University Transportation Research Center - Region 2

Final Report

Impacts of Freight Parking Policies in Urban Areas: The Case of New York City

Performing Organization: Rensselaer Polytechnic Institute

June 2016

University Transportation Research Center - Region 2

The Region 2 University Transportation Research Center (UTRC) is one of ten original University Transportation Centers established in 1987 by the U.S. Congress. These Centers were established with the recognition that transportation plays a key role in the nation's economy and the quality of life of its citizens. University faculty members provide a critical link in resolving our national and regional transportation problems while training the professionals who address our transportation systems and their customers on a daily basis.

The UTRC was established in order to support research, education and the transfer of technology in the field of transportation. The theme of the Center is "Planning and Managing Regional Transportation Systems in a Changing World." Presently, under the direction of Dr. Camille Kamga, the UTRC represents USDOT Region II, including New York, New Jersey, Puerto Rico and the U.S. Virgin Islands. Functioning as a consortium of twelve major Universities throughout the region, UTRC is located at the CUNY Institute for Transportation Systems at The City College of New York, the lead institution of the consortium. The Center, through its consortium, an Agency-Industry Council and its Director and Staff, supports research, education, and technology transfer under its theme. UTRC's three main goals are:

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16. Abstract

The research has tested several policy scenarios, and the practical implications of parking supply management is discussed. The results obtained help provide a better understanding of the need of freight parking and the policy alternatives available to improve the efficiency of urban freight systems. The results of the simulation provided the following insights related to which parking policies could be implemented to improve freight parking. While increased parking supply is not an easy feat, this would be a very effective policy that can decrease the average search time of trucks by 61%, shaving an average of 16 minutes of travel time off per delivery. This change would have important effects not only on freight traffic but also on other users of the transportation network. From the fieldwork conducted by the authors, it is clear that the current parking inventory is not utilized in the most efficient manner, and there are various avenues by which more supply could be added to the existing parking availability, such as adding more freight parking spaces in alleyways, or the implementation of the delivery time windows as a way to better manage the existing infrastructure and provide the additional number of spaces needed. The research also shows that changing the total amount of time it takes to make deliveries also impacts the parking. The analyses show that a decrease of 10% in the delivery time can yield up to 55% reduction of average search time, and conversely, an increase of delivery times by 10% results in a 200% increase of search time in average. This highlights the important role receivers play in the performance of urban freight systems. Therefore, policy interventions that engage receivers with other stakeholders, and target better freight demand management practices such as receiver led consolidation, can show significant benefits.

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1. EXECUTIVE SUMMARY

Freight flows are a physical expression of the economy, so fostering efficiency in the movement of freight from producers to consumers will spur growth for the economy and employment. However, the transportation of freight generates traffic, resulting in congestion, pollution, noise, infrastructure damage, and threats to the quality of life. A goal of transportation policy should be to maximize the net social benefits of freight activity while mitigating the negative impacts associated with this activity.

Achieving a proper balance is always a challenge, as it is in the case of parking and curb allocation for freight vehicles. In most city centers and business districts (CBDs), parking is very limited, translating into trucks double parking, idling, circling blocks, or extending into sidewalks and roadways when using undersized loading areas. This is not only an enforcement issue; frequently, the number of available parking spaces is not enough to satisfy the needs of delivery trucks. In Manhattan for instance, there are ten ZIP codes where the linear capacity of the streets is insufficient to accommodate the trucks needed to make deliveries (Jaller et al. 2013) . As a result, carriers are in most cases, forced to park illegally and pay large amounts of money in parking fines ($500 to $1000 per truck per month) (Holguín-Veras et al. 2008). Freight vehicles need to park close to their customers, as the cost of walking from a parking facility to their destinations is very high; and reduces the size of the loads drivers can carry, all of which increases delivery and parking times.

As demand for parking increases in CBDs, there is an increasing need for analysis tools to support decisions that will strike a viable balance between supply and demand. Policy makers need these tools to identify and analyze the impacts of potential policies. Traffic simulation tools have been developed to support efforts devoted to modeling passenger car traffic, but most of these pay almost no attention to the effects of the parking allocations, travel times and congestion generated by delivery trucks. There is a lack of data, and knowledge about how the whole system works, and how best to influence it to achieve policy goals. The development of tools aimed at a fuller understanding of parking conditions in urban areas will help to fill this void, and allow public agencies to manage and regulate parking—for passenger and freight traffic—more effectively.

The research has tested several policy scenarios, and the practical implications of parking supply management is discussed. The results obtained help provide a better understanding of the need of freight parking and the policy alternatives available to improve the efficiency of urban freight systems. The results of the simulation provided the following insights related to which parking policies could be implemented to improve freight parking. While increased parking supply is not an easy feat, this would be a very effective policy that can decrease the average search time of trucks by 61%, shaving an average of 16 minutes of travel time off per delivery. This change would have important effects not only on freight traffic but also on other users of the transportation network. From the fieldwork conducted by the authors, it is clear that the current parking inventory is not utilized in the most efficient manner, and there are various avenues by which more supply could be added to the existing parking availability, such as adding more freight parking spaces in alleyways, or the implementation of the delivery time windows as a way to better manage the existing infrastructure and provide the additional number of spaces needed. The research also shows that changing the total amount of time it takes to make deliveries also impacts the parking. The analyses show that a decrease of 10% in the delivery time can yield up to 55% reduction of average search time, and conversely, an increase of delivery times by 10% results in a 200% increase of search time in average. This highlights the important role receivers play in the performance of urban freight systems. Therefore, policy interventions that engage receivers with other stakeholders, and target better freight demand management practices such as receiver led consolidation, can show significant benefits.

2. INTRODUCTION

As freight flows are a physical expression of the economy, fostering efficient freight flows will spur economic growth and employment. Conversely, hampering the movement of goods from producers to consumers can lead to economic and employment losses. Urban areas rely on their freight transportation system for the delivery of the massive amounts of cargo needed to sustain the manufacturing and commerce industries and local consumption. In the NYC metropolitan area, the amount of cargo entering the area is equivalent to 45kg per person, per day (Wood and Leighton 1969). Obviously, the transportation of such large amounts of cargo generates an equally large amount of freight traffic, which in turn produces congestion, pollution, noise, infrastructure damage, and detracts from the quality of life. The main goal of transportation policy should therefore be to maximize the net social benefits of freight activity by ensuring efficient freight flows, while ameliorating the negative impacts associated with freight traffic.

Achieving a proper balance can be a challenge, as it is in terms of freight parking and curb allocation. In most city centers and business districts (CBDs), parking is very limited – even more so for trucks and commercial vehicles. It is not easy for most drivers to find easily accessible curb side parking for pick-up and delivery operations, which translates into trucks double parking, idling, spending considerable time circling a block waiting for a preferred parking space, or extending into sidewalks and roadways while using undersized loading areas. This is not only an enforcement issue; frequently, the number of parking spaces available is not enough to satisfy the needs of delivery trucks. Capacity is limited, and space must be shared by cars, buses, and service and freight vehicles. In Manhattan, for instance, there are ten ZIP codes where the linear capacity of all available on street parking (for both passenger and commercial vehicles) is insufficient to accommodate all of the delivery trucks that need to park to make deliveries (Jaller et al. 2013). As a result, carriers are forced to double park and pay large amounts in parking fines ($500 to $1000 per truck per month in NYC) (Holguín-Veras et al. 2007, Holguín-Veras et al. 2008). Freight vehicles need to park close to their customers, as the cost of walking from a parking facility to their destinations is very high; parking further away means the drivers need to use hand carts and other methods to bring the packages to the final destination and sometimes make multiple trips back to the truck, this translates into significant increases in delivery times.

Given the disparity between the supply and demand for curb space, it is important to develop policies to improve the urban freight system (UFS). However, it is also important to acknowledge that policies and strategies do not have the same impacts for passenger vehicles compared to trucks. For example, while parking restrictions could play a significant role in reducing passenger car traffic and fostering a shift to other modes, they do not have the same effect for freight traffic, as there are no practical mode alternatives to trucks in most urban areas. Table 1 shows a number of parking-related policies implemented in urban areas. This sample of measures shows how commercial vehicle parking has been overlooked, as most of the policies concentrate on passenger traffic or expect equivalent impacts on freight traffic.

Table 1: Examples of parking policies

Parking Policy	Implemented at:
Advance Parking Management Systems	New York, NY; Chicago, IL; San Francisco, CA; Seattle, WA
Bicycle Parking	New York;, NY Minneapolis, MN; Portland, OR; San Francisco, CA
Car-Free and Car-Capper Residential Development	London, UK
Car-Share Provision	New York, NY; Philadelphia, PA; San Francisco, CA; Washington, DC; Vancouver, BC
In-Lieu Fee	Pasadena, CA; Arlington County, VA; San Francisco, CA; Toronto, ON; Vancouver, BC; Seattle, WA
Land Banking	Palo Alto, CA; San Diego, CA
Maximum Parking Requirements	New York, NY; Chicago, IL; Minneapolis, MN; Portland, OR
Parking Database	Seattle, WA
Parking Cap	Portland, OR
Parking Freeze	Boston, MA
Parking Management Plan	Baltimore, MD; Portland, OR; San Francisco, CA
Residential Parking Permits	Arlington County, VA; Boston, MA; Chicago, IL; San Francisco, CA; Seattle, WA; Los Angeles, CA; Milwaukee, WI; Portland, OR; Toronto, ON; Vancouver, BC; Washington, DC
Shared Parking	Arlington County, VA; Portland, OR; San Diego, CA; Seattle, WA; Washington, DC
Special Population Provision	New York, NY; Los Angeles, CA; San Diego, CA; Seattle, WA
Transferable Parking Rights	Portland, OR
Transit Oriented Development	New York, NY; Arlington County, VA; Boston, MA; Portland, OR; Seattle, WA
Transit Overlay Districts	Chicago, IL; Milwaukee, WI; San Diego, CA
Transportation Improvement/Benefit Districts	Pasadena, CA; Portland, OR; San Diego, CA
Travel Demand Management Plan	Portland, OR; Seattle, WA
Unbundled Parking	San Francisco, CA
Variable Priced Parking/Performance Based Pricing	New York, NY; Boston, MA; Chicago, IL; San Francisco, CA

Source: Adapted from New York City Department of City Planning (2011)

As demand for parking increases in CBDs, so does the need for analysis tools to support planning efforts and more effective policies. Policy makers need these tools to identify the potential impacts of designed policies. There is also a lack of data, fundamental knowledge of how the system works, and how best to influence it towards the achievement of policy goals. In a previous study, the authors developed empirical approximation techniques to estimate the demand for parking, using freight trip generation estimates, and the supply of parking on the basis of curb space. However, these analyses can only provide approximate estimates of the problem; they do not consider the underlying behaviors involved. One way to understand and model the parking problem is through traffic simulation. While some traffic simulation tools have been developed, most efforts have been devoted to modeling passenger traffic, ignoring the effects of parking allocation, travel times and congestion related to freight traffic.

There is a need for tools aimed at a fuller understanding of parking conditions in urban areas to allow public agencies to manage and regulate parking in a holistic manner. This project contributes to the development of such tools. The report is organized as follows: Section 3 contains a review of related work; Section 4 provides details on the simulation system developed; Section 5 describes the case study area in NYC and the data collected as part of the project; Section 6 presents the results of the simulation and Section 7 offers conclusions and recommendations.

3. LITERATURE REVIEW

Parking in most urban areas for any type of vehicle is often a challenge, this problem is often much worse for commercial vehicles making deliveries in the urban core. Parking spaces are limited and delivery trucks are often forced to find a place to park without wasting a lot of time searching. Parking fines are common and carriers are so used to get tickets that they include them as the cost of doing business in large cities such as New York with the purpose of keeping their customers satisfied (Hawkins 2013). When delivery vehicles cannot find a legal parking space near their delivery location they are often forced to circulate in traffic and search for parking, park further away and make several trips walking the packages between the truck and the final destination or park illegally – this typically means double parking close to the delivery location. Each of these alternatives can have negative impacts on both the passenger and freight vehicles in the system. When the trucks have to continue circulating to find parking they are adding to the traffic congestion. When they park further away they are taking parking spaces away from vehicles that might need it in those locations and often times they are parked there much longer because it takes longer for the delivery to take place because of the walking to the final destination that is required. Often times the trucks will resort to double parking in front of their delivery location which causes traffic backups and unsafe conditions. These solutions are not optimal and commercial vehicle parking policies and regulations should be examined in urban areas to avoid these behaviors.

This report provides a summary of the relevant literature reviewed during the project. The review focused on three main areas: truck parking policy in urban areas, choice modeling, and simulation methods of parking policy analysis. The section related to truck parking policy is mainly a summary of (Holguín-Veras et al. 2015) in which a comprehensive description of freight policy in urban areas is discussed.

3.1 Freight Parking in Urban Areas

In (Holguín-Veras et al. 2015), the authors developed a comprehensive Planning Guide related to urban freight initiatives. In that Planning Guide there is an in-depth analysis of strategies related to commercial vehicle parking in metropolitan areas. In this report, a brief summary of the parking section is provided. The reader is directed to (Holguín-Veras et al. 2015), for an expanded explanation of each initiative and the references therein.

Parking initiatives can be classified in two groups: on-street and off-street parking. The first group includes all initiatives related to curbside management and regulations imposed to fit all users on the roads. The main challenge is that the demand for curb space exceeds capacity (Jaller et al. 2013), as cars, buses, and freight vehicles all need access to the curb. Although, freight vehicles should have priority over some of the other modes, that is not the reality. Passenger cars normally have the preference, even more than buses that foster a mode shift and then improvement in congestion. The strategies in this group deal with on-street parking in different ways and include: freight parking and loading zones; loading and parking restrictions; peak-hour clearways; vehicle parking reservation systems; and parking pricing.

Freight Parking and Loading Zones, focus on allocating curb space for parking and loading activities. Initiatives include increasing the size of loading zones where possible, and to move them to the end of the block. Increasing the capacity of parking and loading areas is an obvious and low-cost way to reduce congestion and improve traffic.

Loading and Parking Restrictions. Parking and loading restrictions of various forms have been implemented in metropolitan areas in the U.S. and Europe. Restrictions include time-of-day restrictions for parking, accommodating delivery trucks in “shared” or “flex” spaces, and creating and managing on-street loading bays

(San Francisco County Transportation Authority 2009). Other initiatives that manage curb space by allocating specific time slots for delivery operations have been successfully implemented, such as the NYCDOT Delivery Windows program (Holguín-Veras et al. 2015).

Peak-Hour Clearways are streets with prohibitions for curbside parking, standing or stopping during peak-hours. They facilitate the movement of all vehicles by increasing the capacity of the road, though they also affect the ability of carriers to service premises along the clearway. In New York City, they are called thru-streets and the hours are extended even beyond the peak hours.

Vehicle Parking Reservation Systems makes it possible for drivers to reserve curbside parking space in advance of their arrival. It requires stakeholder coordination, as well as strict enforcement.

Parking Pricing is intertwined with the allocation of curb space among all potential users. A proper amount, and the location of the spaces allocated to freight vehicles is essential. NYC Department of Transportation's (NYCDOT) Commercial Parking/Congestion Pricing program uses parking prices to foster turnover, and a better use of curb space via the muni-meters.

The second group of initiatives focus on off-street parking and loading activities. This group includes: enhanced building codes; timeshare parking space; upgrade parking areas and loading codes; and improved staging areas

Enhanced Building Codes to make sure new buildings have adequate loading docks to meet the demand and ensuring that large vehicles fit in the loading bays.

Timeshare of Parking Space allows the use of parking spaces among various users complementing the on-street parking capacity.

Upgrade Parking Areas and Loading Docks to accommodate the geometric needs of current and future trucks. It also recommends adequate setbacks from roadways so that trucks do not extend into roadways when docking

Improved Staging Areas where possible to foster the development or implementation of on-site and off-street areas at businesses or facilities that regularly receive freight. The challenge involved in establishing these areas is finding a location that will not create conflicts with other residents or users.

3.2 Truck Parking in New York City

Since the focus of this project is to study parking policies that can improve current conditions in New York City, special attention has been given to current parking regulations there.

3.2.1 Initiatives to Foster Freight Parking

There are no accurate estimates of the number of on- or off-street parking spaces in NYC. According to Shoup (2005) and Schaller (2007), there are approximately 29,000 curb spaces in the Central Business District (CBD), from which 6,900 are metered. The NYC Department of City Planning (2011) estimates that there are 85,930 metered on-street parking spaces citywide (including all boroughs), and 102,000 off-street public parking spaces in the CBD. However, not all of them are accessible for commercial vehicles. A survey conducted in 1998 found that many distributors delivering to NYC will subcontract the last part of their deliveries to smaller niche carriers with smaller trucks, not willing to deal with the barriers of congestion, insufficient space, and infrastructural problems. These last mile carriers take on parking fines incurred by this last of available space as a cost of business. This same paper argue that despite major advancements in urban goods movement and distribution activities, the management of supply chain ceases at the point of delivery of products from trucks to establishments (Morris and Kornhauser 2000).

According to Federal Highway Administration (2009), NYCDOT implemented several curbside management strategies identified in its *Commercial Vehicle Parking Plan*. One of the recommendations was to provide additional curbside spaces for commercial vehicles, reducing the amount of time these spaces are occupied and increasing enforcement. The strategy implemented focused on ticket dispensing "Muni-meters" (Figure 1) located along each block of restricted curb space, allow commercial vehicle operators to purchase prepaid parking tickets for up to three hours. The initial implementation focused on the streets bounded between 43rd and 59th and Fifth Avenue and Seventh Avenue and then expanded to cover the streets between Second and Ninth Avenues.

To ensure curb-space turnover, NYCDOT implemented a pricing strategy that consisted in an escalating rate structure designed to encourage shorter dwell times. As a result, of the pricing strategy, the average duration of curbside occupancy has decreased from 160 minutes to 45 minutes and that only about 25 percent of these commercial vehicles are occupying spaces for more than one hour (Federal Highway Administration 2009).

Figure 1: Muni-meter and parking signage in New York City

Another strategy implemented by the city in 2002, is a traffic improvement program called THRU Streets. The objective of this program is to designate specific streets for cross-town travel. Other streets were classified as "non-THRU" streets and policies including the designation of curbside areas for truck loading/unloading were implemented on those. The THRU Streets initiative has helped New York City improve traffic flow within the program area and has reduced conflicts between turning vehicles and pedestrians. NYCDOT designated five one-way street pairs to serve as THRU Streets. The THRU Street system consisted of 36th and 37th, 45th and 46th, 49th and 50th, 53rd and 54th, and 59th and 60th Streets bounded by Sixth Avenue to the west and Third Avenue to the east as shown on Figure 2. After initial results of the pilot implementation, 59th Street was removed from the program and turns onto Park Avenue from any of the THRU Streets.

Figure 2: Thru Streets Area Map. Source: (Federal Highway Administration 2009)

A more recent strategy that has been implemented in NYC is related to delivery time windows. This initiative establishes periods of time in which trucks could use parking spaces to make their deliveries while at other times passenger cars can use them. An implementation was completed on Columbus Avenue between First and Second Avenue. Results indicate a reduction in the total number of commercial vehicles parking in the study area, with a 20% decrease (from over 180 to approximately 140) for a six-block area. The vast majority of the reduction was in vehicles that were illegally parking in travel lanes. With the new delivery windows, the percent of commercial vehicles parked in a travel lane (or mixing zone) decreased by nearly half, while the number of legally parked vehicles remained relatively constant (Holguín-Veras et al. 2015). When policies such as this are implemented correctly the results can be beneficial for all users of the system.

3.2.2 Rules and Regulations in Place

Parking in New York City is regulated by Section 4-08 of the NYC traffic rules (New York City Department of Transportation 2012), which defines general guidelines. Other sections discuss further regulations: Section 4-01 provides information about different definitions of words and phrases; section 4-13 defines trucks for truck routes restrictions; and, section 4-15 contains detailed vehicle limitation considerations.

Moreover, there are special rules in midtown Manhattan impacting freight deliveries referring to: method of parking, standing time limit and parking in the garment district (New York City Department of Transportation 2015). Between 7 a.m. and 7 p.m. daily, except Sundays, from 14th to 60th Streets, 1st to 8th Avenues, all inclusive, no freight vehicle shall stop, stand, or park in any of the streets herein designated, other than parallel and close to the curb, and occupy no more than ten feet of roadway space from the nearest curb, and in no case shall any such vehicle be backed in at an angle to the curb. Moreover, between the hours of 7 a.m. and 7 p.m., daily except Sundays, from 14th to 60th Streets, 1st to 8th Avenues, all inclusive, no commercial vehicle can park or stand for a period of more than three hours unless otherwise posted. The maximum time for a metered parking on a single block shall be a total of three hours, unless otherwise indicated by a posted sign. Finally, parking in the garment district is restricted to trucks. No vehicles except trucks and vans bearing commercial plates shall stand at the curb for the purpose of expeditiously loading and unloading between the hours of 7 a.m. and 7 p.m. daily, including Sundays, from 35th Street to 41st Street, between Avenue of the Americas and 8th Avenue, all inclusive (New York City Department of Transportation 2012).

Although parking in the Central Business District (CBD) in the city of New York, the rules allow double parking of commercial vehicles under specific circumstances. Double parking is allowed at those locations and during such hours that stopping, standing, or parking is not prohibited, while expeditiously making pickups, deliveries or service calls (no more than 30 min), provided that there is no unoccupied parking space or designated loading zone on either side of the street within 100 feet that can be used for such standing, and as long as it is not blocking a bicycle lane (New York City Department of Transportation 2012).

3.3 Parking Choice Modeling

Since the early stages of choice modeling, the main efforts for implementation and uses have been devoted to passenger cars (Thompson and Richardson 1998, Arnott and Rowse 1999, Habib et al. 2012) and potential alternatives. In most cases, the choices and models have been devoted to propose policies to induce modal shifts from passenger cars to other modes such as transit or biking.

A small body of research has been developed to propose alternatives to commercial vehicles as they, in most cases, are not able to change the type of mode used to make deliveries, especially in urban areas. Major challenges are faced by truck drivers in completing deliveries in the last mile. One of these is deciding where to park and how to decide among parking choices.

For drivers, finding a parking space in urban areas is a major issue that has been understudied. Van der Goot (1982) conducted a study on the factors that determine the choice of parking places of visitors to a city center. A logit model was proposed and it was found that walking time greatly influenced the driver's choice with clear preference to use "illegal parking" as an "ideal" parking place on the street. After that, Axhausen and Polak (1991) used stated preference (SP) surveys to estimate a logit model to analyze the impacts of changes in parking attributes based on collected data in Germany and the United Kingdom. Results highlighted the need to identify the costs associated with different components of the parking activity (e.g., general in-vehicle time, parking search time, egress time) and based on that, they found that walking time, trip duration, parking fee, and parking search time were all significant factors in selecting a parking location. Teknomo and Hokao (1997) tried to understand the parkers' behavior in choosing a parking location by developing three types of choice models in a CBD area in Indonesia and concurred with Axhausen and Polak (1991) that the parking choice is influenced by the availability of parking spaces, search and queue time, walking time, and parking fee among other attributes like security and comfort. Hunt and Stefans' tour based microsimulation found inverse relationships between tour generation rates and accessibilities. They also found that travel time has a much greater impact to predicting the end of a tour than total elapsed time. Munuzuri et al. (2002) developed a microscopic traffic simulator to use as a tool for in urban freight planning. The paper describes the general operating principles of the parking search model for both private traffic and freight transport. Munizuri et all (2009) found that the major challenges in modeling urban freight stem from multiple stops in the city, changing designated routes day to day, and higher level commercial and supply chain considerations involved. Challenges also arise from the lack of data available due to reluctance of transport companies to provide this information due to their competitive market. The most recent study was developed by Nourinejad et al. (2014) in which an econometric parking choice model was developed that accounting for parking type and location. The model was integrated with a traffic simulator and used to evaluate the impact of two parking policy scenarios. Results show that searching times for freight vehicles are lower when some streets in the study area are reserved for loading/unloading activities. This also led to high search and walking times for passenger car users.

3.4 Modeling and Simulation Techniques

Despite its importance, commercial vehicle parking has received little attention in the literature concerned with urban planning. The reality is that commercial parking in urban areas plays a key role in the management of transportation systems. This is particularly important in dense urban areas where both commercial vehicles and private cars compete for curb space. Unfortunately only a handful of publications consider the modeling of freight parking and the quantification of impacts. Models based on freight trip generation are added to the aforementioned models based on equilibrium and simulation.

Most of the research has focused on the analysis of private car parking (see Young et al. (1991) and Marsden (2006)). In this context, two approaches to determine parking in urban areas predominate in the literature: equilibrium and simulation models. Equilibrium models incorporate the cost components to the decision of the traveler regarding parking. In this context, Arnott (2006) represent the first evaluation of the impact of cars cruising for parking from an economic perspective. The model takes into account monetary and time costs, and the fact that cruising for parking will increase the cost of parking for the system. The authors assume that only on-street is available and that cars take the first vacant parking space. Li et al. (2007) expand this work to take into account a multimodal network. The authors use a multinomial logit model for the modal split and a simultaneous route and parking location choice in a user equilibrium manner. Analyses include the impact of transit level of service, parking fees, and road and parking capacity. Later, Van Ommeren et al. (2012) retakes the importance of cruising vehicles. The authors estimate cruising time and relate the willingness of the driver to cruise to travel and parking duration, and income. As expected, the higher the income the lower the willingness to cruise for parking. Opposite situation occurs in the case of travel and parking duration. Unfortunately, equilibrium models do not incorporate time of day, variability of parking availability, and distance to the destination.

Simulation based models overcome these issues. For example, Benenson (2008) makes the difference between residential travelers and visitors. In this model travelers become aware of parking at 250 meters before their destination. The authors apply their model to the city of Tel Aviv. Similar approach is used by Dieussaert et al. (2009). The authors propose a spatio-temporal agent-based simulation that incorporates both traffic and parking behavior. It is important to highlight that the authors recognize the complexities of understanding the search strategy of the driver.

Munuzuri et al. (2002) developed a microscopic traffic simulation for parking. The authors incorporate both private cars and freight vehicles. The main difference is that freight vehicles have a set of stops instead of a single destination as the case of private cars. In this simulation, the delivery point is critical for the decision of parking. When available, loading zones are more likely to be selected than street parking. In another recent study in Chicago, Vitoriano et al. (2011) provides insights about the factors affecting truck parking by analyzing parking violation frequency in urban areas. The authors developed a hot-and-cold-spot identification procedure that highlights the spatial location and concentration of citations, and conducts regression analyses that provides more details about the variables (socio-economic, physical) that can impact the concentration of citations. More recently, Jaller et al. (2013) developed an approximation technique to estimate the demand for parking using freight trip generation data, and the supply of parking on the basis of curb space available. Parking demand is expressed as a function of the freight trip generation of individual establishments, and parking availability is estimated as a function of curb space dimensions and commercial vehicle characteristics. The authors implemented the methodology to quantify parking demand in New York City at the ZIP code level.

As shown in this literature review, significant research has focused on searching for parking in urban areas. However, there has been little consideration given to freight parking behavior in this literature. The impact of freight traffic should not be discounted as it is significant, especially in busy commercial districts. On the other hand, freight parking behavior is very different from that of passenger vehicles, with different motivations, dwell times and incentives. Therefore, there is a need to better understand freight parking behavior and the development of models for this purpose as a means to improve urban freight systems.

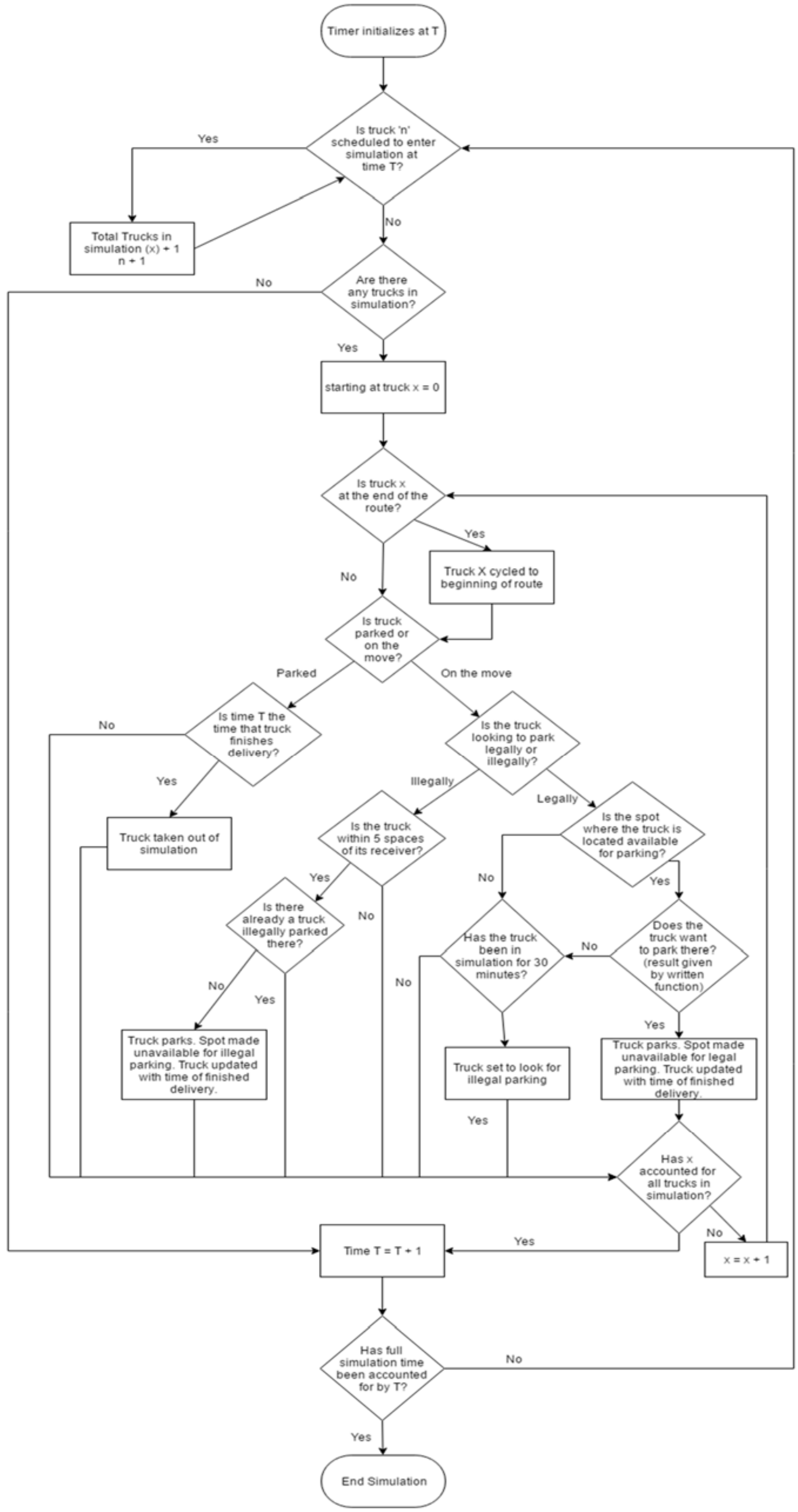
4. DESCRIPTION OF SIMULATION SYSTEM

A Freight Microsimulation Framework has been developed to capture the behavior and interactions of micro units, in this case the system evaluates each individual truck. The simulation system design is an abstraction that reduces the complexity of the parking behavior of trucks making deliveries in urban areas. The main objective of this tool is to analyze the impact of policy changes on the distribution of target variables. This type of simulation is done for explanatory purposes. The hope is that the phenomena emerging from the actions and interactions of the agents in the simulation have predictive and explanatory power on the impact that different parking policies can have on parking behavior. The framework generates social phenomena from the bottom up, with a starting point of individual behavior that is drawn from empirical data and carefully tested using well-established statistical and econometric methods in order to allow for inference over truck drivers decision making strategies. By creating a microsimulation which simulates freight parking and movement as discrete events and implements realistic routes, the authors gain insight towards freight delivery behavior so that policy recommendations can be made.

Freight Microsimulation focuses on freight parking behavior, in this case the micro units correspond to truck drivers making deliveries in a congested urban area, and the framework is composed of a set of rules operating on a representative sample of these micro units. This behavioral model captures the decisions of truck drivers making deliveries regarding their parking practices, drawing from current theories found in the literature as well as interviews to subjects.

The set of rules captured are the basis of the framework presented in Figure 3. The framework is implemented as a computer code in Visual Basic, and has two main components: Scenario generation and Freight Microsimulation. The *scenario generation* draws from the input data characterizing the study area to estimate the freight trips that will arrive in the area on the simulated time period. As an input to the system, users must provide estimates of freight trip attraction and production of the study area by industry sector. The user can add this information as inputs or could use freight trip generation models previously calibrated by the authors in a separate project zip code and industry sector (Holguín Veras et al. 2015, Holguín-Veras et al. 2017) . *Freight Microsimulation* is a discrete event microsimulation, as simulation time increases, the agents (trucks) navigate the study area in predetermined delivery routes. At each simulation time interval, the agents make decisions about their next steps: whether they are navigating to a delivery stop, or they are parked conducting a delivery. Once a truck is near its destination they need to decide where to park according to the current conditions in the area. The parking decision function models the truck drivers' decision as a random variable and uses proximity to receiver as the main factor. The simulation framework has designated parking 'zones' that represent likelihood that a truck will park in regards to distance for each specific receiver.

Figure 3: Freight Microsimulation Framework



5. CASE STUDY

A case study area was selected in Midtown Manhattan, NYC to test the simulation framework developed. The area has been selected because of the presence of large freight traffic generators (LTGs), which include retailers, hotels, restaurants and mixed-use buildings among others. These LTGs are facilities housing businesses that individually or collectively produce and attract a large number of daily truck trips. These LTGs offer great opportunities for understanding the complexities of urban freight movement and the associated demand for parking, as they attract a wide variety of freight vehicles and have much larger volume of freight trips than other businesses.

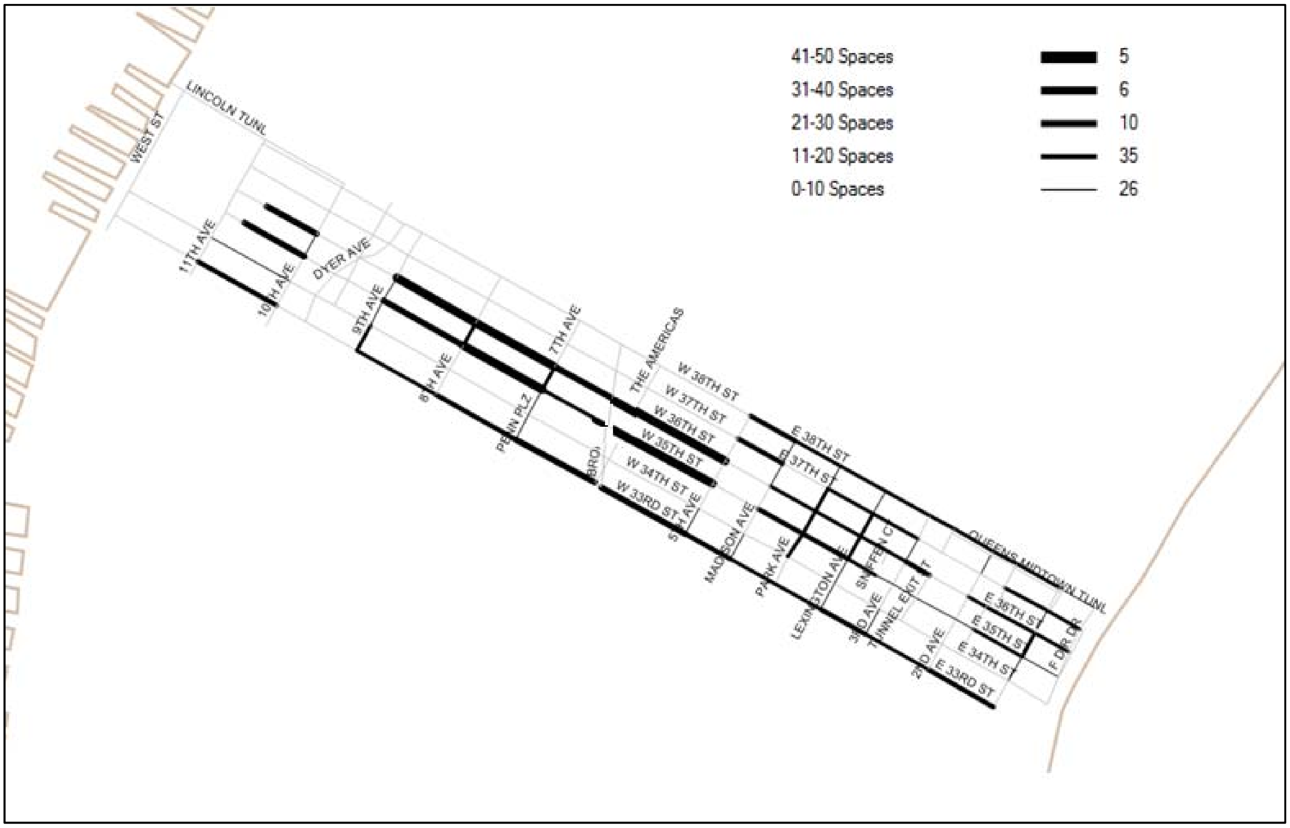
The study area selected, which is between 34th and 38th Streets in Midtown Manhattan is home to a large number of LTGs, as shown as red stars in the map shown in Figure 4. The estimated freight trip attraction of the businesses in the area attracts an estimated 7,915 daily freight trips (Jaller et al. 2015). To compound the parking situation, most of these establishments do not have sufficient loading areas to service all the trucks making deliveries. Thus, there is a high need of on-street parking for freight activity.

Figure 4: Location of large traffic generators in Manhattan

5.1 Data Collection

The team has conducted data collection efforts to characterize the study area. In this sense, information about parking availability and parking regulations was gathered. An inventory of on-street parking spaces was constructed by labeling each individual space in the study area, taking into account the geometric characteristics of each street and available information. The information was retrieved from NYCDOT's traffic sign database, STATUS, made available through the NYC Open Data Initiative. This database provides description, location and installation dates for DOT traffic signs (NYC Open Data 2015). Figure 5 shows the study area and parking capacity, which was validated through field trips to verify the information obtained in the database. The selected area has 103 parking spaces. As can be seen in the figure, there is not enough parking available for the need of this busy commercial district. In different trips made to the study area, the authors found that parking spaces available for freight use were occupied by service vehicles and construction equipment, further diminishing the availability of parking for freight vehicles.

Figure 5: Study Area in Lower Manhattan



5.1.1 Time Lapse Camera

The research team worked closely with NYCDOT to deploy 16 time lapse cameras at the locations shown in Figure 6. Once the sites were identified NYCDOT used bucket trucks to deploy the cameras on signal poles and other sign structures. The cameras collected a picture every thirty seconds, 24 hours a day for approximately one week in mid-August 2015. All of the cameras were deployed on the same day so uniform footage could be collected and compared. Information collected by the cameras allowed the team to identify the traffic flows in the study area together with parking times and parking violations. The analysis of this data was conducted by student interns at NYCDOT and complemented by undergraduate students at RPI. The analyses produced input parameters to be used in the simulation.

Figure 6: Map of Camera Locations

5.1.2 Truck Driver Survey

In order to accurately build the microsimulation model the team conducted in person and electronic surveys with truck drivers in the New York City area. To understand the behavior of the truck drivers and their parking choices a survey was designed to help model parking choices. It was found that the in person surveys were time consuming because it was difficult to find enough truck drivers willing to participate – even though there were plenty of trucks on the streets many of the drivers were inside the buildings making deliveries so they were not accessible. Also, the drivers were typically focused on making their deliveries and usually could not take five minutes to stop and answer questions. In one day a team of two researchers were able to conduct ten worthwhile driver surveys. These ten surveys did provide useful information to define the questions for the electronic survey. The team then carefully crafted an online survey which could target a greater number of drivers. The team incentivized the drivers to take the survey by offering them to be placed in a raffle to win $25 gift cards, roughly 1 in 5 participants would win a gift card upon successful completion of the survey. To disseminate this survey postcards describing the survey and the raffle were created and disseminated in person and online. The in person postcards were placed on trucks windshields or handed to drivers in the study area and the ones disseminated online were done by NYCDOT and trade groups such as the Trucking Association of New York (TANY). The handout can be seen in Appendix A. This handout contained links to the informational webpage. A screenshot of this webpage is shown in Appendix B, participants were given one month to complete the survey.

For the survey, scenarios were created with a combination of three variables and the participants were given three options to choose from as well as a box to enter another behavior. The three variables include the *time spent searching* for a parking spot, the *time it takes to walk* from the spot to the delivery point, and the *cost per hour* of parking (See Table 1). A total of 64 combinations of the scenarios were chosen to include in the survey. Though a factorial fractional design was used to select the subsets of eight scenarios asked to each respondent. Taking advantage of the target audience to gather more information, the survey also included questions about typical delivery aspects, especially to identify the key commodities transported to the area and background of the type of trucking company.

Table 2: Experimental Variables Used in Driver Survey

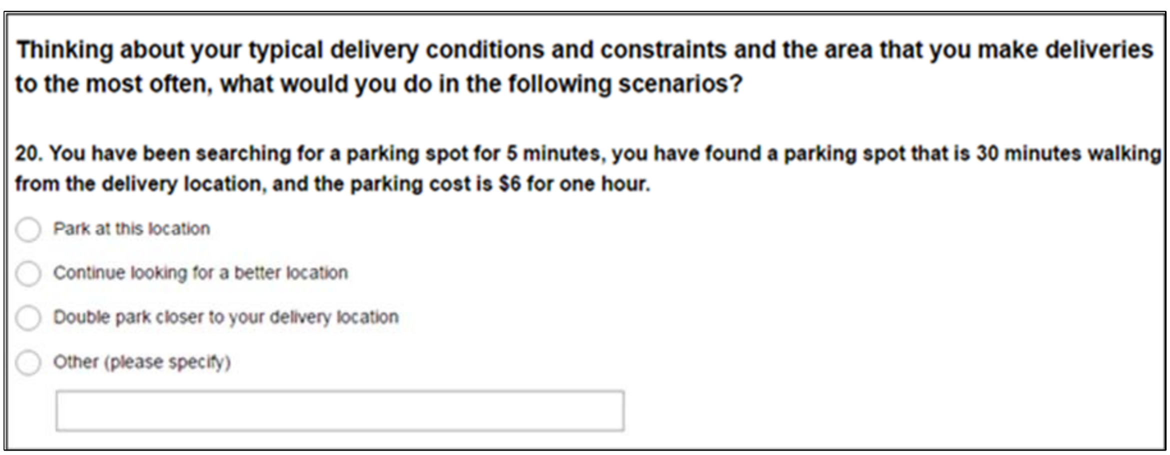
Searching Time (min)	Walking Time (min)	Cost ($/hour)
5	5	3
10	10	6
15	20	9
30	30	12

A distinction was made whether the survey responder was either a truck driver/assistant or a fleet manager/dispatcher. Based on the role, the wording of the survey was customized. The first set of questions gathered information about the company such as the number of vehicles owned and licensed drivers employed as well as the type of goods normally transported. Typical delivery start and end time, type of truck(s), number of deliveries per trip, and typical costs of parking tickets per day were asked. The typical minutes spent searching for a parking spot and walking to a delivery locations were included.

The next identifier for each participant is the usual start and delivery locations of their routes. If Manhattan was selected as the delivery destination then the responder was further asked to distinguish between Uptown, Midtown, and Downtown. Finally for each of these a list of all pertinent neighborhoods was given.

Due to the large number of scenarios the questions were split into eight segments of eight questions each. The scenarios were randomly distributed to the surveys. The scenario questions are stated as shown in Figure 7. In the survey the scenarios are displayed randomly to avoid any bias from the sorting of the questions. To assign the questionnaires to respondents an informational webpage was created to randomly link to the surveys.

Figure 7: Scenario Survey Question Example



Thinking about your typical delivery conditions and constraints and the area that you make deliveries to the most often, what would you do in the following scenarios?

20. You have been searching for a parking spot for 5 minutes, you have found a parking spot that is 30 minutes walking from the delivery location, and the parking cost is $6 for one hour.

- Park at this location
- Continue looking for a better location
- Double park closer to your delivery location
- Other (please specify)

A total of 24 respondents participated in the survey with an average of 3 responses per 8 scenario subset. We observed that several more participants initiated the survey but did not complete the questionnaire. In total, we received 18 complete responses that evaluate all the scenarios posed by the questionnaire.

The respondents consisted of 78% drivers and 22% fleet managers or dispatchers. The size of the businesses varied between 1 to 6000 vehicle operations. The average number of vehicles owned by the company for which the respondent worked for is 600, 8 of which have values less than 10. This clearly shows that a wide range of survey respondents were reached; some from small independent fleets and owner operators and others from large nationwide trucking companies.

The typical time spent looking for a parking spot, provided by 16 of the respondents, is an average of 24 minutes. The minimum is 3 minutes in Brooklyn, and the maximum of 60 minutes is in Midtown East, with an overall mode of 20 minutes. The walking distance to a delivery location, is an average of 10 minutes with a minimum of 0 in Brooklyn and max of 45 minutes in Queens. The typical time spent at a parking spot ranges from 10 minutes in Queens to "All Day" in the Financial District (Lower Manhattan). Excluding one outlier that responded "all day", the average time spent parking is 1.5 hours with a max of 5 hours in Midtown West.

Of these responses, the overwhelming majority (63%) of participants stated that their first option is to double park in the absence of parking, while (50%) selected to Double Park in front of the delivery location for every scenario given, regardless of whether there was parking availability nearby.

6. SIMULATION RESULTS

The simulation framework developed aims to replicate travel and parking behavior, which relies on driver behavior and its interaction with the infrastructure. The system was used to evaluate various parking policies. In this report we analyze the relationship between parking supply and three key variables of the freight system, these indicators are average search time, average walking distance and total network travel time; the simulation also considered double parking outcomes as it was shown in the survey that this is a common practice of drivers making deliveries in the area. Vehicle search time estimation starts when the vehicle enters a radius of 250 m (820.2 feet) of its destination, until the vehicle locates a parking spot or decides to Double Park. Walking distance is defined as the distance between the final destination of the delivery and the parking location. The desired outcome of policy intervention would be to lower the results of both measures because that would mean a more efficient use of the available infrastructure, and it would benefit all stakeholders. This section discusses the results of the parking policy scenarios assessed.

6.1 Key Assumptions

For all scenarios computed, trucks were randomly assigned between one and three deliveries to be made to different receivers in the study area. Parking spots are assumed to be 24 feet (.0073152km) and the receivers are all located in a 0.75km study area. The distribution of entering times for trucks was as follows: 22.5% of trucks deliver between 6 and 8am; 15% of trucks deliver between 8 and 10am; and another 12.5% of trucks delivered between 10am and Noon; 40% of the remaining population of trucks deliver between Noon and 10pm; the final 10% of trucks deliver between 10pm and 6am the next day.

6.2 Population of Carriers

In order to generate a population of carriers that serve the study area, the first step is to estimate the number of freight trips attracted by the receivers in the simulation. In this case, we have used Freight Trip Generation models that estimate freight attraction as a function of employment (Holguín-Veras et al. 2017). Data about employment was obtained from the US Census Bureau (U.S. Census Bureau 2016) for the study area.

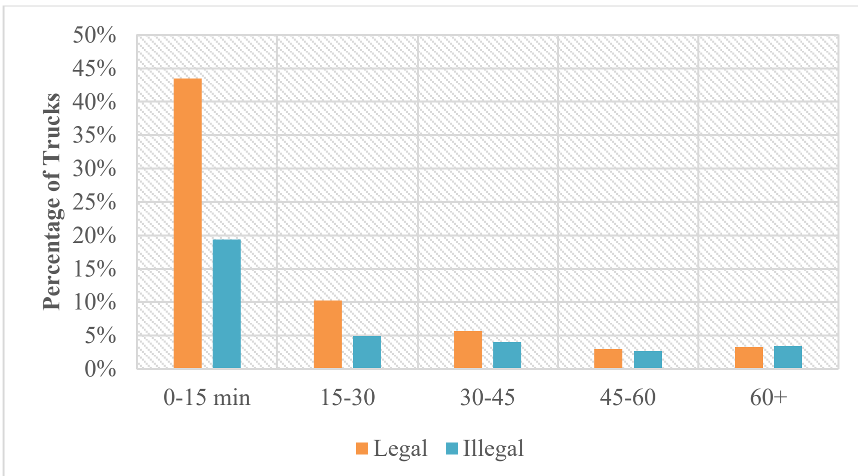
6.3 Results

In all, 7 scenarios are presented in this report. These scenarios evaluated the effects of changes in parking policies. The rest of this section provides detailed analysis of the results obtained and a summary table is presented at the end of this section.

6.3.1 Scenario 1: Current Conditions

The first scenario represents the base case conditions from the case study area, where the parking supply is not adequate for the demand. In this case, the results show that the average delivery time was 20 minutes per receiver, with most trucks that parked in a legal parking spot spend under 15 minutes searching for an available location. In all 34% of the trucks making deliveries in the area resorted to park illegally as there were no available spots for them to make their delivery windows.

Figure 8: Scenario 1 – Time Spent Looking for Parking



6.3.2 Scenario 2: Increased Parking Availability (5%)

In Scenario 2, parking supply was increased by 5%. In this case, the percentage of deliveries made legally increases while delivery time remains an average of 20 minutes per receiver. The averge walking distance per increases by 1 meter, as a consecuence of drivers double parking less, as vehicles who double decide to double park do so in the vecinity of the delivery location, while those that park legally need to find parking sports which are further away from their destination. This increase in parking supply results in a significant improvement in average search time, from 28 minutes in the base case to 11 minutes, deceasing by 61% in average.

Figure 9: Scenario 2 – Time Spent Looking for Parking (Min)

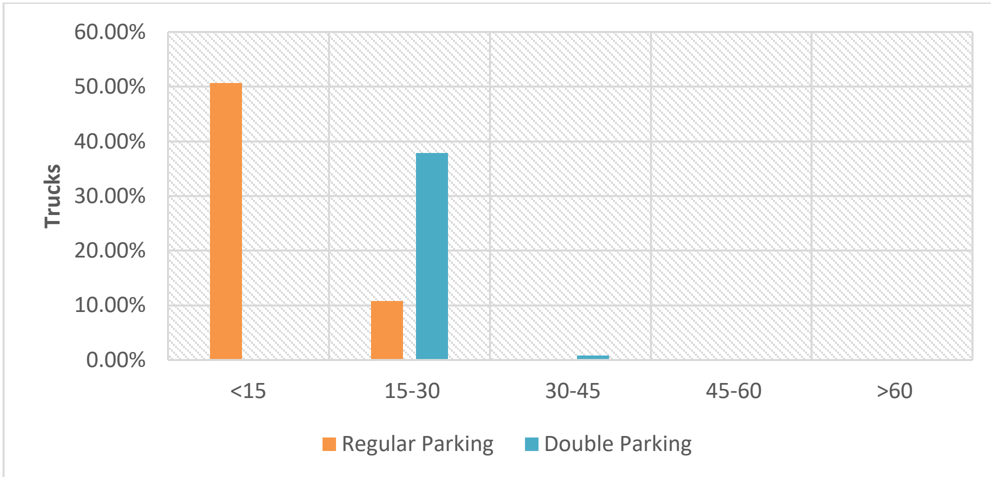
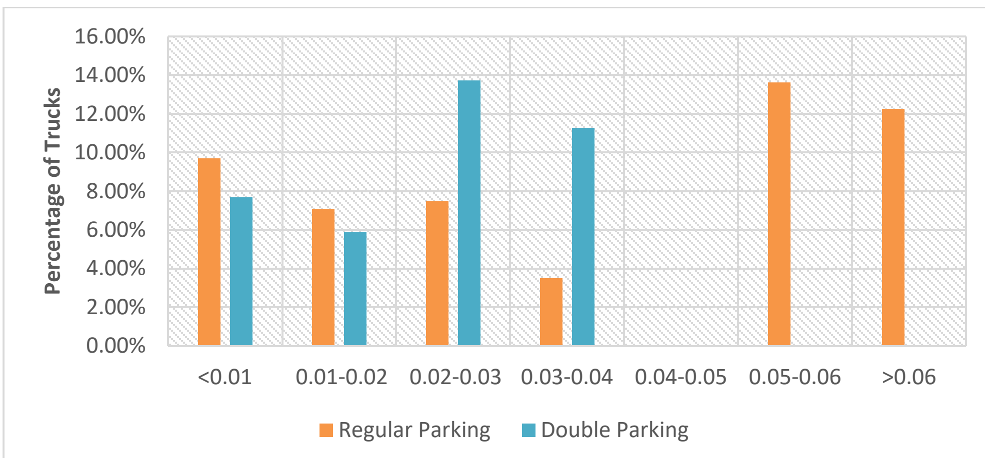


Figure 10: Scenario 2 – Distance Walked (km)



6.3.3 Scenario 3: Increased Parking Availability (10%)

In Scenario 3, the parking supply is increased again, this time by 10%. The results show that a 10% increase produced the same improvements as 5% increase in supply in terms of average search time, in this case trucks had to travel 16 minutes less than the best case in average. Walking times remained similar. However, the number of trucks that parked illegally decreased significantly, from 51% to 25% in this case.

Figure 11: Scenario 3 – Time Spent Looking for Parking (Min)

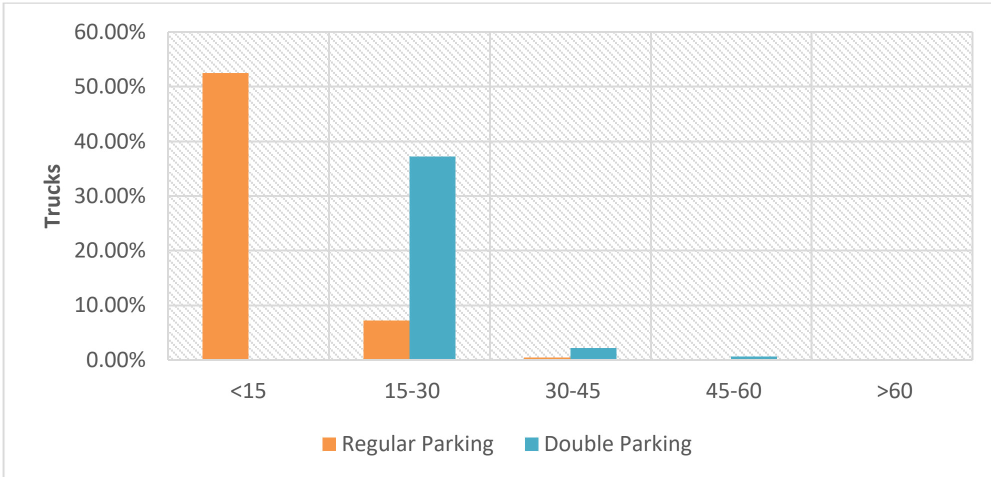
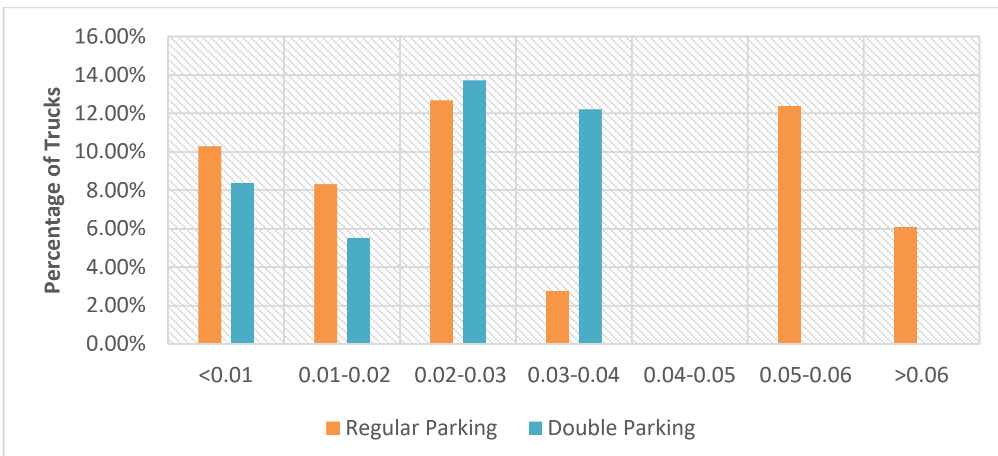


Figure 12: Scenario 3 – Distance Walked (km)



6.3.4 Scenario 4: Increased Parking Availability (+20%)

In Scenario 4, we evaluate an increase in parking supply by 20%. In this case, the percentage of deliveries made legally increases while delivery time remains an average of 20 minutes per receiver. The average walking time per receiver does not impove significantly, the main improvement is seen in in average search time, which decreases from 28 minutes in the base case to 10 minutes with the increase in supply. However, the incremental benefits are not significant from a 10% increase in supply. This is also the case from other performance measures, such as the percentage of trucks that double park and average walking distance, which suggests that there are no further improvements that justify more increase in supply.

Figure 13: Scenario 4 – Time Spent Looking for Parking (Min)

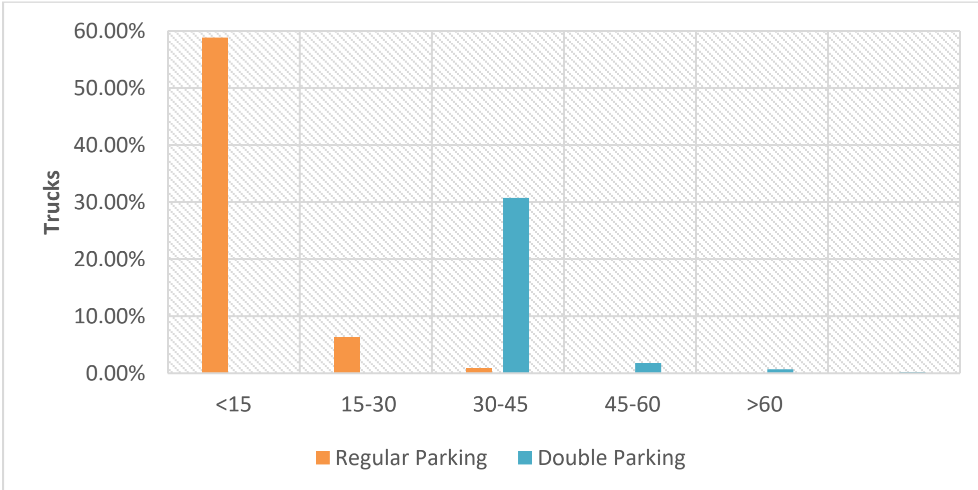
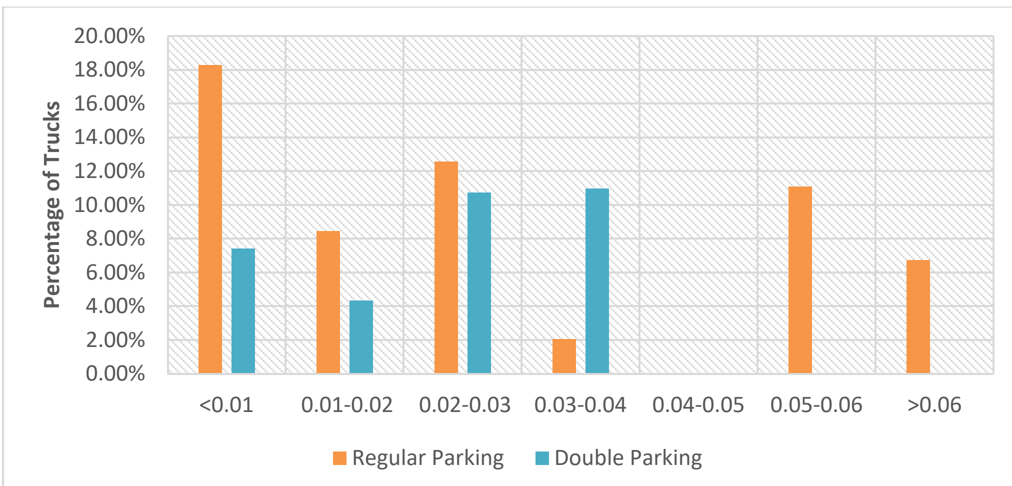


Figure 14: Scenario 4 – Distance Walked (km)



6.3.5 Scenario 5: Reduced Parking Availability (-10%)

In Scenario 5, we evaluate the effects of a diminished supply. The performance metrics show that a reduction of 10% in parking supply would increase the average search time on the study area by 3 minutes. While the percentage of trucks that park illegally is 30%, and the average walking distance would increase by 1 meter per delivery.

Figure 15: Scenario 5 – Time Spent Looking for Parking (Min)

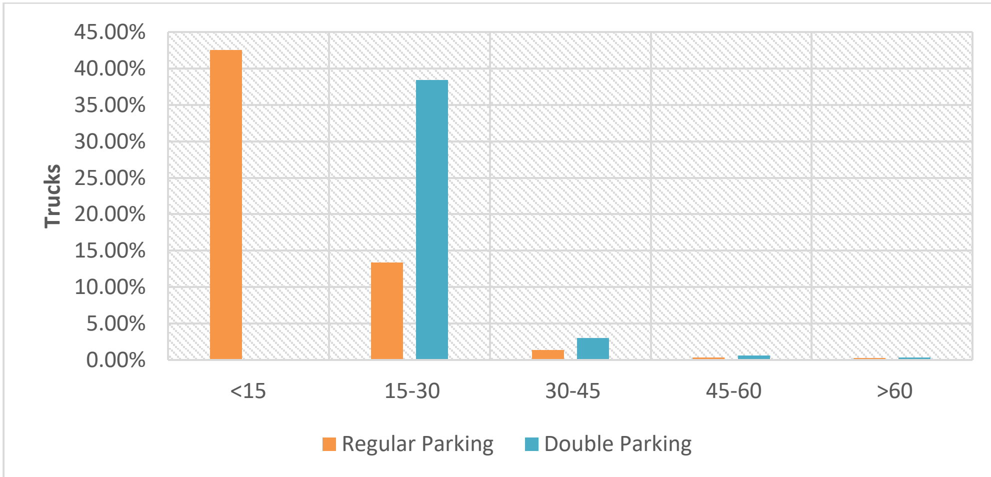
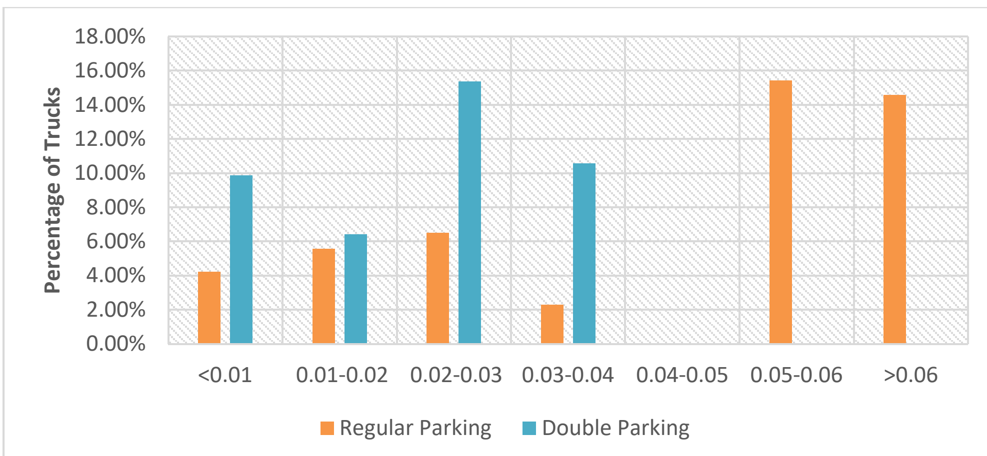


Figure 16: Scenario 5 – Distance Walked (km)



6.3.6 Scenario 6: Reduced Service Time

In Scenario 6, we evaluate the impacts of reducing the delivery time, or the time spent handling deliveries at the receiver by 10 minutes. Intuitively, the results show that this strategy would reduce the average dwell time of trucks and therefore make more spaces available, therefore, resulting in an average reduction of 15 minutes of search time. However, the number of trucks that decide to park illegally remains stable at 33%, as improving this outcome would require a more significantly increase in parking supply.

Figure 17: Scenario 6 – Time Spent Looking for Parking (Min)

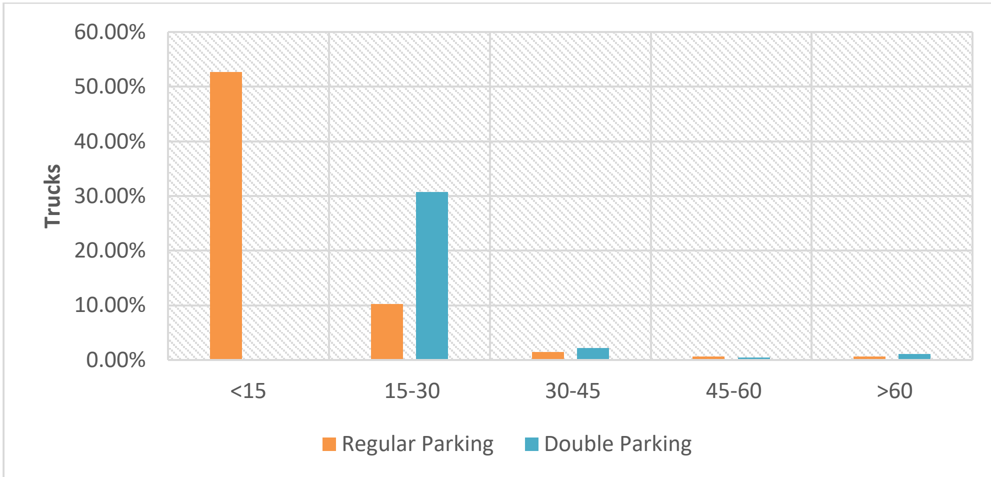
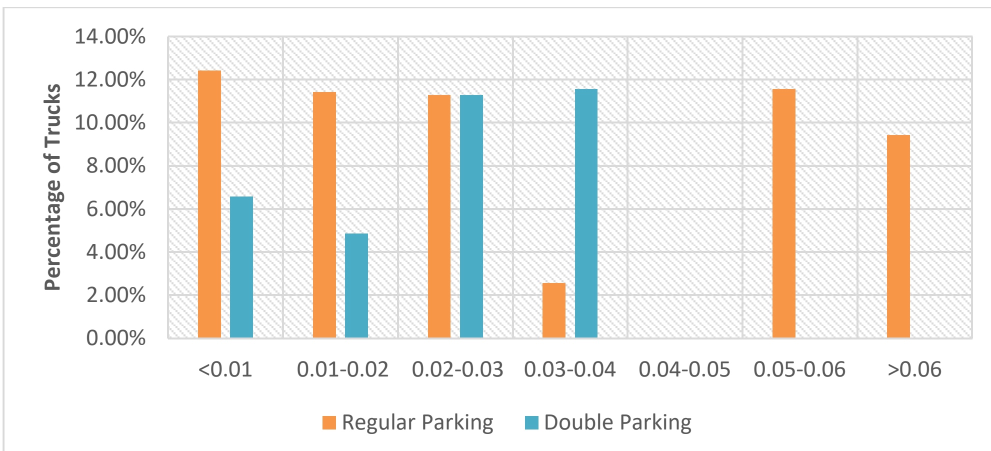


Figure 18: Scenario 6 – Distance Walked (km)



6.3.7 Scenario 7: Increased Service Time

In Scenario 7, we evaluate what would be the effect of increasing the delivery time by 10 minutes. In this case the average search time saw a dramatic increase of 27 minutes per delivery truck, and the number of trucks that parked illegally also increased to 39%. While the average distance walked did not increase significantly, the distance traveled in the study area nearly doubled, as this measure is correlated with average search time.

Figure 19: Scenario 7 – Time Spent Looking for Parking (Min)

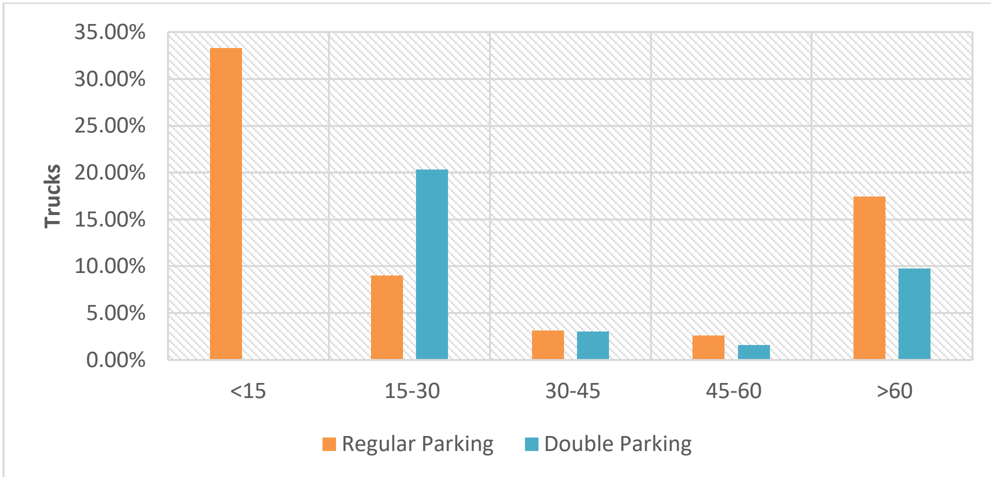
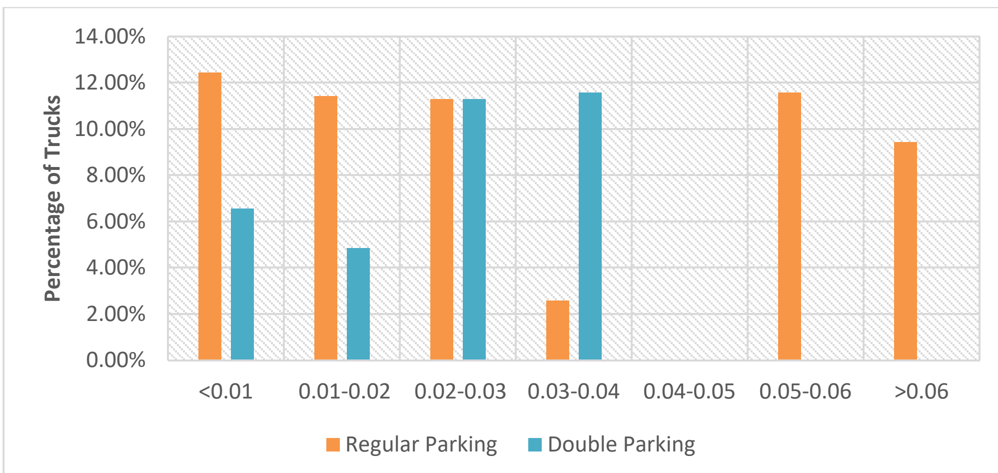


Figure 20: Scenario 7 – Distance Walked (km)



6.3.8 Summary of Findings

The scenarios evaluated in the simulation provided the following insights related to parking in the study area selected in New York City:

- Increasing parking supply can reduce average search time and reduces the number of trucks parked illegally. Different levels of increases in parking availability were tested and it was found that 5% produces the most significant leap in terms of reduction of average search time, decreasing this metric by 61% from the base case, while a 10% and 20% increase in supply only produce minimal improvements of 1-2% over the original 5% increase.
- Reducing the delivery time can also have significant effects on average search time, a 10% reduction in delivery time can yield up to 55% reduction of average search time.
- Conversely, increasing delivery times by 10% was shown to be the most impactful factor, resulting in an increase of average search time of 200% as well as an increase of the number of trucks that park illegally by 15%.

- The interventions evaluated did not have much effect in average walking time, upon further analysis this is due to the fact that there is a large number of trucks that still opt to park illegally in close proximity to their delivery location. While average results do not show much improvement, the range of distances walked can be reduced by up to 15% from increased parking supply or reduced delivery times.

Summary statistics for the results of each of the seven scenarios are summarized in Table 3.

Table 3: Summary Statistics of Simulation Results

Scenario	Performance Measure	Unit	Average	Std Dev	Min	Max
Scenario 1	Distance Traveled in the Study Area	Km	1.19	1.62	12.77	0
	Search Time	Minutes	27.08	36.83	291	0
	Distance Walked per Delivery	Km	0.03	0.02	0.11	0
Scenario 2	Distance Traveled in the Study Area	Km	0.47	0.38	0	1.62
	Search Time	Minutes	10.62	8.67	0	36.83
	Distance Walked per Delivery	Km	0.04	0.03	0	0.11
Scenario 3	Distance Traveled in the Study Area	Km	0.48	0.44	0	3.05
	Search Time	Minutes	10.93	9.94	0	69.5
	Distance Walked per Delivery	Km	0.03	0.02	0	0.11
Scenario 4	Distance Traveled in the Study Area	Km	0.44	0.46	3.13	0
	Search Time	Minutes	10	10.43	71.3	0
	Distance Walked per Delivery	Km	0.03	0.02	0.11	0
Scenario 5	Distance Traveled in the Study Area	Km	0.58	0.49	0	3.84
	Search Time	Minutes	13.21	11.19	0	87.5
	Distance Walked per Delivery	Km	0.04	0.03	0	0.11
Scenario 6	Distance Traveled in the Study Area	Km	0.53	0.61	0	4.62
	Search Time	Minutes	12.19	13.82	0	105.33
	Distance Walked per Delivery	Km	0.03	0.02	0	0.11
Scenario 7	Distance Traveled in the Study Area	Km	2.38	3.4	0	23.23
	Search Time	Minutes	54.16	77.52	0	529.17
	Distance Walked per Delivery	Km	0.03	0.02	0	0.11

7. CONCLUSIONS AND RECOMMENDATIONS

Drivers of commercial vehicles often find that making deliveries in metropolitan areas is a major challenge because of congestion and the lack of parking space. Many commercial vehicles thus have to circle around the delivery location, producing negative externalities such as congestion, emissions, and traffic safety issues. This research investigates freight parking behavior in urban environments, with particular focus on the challenges faced by freight traffic making deliveries in a study area in New York City. The research conducted extends the literature by evaluating performance metrics of freight parking such as walking distance and parking search times that are not commonly found in the literature. The project has developed a behavioral microsimulation tool that captures the decisions made by freight carriers in terms of parking choice, and can be easily adapted to other urban areas providing appropriate data of parking availability and freight trip generation.

The results of the simulation provided the following insights related to which parking policies could be implemented to improve freight parking. While increased parking supply is not an easy feat, this would be a very effective policy that can decrease the average search time of trucks by 61%, shaving an average of 16 minutes of travel time off per delivery. This change would have important effects not only on freight traffic but also on other users of the transportation network. From the fieldwork conducted by the authors, it is clear that the current parking inventory is not utilized in the most efficient manner, and there are various avenues by which more supply could be added to the existing parking availability, such as adding more freight parking spaces in alleyways, or the implementation of the delivery time windows as a way to better manage the existing infrastructure and provide the additional number of spaces needed.

Another relevant result showed that service times have a significant impact on the performance of the freight system. The analyses show that a decrease of 10% in the delivery time can yield up to 55% reduction of average search time, and the results are also relevant the other way around, as an increase of delivery times by 10% results in a 200% increase of search time in average. These results highlight the important role that receivers play in the performance of urban freight systems. Therefore, policy interventions that engage receivers along with other stakeholders, and target better freight demand management practices such as receiver led consolidation, can show significant benefits.

The research has tested several policy scenarios, and the practical implications of parking supply management is discussed. The results obtained help provide a better understanding of the need of freight parking and the policy alternatives available to improve the efficiency of urban freight systems. This research could be further extended to evaluate the effectiveness of other parking policies such as parking information systems and pricing strategies, by collecting data about price or prior knowledge of parking availability. Other initiatives such as off-hour deliveries (OHD) can play a key role in reducing the parking demand during the day hours and improving the system performance for all users by reducing the number of legally and illegally parked trucks. In most cases deliveries during the off-hours can be done at the curb and in front of the final delivery location. Fostering sustainable delivery, such as properly designed transfer facilities that allow deliveries to be made via cargo bikes and handcarts, provides a promising solution to the parking problem. However, these modes could have a limited distance range, limited capacity and need space to transfer goods. Both in New York City and in other cities worldwide it is necessary to develop parking policies that consider the importance of delivery vehicles and allow goods to be moved with fewer negative implications.

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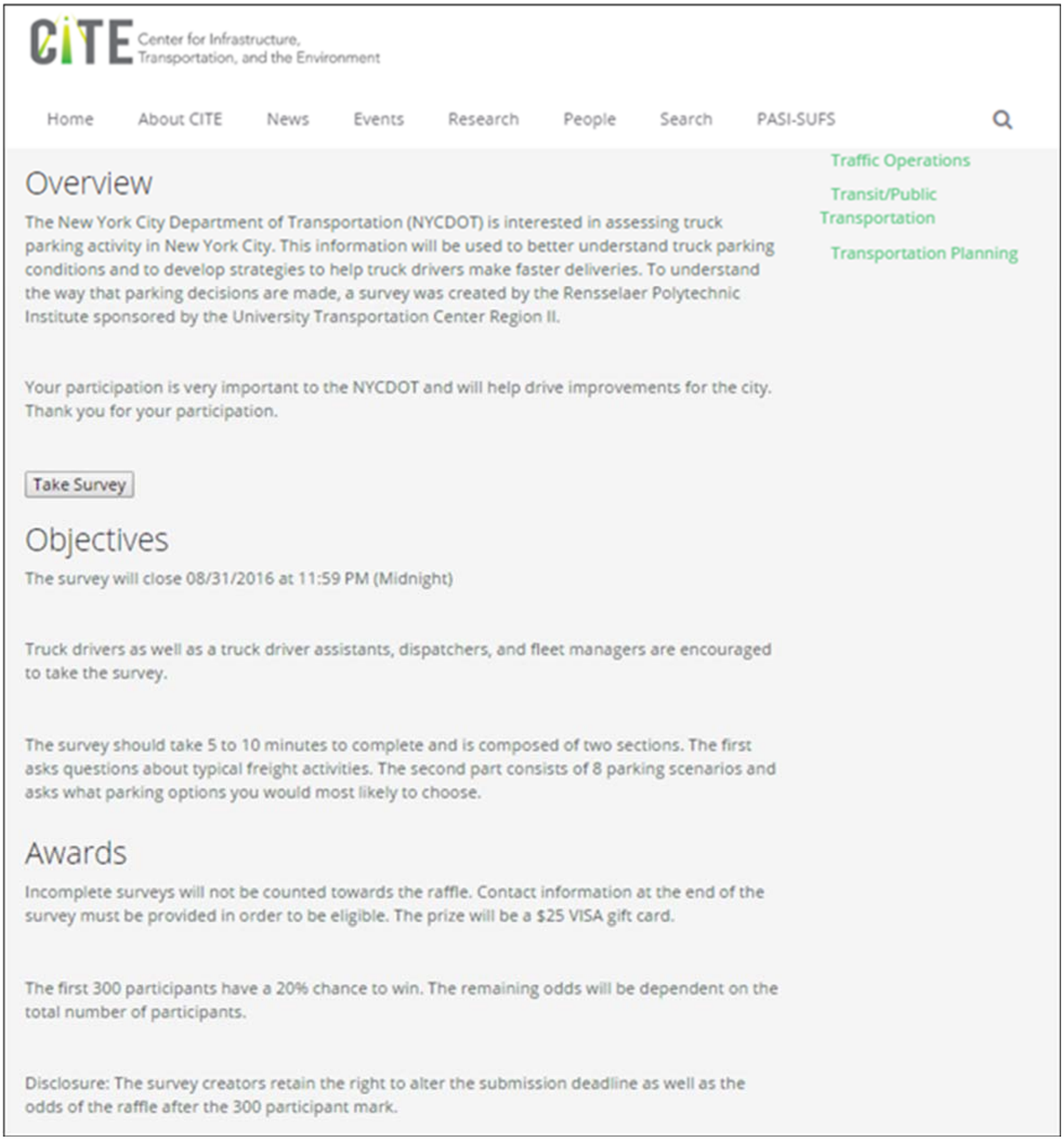
APPENDIX

A. Handout Parking Survey

B. Survey Website



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Overview

The New York City Department of Transportation (NYCDOT) is interested in assessing truck parking activity in New York City. This information will be used to better understand truck parking conditions and to develop strategies to help truck drivers make faster deliveries. To understand the way that parking decisions are made, a survey was created by the Rensselaer Polytechnic Institute sponsored by the University Transportation Center Region II.

Your participation is very important to the NYCDOT and will help drive improvements for the city. Thank you for your participation.

Take Survey

Objectives

The survey will close 08/31/2016 at 11:59 PM (Midnight)

Truck drivers as well as a truck driver assistants, dispatchers, and fleet managers are encouraged to take the survey.

The survey should take 5 to 10 minutes to complete and is composed of two sections. The first asks questions about typical freight activities. The second part consists of 8 parking scenarios and asks what parking options you would most likely to choose.

Awards

Incomplete surveys will not be counted towards the raffle. Contact information at the end of the survey must be provided in order to be eligible. The prize will be a $25 VISA gift card.

The first 300 participants have a 20% chance to win. The remaining odds will be dependent on the total number of participants.

Disclosure: The survey creators retain the right to alter the submission deadline as well as the odds of the raffle after the 300 participant mark.

http://cite.rpi.edu/en/project-categories-2/freight-transportation/item/parking

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