initiatives created if implementing recommendation 5. However, the data-sharing system presented here does not require implementation of either of those recommendations, since it presents a method for sharing information with the public and aggregating freight delivery data from multiple sources. If the county adopts this recommendation in conjunction with recommendations 4 and 5, it should commence no earlier than six months after the start of recommendation 4 and not before the creation of the UFC. This permits sufficient time for stakeholders to become confident in their working relationships with one another, and that the data is being shared within a collaborative, not competitive, environment. Because this is a blueprint recommendation, not a project, cost estimates are not provided.

Recommended method for sharing freight data

The development of a relational database management system (RDBMS) would be required for storing and managing the newly collected freight data. The information stored in this database can be managed using Structure Query Language queries allowing analytics capabilities that can aid in transportation planning. Bronzini et al (2009) and Ma et al (2016) detail methods for extracting and sharing data from existing Enterprise Resource Planning and Supply Chain Management systems and GPS transponder systems.
Regardless of platform chosen, the following data fields should be included in data extracted from freight companies:

- Pick-up/drop-off/both
- Address of delivery event
- Date of event
- Time of day (start time)
- Dwelling time or time on site
- Vehicle type and size
- Units or volume (number of pieces)

These fields provide sufficient information to identify trends, but not enough to serve as a source for business intelligence. Such limited data should promote collaboration and simplify data extraction. The specific rationales for selecting these fields are:

- Company names for carrier and customer are not fields, nor is vehicle identification (for example, state registration or corporate resource number). This prevents mining the data for law enforcement or business intelligence purposes.
- Recording the size and type of vehicle provides a general understanding of how the delivery might impact other modes.
- The address should be a street address or, if possible, geographic coordinates of the delivery vehicle location at the time the goods are unloaded from or loaded in the vehicle.
- The type of good delivered is immaterial to identifying delivery practices and impact on other transportation modes, but the total number of units or volume of the delivery may yield correlations between delivery size and other factors, such as dwelling time, traffic congestion, or general locations within the county.
Recommended Future Research

The following are recommended research opportunities for Arlington County to further explore connected city concepts. These recommendations expand beyond the scope of the recommendations found in the Blueprint section. They represent ways in which Arlington may connect other elements of its transportation network into a developed connected city program. Recommendations for connected city applications that fell beyond the scope of this report, but are worth Arlington County’s consideration.

Connecting Traffic Accident and Injury Data with Other Data to Improve Safety

This Blueprint does not explore ways to improve the safety of traffic flow, for all transportation modes, in Arlington County. Summary analysis of traffic fatalities and accidents available through National Highway Traffic Safety Administration’s National Center for Statistics and Analysis revealed insufficiently granular data to identify opportunities for a connected city to mitigate collisions between transit vehicles, freight vehicles, bicyclists, and pedestrians. Sufficiently detailed surveys and collection of data from public safety reports were beyond the scope of this study.

In a connected city, opportunities theoretically exist for real-time tracking of accidents and the presence of obstructions in road networks (accidents, construction, peak hour congestion, delivery vehicles). Moreover, using complete streets methods, analysis of such information in conjunction with local economic indicators (often crowd-sourced) could provide transportation planners the means to identify whether areas of periodic popularity (for example, restaurants, event locations) have sufficiently planned traffic safety measures in place. Mobile mapping applications such as Waze and Google or Apple Maps also illustrate potential growth vectors for connecting transportation management data to other information to provide users with the ability to efficiently and safely get from origin to destination.

Meal Deliveries and Taxis

This research did not include observations of meal deliveries or taxi services. These vehicles are typically small, are subject to parking and standing ordinances, and conduct multiple short trips throughout the county, possibly with little impact to traffic flow. With the expansion of businesses such as Uber, including UberEATS, taxis and meal deliveries may experience significant disruption in the near future. Further research might reveal opportunities to improve the connection of these services with the rest of the transportation network. Innovation is already occurring privately, so the public sector should consider doing so also.
Appendix A: Glossary

Acronyms

AASHTO—American Association of State Highway and Transportation Officials
ACCS—Arlington County Commuter Services
ADA—Americans with Disabilities Act
ART—Arlington Transit
CUE—City-University Energysaver
FM/LM—First Mile/Last Mile
HoReCa—Hotel, Restaurant and Catering
ITS—Intelligent Transportation System
LCD—Liquid Crystal Display
LED—Light-Emitting Diode
MTA—Maryland Transit Administration
PRTC—Potomac and Rappahannock Transportation Commission
PTN—Primary Transit Network
PSTA—Pinellas Suncoast Transit Authority
RDBMS—Relational Database Management System
RFTM—Road Freight Transportation Management
STAR—Secondary Transit Network
STN—Secondary Transit Network
TNC—Transportation Network Company
TPB—Transportation Planning Board
UPS—United Parcel Service
VRE—Virginia Railway Express
VDOT—Virginia Department of Transportation
WMATA—Washington Metropolitan Area Transit Authority
Terms

**Complete Streets**—An urban design principle that encourages the development of streets that are “designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities” (Smart Growth America 2017).


(a) Business to consumer: Business sells products directly to consumers over the internet.
(b) Business to business: Companies sell products to other companies over the internet.
(c) Consumer to business: Consumers sell products to businesses over the internet.
(d) Consumer to consumer: Consumers sell products to other consumers.

(Study.com, 2003-2017)

**First Mile/Last Mile**—First mile is a term that describes the movement of people and goods from their starting destination, Arlington County, to a transportation hub. Last mile is a term that describes the movement of people and goods from a transportation hub to their final destination, Arlington County.

**Freight Carrier**—Company engaged in shipping packaged, boxed, and palletized goods.

Hotel, Restaurant and Catering (HoReCa)—Refers to a foodservice industry sector that sells food and/or beverages.

**Urban Freight**—The movement of freight vehicles whose primary purpose is to carry goods into, out of and within Arlington County to, both, residential and commercial customers. Freight vehicles include the following categories: Retail (including e-commerce); express, courier and post (e.g. USPS, UPS, FedEx, etc.); hotel, restaurant and catering (HoReCa) (e.g. Aramark, Sysco, Pepsi, etc.); and grocery delivery (e.g. AmazonFresh, Peapod by Giant, etc.)
Appendix B: Review of Freight Literature Summaries

**ALICE-ERTRAC (2014)** identifies research methods, end-states, and timelines to “achieve a full integration of freight flows in cities’ operations and activities that allow citizens to access the goods they require and the goods to reach the citizens.” Broadly defining *urban freight* as “all movements of goods into, out of, through or within the urban area,” including shopping trips and waste removal (ALICE-ERTRAC 2014, 3), the guide focuses the proposed research less on specific freight transportation practices and more on improving: overall system energy efficiency (road network improvements and vehicle technologies); air quality and noise abatement; customer satisfaction (timely, reliable deliveries); and freight safety and security. It recommends a mix of public and private sector research initiatives.

**BMS (2011)** defines existing urban freight delivery challenges, using several large U.S. and European cities as evidence, and classifies design solutions based on those cities’ responses to those challenges. The report identifies solutions for: accommodation of delivery vehicles in urban design; reduction of congestion and pollution caused by delivery vehicles; enforcement of existing traffic and parking regulations; and redesign of delivery areas to improve service times and convenience. The target audience is the Better Market Street group in San Francisco, CA, a public-private partnership.

**Bronzini et al. (2009)** investigated the feasibility of implementing a freight data exchange network. The envisioned network was a centralized data repository where data providers and users could input and access freight datasets, metadata, reports of quality or other data issues, and reports documenting how data were used for specific applications (Bronzini et al. 2009, 3–6). The study noted that:

“In order for the Freight Data Exchange Network to succeed there must be a set of willing participants of two types—data users and data providers. Data users are primarily state DOTs and local MPOs, and the contractors (consulting firms, universities) who support their transportation planning, design, and operations needs. Data providers are envisioned to be primarily transportation carriers (truck, rail, water, intermodal), shippers, and the various third parties who support freight transportation and logistics activities (3rd party logistics providers, freight bill audit firms, freight forwarders, etc.).” (7)

The study identified the necessary data sets and network framework — data format, connectivity requirements, network security measures, costs and user fees — and illustrated potential uses of the data by providers as well as users (Bronzini et al. 2009, 15–23). Serving as a complete framework for data exchange, the study highlights the benefits to planning when permitting input and access by the private as well as the public sector.
The FHWA (2009) study of initiatives in Washington, D.C., to reduce traffic congestion and safety concerns was foundational to understanding both the region’s challenges as well as the general interactions between freight vehicles and pedestrians, bikers, public transit and other vehicles. Using a mix of public outreach, workshops with property managers, and revised parking schemes in pilot test areas in the city’s busier corridors, the District Department of Transportation’s efforts showed a “statistically significant reduction in automobile and bicycle travel times” and increased by 50% the monthly number of parking violation citations between September 2006 and May 2007 (FHWA 2009, 8). However, freight carriers appear to have had little input on shaping the city’s revisions — they received rather than helped devise revised parking policies (FHWA 2009, 7–8). Increased curb-side parking spaces and relocation of loading zones did provide delivery drivers the means to avoid double-parking as frequently (FHWA 2009, 6), although the study made no mention how this affected the distances drivers had to negotiate between delivery vehicle and freight destination. Thus, although the efforts appeared to ease congestion and enhance some aspects of safety, the study left unknown whether overall delivery efficiency improved also. Foundational though FHWA’s study may be, the relative lack of input from freight carriers highlights the need for collaboration with all stakeholders — residents, property owners, freight carriers, law enforcement, business associations, and transportation planners — and the adverse impacts of stovepiped information streams — delivery schedules, customer satisfaction, traffic flow, accident reporting, and development plans, to name a few.

Ma et al. (2016) provided a comprehensive study of freight delivery vehicle trip-chaining in the state of Washington, explaining how to extract delivery route and dwell (idling) times from vehicle GPS data. The study defines the necessary data sets and algorithms to extract this information, providing a framework that could be used within a data-sharing network to aid transportation planners as well as industry analysts. According to the study, use of GPS data results in more accurate information and eases the burden of data collection on businesses and planners (Ma et al. 2016, 44):

“Data scarcity is an ongoing limitation on the development of freight performance measures and activity-based freight demand models. Freight activity information (e.g., trip tour and travel patterns) need to be used to model freight movements accurately. Freight activity information is often difficult to acquire because of concerns related to the protection of customers’ privacy and business competitiveness. Traditionally, most freight demand forecasting studies have relied on manual data collection methods, such as travel diaries or logs and surveys. These methods are fairly costly and difficult to implement at a multiday level, because of low response rates and inaccuracy.”

Using the extracted information, Ma et al. were able to identify delivery locations, idling times, road networks used, and the impact of times of day on drivers’ choices. The study also
demonstrated how, due to the complexity of freight trip-chaining, planners familiar with passenger trip-chain modeling may not be as successful when modeling freight movements.

**PIARC (2012)** provides a workflow to identify and solve the challenges that the public sector encounters when including urban freight in transportation and development planning. It defines six categories of solutions that enable the public and private sectors to address specific problems and identify stakeholders: Infrastructure, Regulatory, Logistical, Co-operative, Technology, and Behavioral Change (PIARC 2012, 31). The workflow assumes collaboration between local governments, especially across jurisdictions, and between freight carriers and the public sector.

**PIARC (2013)** builds on PIARC (2012), focusing on how to include road freight transportation management systems in broader urban development planning. The report concentrates on methods to make freight vehicles more efficient, thereby lessening their impact on traffic congestion, pollution (air and noise), and improving overall system reliability. By focusing on information management and vehicle technologies, PIARC (2013) identifies a number of solutions not detailed in PIARC (2012), including loading and idling time restrictions and improved data sharing between carriers and their customers. A mix of public and private sector solutions, including carriers and customers, is key.

**NCFRP (2012)** details urban freight challenges and presents a guide for creating public sector solutions. Key challenges are increasing urbanization, traffic congestion, conflicts between environmental protection and economic growth, and freight data heterogeneity. Proposed solutions center on local government oversight based on findings generated by collaboration with freight carriers, customers, and urban residents.

**NCHRP (2016)** provides a guide for identifying stakeholders and developing tools to integrate freight delivery into a “smart growth environment” in urban areas (§ 1.1). The guide’s core strategy is the inclusion of freight carriers in urban planning in order to balance environmental protections and residents’ health and safety with realistic means to deliver goods into and out of urban areas (NCHRP 2016, § 2.4). Public sector solutions are its focus.

**Sánchez-Díaz et al (2016)** detail the effectiveness of off-peak hour deliveries and alternative delivery reception schemes developed as pilot tests over the last decade in New York City, London, Denmark, Paris, and Stockholm (§ 5). Reductions in noise, CO, emissions, travel time and service time occurred in all tests. After identifying common challenges for urban freight delivery, the report classifies the pilots according to levels of public sector governance and assistance. Success occurs due to collaboration between carriers and local government, with limited government intervention and extensive accommodation of the private sector (voluntary schemes) (§ 7).

**Taniguchi (2013)** addresses the need for urban freight management to promote sustainable and livable cities. Noting a global trend toward urbanization, the presentation focuses on the increasing need to balance the timely and efficient provision of goods to residents with environmentally conscious methods that reduce public health effects. The ideal balance combines intelligent transport systems and advanced information systems in urban areas with existing enterprise resource planning and supply chain management systems. Although
collaboration is a key component, information sharing, even between competitors, provides the framework on which to build solutions.

**Taniguchi (2014)** proposes development of joint delivery systems, even between competitors, as a means to reduce urban traffic congestion and pollution without loss of delivery timeliness or reliability. Neutral last-mile carriers using consolidated downtown delivery depots provide the first step toward urban freight management using joint delivery. The presentation highlighted pilot projects in Japan as possible models, each a mix of local government and private sector solutions.

**The Urban Freight Lab** at the University of Washington is a public and private sector working group tasked with developing improvements for freight delivery in Seattle, with broader applications to the U.S. (UW 2017). Urban Freight Lab members include the Seattle Department of Transportation, retailers, urban logistics companies, technology companies, commercial vehicle manufacturers and building developers and operators. Illustrating the benefits of partnering transportation planners with private companies and community representatives, the Urban Freight Lab’s earliest initiatives identified the diverse range of stakeholders, common business practices, and specific problems that each category of stakeholder faces. Having developed a long-range strategy with specific milestones, the Urban Freight Lab developed pilot tests of revised loading zones and curb-spaces, communal delivery areas, and radical new street design concepts following Complete Streets models. Data-driven and focused on collaboration among a complete set of stakeholders, the project is ongoing and represents a potential model for Arlington to develop a similar working group.
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