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Commercial Vehicle Parking in Downtown Seattle: Insights on the Battle for the Curb

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Abstract

Rapid urban growth puts pressure on local governments to rethink how they manage street curb parking. Competition for space among road users and lack of adequate infrastructure force delivery drivers either to search for vacant spaces or to park in unsuitable areas, which negatively impacts road capacity and causes inconvenience to other users of the road. The purpose of this paper is to advance research by providing data-based insight into what is actually happening at the curb. To achieve this objective, the research team developed and implemented a data collection method to quantify the usage of curb space in the densest urban area of Seattle, Center City. This study captures the parking behavior of commercial vehicles everywhere along the block face as well as the parking activities of all vehicles (including passenger vehicles) in commercial vehicle loading zones. Based on the empirical findings, important characteristics of Seattle's urban freight parking operations are described, including a detailed classification of vehicle types, dwell time distribution, and choice of curb use for parking (e.g., authorized and unauthorized spaces). The relationship between land use and commercial vehicle parking operations at the curb is discussed. Seattle's parking management initiatives will benefit from the insights into current behavior gained from this research.

Rapid urban growth, increasing demand, and higher customer expectations have amplified the challenges of urban freight movement. Finding an adequate space to park can be a major challenge in urban areas. For commercial vehicles used for freight transportation and provision of services, the lack of parking spaces and parking policies that recognize those vehicles' unique needs can have negative impacts which affect all users of the road and particularly the drivers of these commercial vehicles (*1–4*).

The curb is an important part of the public right-of-way. It provides a space for vehicles to park on-street; for delivery vehicles (i.e., cargo bikes, cargo vans, and trucks), in particular, it also provides a dedicated space for the loading and unloading of goods close to destinations. Hence it is a key asset for urban freight transportation planning which local governments can administer to support delivery and collection of goods.

According to Marcucci et al. (*5*), the development of sustainable management policies for urban logistics should be based on site-specific data given the heterogeneity and complexity of urban freight systems. Current loading/unloading parking policies include time restrictions, duration, pricing, space management, and enforcement (*6, 7*). However, as Marcucci et al. pointed out after an extensive review of the literature on freight parking policy, the quantification of commercial vehicle operations on the curb to inform policy decision making is nonexistent (*5*). Therefore, local governments often lack data about the current usage of the curb and parking infrastructure, which is necessary to evaluate and establish these policies and therefore make well-informed decisions regarding freight planning, especially in dense, constrained urban areas.

Given the importance of the curb as an essential piece of the load/unload infrastructure, this paper investigates what is actually happening at the curb, developing an evidence-based understanding of the current use of this infrastructure. The research team developed and applied a systematic data collection method resulting in

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empirical findings about the usage of public parking for loading and unloading operations in the Seattle downtown area.

This research documents and analyzes the parking patterns of commercial vehicles (i.e., delivery, service, waste management, and construction vehicles) in the area around five prototype buildings located in the Center City area. The results of this research will help to develop and inform parking management initiatives.

The paper includes four sections in addition to this introduction. The second section discusses previous freight parking studies and the existing freight parking policies in cities, and explores which of these approaches are being used in Seattle. The third section proposes a data collection method to document freight-related parking operations at the curb though direct observations. The fourth section provides empirical findings from data collection in Seattle. The fifth and last section includes a discussion of the findings and concluding remarks.

Literature Review

On-street parking is a scarce resource in urban areas, with many competing demands for its use. Many studies describe how competition for space among road users and lack of adequate infrastructure force drivers either to search for vacant spaces (adding time to the delivery route) or to park in unsuitable areas (negatively affecting road capacity and causing inconvenience to other users of the road). Both behaviors lead to congestion, safety issues, and conflicts between modes (*1–3, 8*).

On-street parking is often the focus of parking policies where there is not ample supply to fulfill demand. Parking policy relates to the management of the price, supply, duration, and location of parking to enhance the urban environment (*6*). Specific to urban freight parking, Nourinejad et al. categorize the main vehicle parking policies as follows (*7*):

1. Time restrictions
2. Pricing strategies
3. Land use and space management
4. Parking enforcement

Alternatively, off-street parking policies generally focus on setting a rate (parking spaces per activity level) at which parking should be provided (*6*). A surrogate measure of activity (e.g., floor area, type of commercial activity, number of employees, etc.), which is relatively easy to measure, is used to calculate the number of required parking spaces. However, this approach is limited for both on- and off-street load/unload infrastructure because, as research suggests, the relationship between these measures and the demand for parking is not constant.

For example, Cherrett et al. (*9*) and Muñuzuri et al. (*10*) discussed the relationship between the floor area of retailers and the quantity of freight traffic (*9, 10*). Both found that larger retailers do not always generate the greatest quantity of freight traffic. More specifically, Muñuzuri et al. claimed that larger establishments receive more freight per delivery but not more deliveries per day (*10*).

Moreover, Pierce and Shoup (*11*) estimated price elasticity of parking demand based on the results of the curb management system SFPark in San Francisco, CA—a demand-based pricing system which adjusts prices based on occupancy of curb meter parking without distinguishing between commercial and passenger vehicles (*11*). Treating these two users of the curb equally may not be the correct approach, however. As the San Francisco County Transportation Authority report indicates "while demand for parking is variable and drivers can switch travel patterns or modes if parking is not readily available, commercial loading demand is more likely to remain constant regardless of the supply of loading zones because few alternatives exist to truck or other deliveries" (*12*).

In an effort to overcome the lack of empirical evidence about commercial vehicle parking behavior, a few studies have documented unauthorized behavior. For example, Jaller et al. documented parking operations of 374 commercial vehicles in Midtown, New York City, and found that almost one quarter occurred in unauthorized parking areas, including not paid/expired parking meter, blocking a fire hydrant, and double parking (*4*).

Richards (*13*) described how the Washington DC Department of Transportation used data to support the implementation of a commercial vehicle loading zone (CVLZ) management program and a new regulation which required commercial vehicles to display annual or daily passes to park. By using data from pay-by-phone transactions of meter parking for trucks, this research documented the ratio of truck transactions versus unauthorized users' transactions. Additionally, the research team used parking citations to document aggregate trends of parking violations including double parking, overstays of parking stall time, and non-truck parking in load zones. They found that between Monday and Friday approximately half of the pay-by-phone transactions in loading zones were done by unauthorized users instead of trucks.

Seattle Context

Seattle's curb regulations consider "load zones" as the type of curb that provides areas solely for loading and

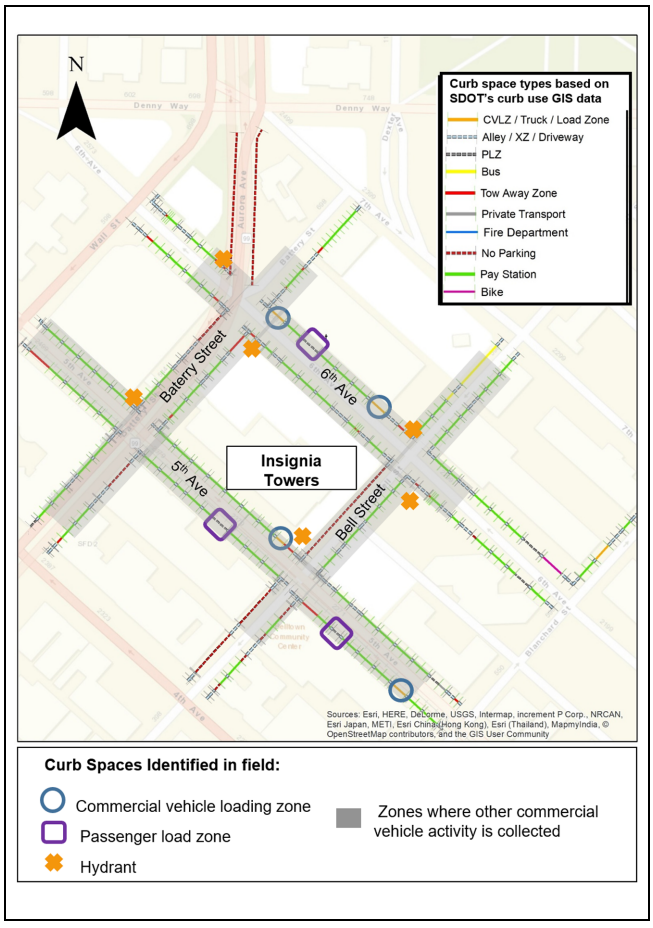


Figure 1. Insignia Towers building study area in downtown Seattle.

unloading people and goods and should not be used for parking. "Passenger load zones" (PLZ) are allocated for quick passenger drop-off and pick-ups and the driver should remain in the vehicle. Load zones for commercial vehicles include two types of spaces (*14*):

- Truck-only load zone: Areas restricted to vehicles licensed as trucks for either delivery or pick-up of products, merchandise, or other commodities.
- CVLZ: Established in Seattle in 1989, their purpose is to provide space for service delivery vehicles with a 30-min limit.

For CVLZs in particular, permits are required for use. The Seattle Department of Transportation (SDOT) is the institution that manages and issues permits for CVLZ use. According to SDOT, an average of 4,000 CVLZ permits are issued per year (*15*).

Off-street freight load/unload parking requirements consider three categories of loading demand based on land use: high, medium, and low demand, and have a different set of thresholds and requirements for the number of loading zones depending on the demand category (*16*). Width requirements for parking spaces are segmented according to demand and the largest weekly delivery truck.

Regarding curb parking operations in Seattle, since 2010 SDOT has collected and reviewed occupancy data on all paid parking areas in the city, which is, to the extent of the authors' knowledge, the only quantitative initiative to measure parking operations at the curb in Seattle. The data is used to set and adjust on-street parking rates and hours through the Performance-Based Parking Pricing Program. This data-driven approach uses the principles of supply and demand to help ensure the city's goals of one to two spaces available per block (*17*); but has the limitation that it only applies to paid parking locations, and monitoring is applied to commercial vehicles and other curb users without distinction.

Data Collection Method

The research team developed a data collection method to record the type of vehicle and type of curb where the vehicles were parking with a reasonable level of accuracy and detail in a defined three-by-three city block grid. The data collected gave researchers data-based evidence of commercial vehicle parking patterns anywhere along the curb (i.e., where and how long they parked on the curb); and an understanding of how the CVLZs were used by any type of vehicle for five different three-by-three city block grids.

Because of the challenges of street visibility and the complexity of vehicle and behavior studies, the curb observation study involved the use of human observers to collect data in the field. The researchers designed a "position" system for collecting data. Positions are fixed locations which provide the data collector with a clear view to record each parking operation of interest on his/her assigned area meeting the time precision defined in the study. From their positions, data collectors monitored a number of CVLZs, PLZs, hydrants, and other zones (e.g., travel lanes) where unauthorized commercial vehicle parking behavior might occur (such as double parking).

Data collectors recorded:

- The start and end parking time of vehicles in each curb space or area
- Location where the driver parked
- The vehicle type

An initial field assessment of the study area was necessary to define the configurations of the positions. Figure 1 shows the size of the study area surrounding one of the prototype buildings as an example. The

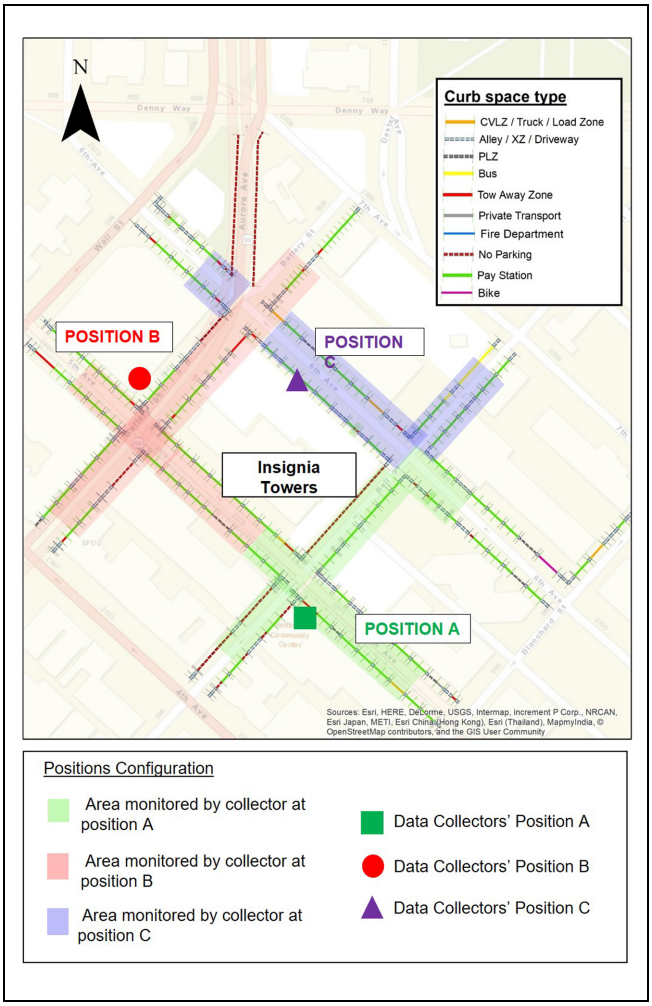


Figure 2. Positions of data collectors at Insignia Towers building study area.

number of positions in a study area will depend on the size of the area, the configuration of the urban environment, and the precision required for the study. Position maps and data collection forms were prepared for each position. The data collection forms are spreadsheets structured with the curb spaces and zones to be monitored. The curb spaces and zones in the spreadsheet are ordered to allow an easy scan of the area by the data collector and are color-coded to facilitate their localization in the position layout map.

During the development of the method, researchers ran a pilot survey to test the position maps and data collection forms for reliability. After running the pilot, the research team decided to implement the survey with hard copies of spreadsheets. Using hard copies proved to be a faster and more efficient method than using electronic devices. This allowed the research team to cover a larger area with the defined time precision for this study (i.e., 1 min for all vehicles observed).

During the implementation of the method, the team tested various position configurations to determine which would enable collectors to collect the needed information reliably within a 1-min interval. Based on the field pilot results, the researchers created up to four positions for each building for a total of 14 positions across all the study areas. Figure 2 shows one of the study areas (i.e., Insignia Towers) curb space map with three positions.

Vehicle Typology

The research team designed a detailed vehicle typology to track specific vehicle categories consistently and accurately. The typology covers a wide range of vehicle types that can load/unload at the curb and is based on prior fieldwork and knowledge of curb and alley operations in the downtown Seattle area. (see Table 1).

For this research, the commercial vehicles of interest included trailers, box trucks, cargo vans, cargo bikes, service vehicles, waste management trucks, and construction vehicles. When there was not enough information visible to classify a van as cargo or service (e.g., business logo), it was classified as general van. Passenger vehicles with commercial permits were not distinguished from those without a permit.

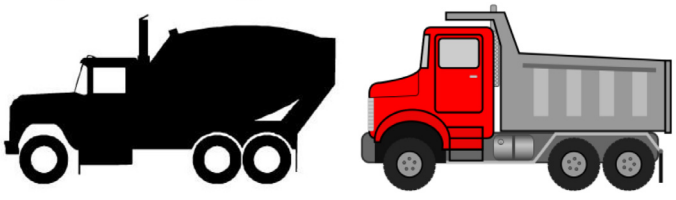
Additionally, this paper uses the term "delivery vehicle" to group commercial vehicles used by carriers to transport and deliver different types of commodities (i.e., trailer trucks, box trucks, cargo vans, and cargo bikes). Although, passenger vehicles are also used for delivery of goods (e.g., Uber Eats, Amazon Prime Now, Amazon Fresh), these activities were not recorded as commercial vehicle activities.

Seattle Case Study

The research team conducted the curb occupancy study in five different areas of downtown Seattle with different combinations of land uses, see Figure 3. The areas studied surround five prototype buildings preselected and studied in previous research on urban goods delivery (*18*). The preselected buildings represent five archetypes: a hotel (Four Seasons Hotel), a high-rise office building (Seattle Municipal Tower), a historical building (Dexter Horton), a retail center (Westlake Center), and a residential building (Insignia Towers). These buildings were intentionally chosen to deepen the understanding of the urban goods delivery system in Center City.

The objective of choosing the same locations was to provide a new layer of information about how the freight infrastructure network is being used. This additional layer of information constitutes a further step to build a comprehensive picture of loading/unloading operations based on the features of the locations served.

Table 1. Types of Vehicles

Commercial vehicles	
Delivery vehicles Trailer truck	
Single unit truck—box truck	
Cargo van	
Cargo bike	
Waste management trucks	
Service vehicles[a]	
General van[b]	
Construction vehicles	

(continued)

Table 1. (continued)

Other categories	
Passenger vehicles	
Taxi	
Motorcycle	
Buses	
Emergency vehicles	

[a]Service vehicles include vans and pick-up vehicles used for service operations.
[b]Cargo or service vans usually display a business logo. If there was not enough information visible, vehicle was marked as a general van.

Study Parameters

Based on the project scope and in-field assessment of the areas surrounding the prototype buildings, the research team defined a three-by-three city block grid around each area because delivery vehicles need to park close to the delivery address. It was assumed that they would not park more than one block away from the delivery address. Block faces in downtown Seattle are typically between 300 and 400 feet long.

The research team conducted an inventory of the CVLZs and PLZs that serve each of the five prototype buildings. Additionally, since commercial vehicle parking operations could also take place outside of the CVLZs and PLZs, the database included, to the extent possible, areas where parking operations might occur, such as travel lanes, bus lanes, curb segments close to hydrants, tow-away-zones, and on-street meter parking.

Table 2 shows the total length and number of CVLZs and PLZs in each building area during the data collection effort.

Study Sample

The research team deployed six data collectors working to observe each study area for three days over roughly six weeks in October and December 2017. The five locations were monitored during three weekdays for between four and eight hours per day. Between the five study locations, 1,816 parking operations by all vehicles parked in CVLZs and all commercial vehicles in the five study areas were observed. A total of 1,254 commercial vehicles were observed, 382 of which were parked in CVLZs and 872 were parked outside of CVLZs. An additional 562 non-commercial vehicles were parked in CVLZs, making a total of 948 parking operations observed in CVLZs.

Findings

Finding 1: Commercial Vehicles Are Parking outside of CVLZs. While commercial vehicles did park in CVLZs (35%), across all study areas an average of 40% of

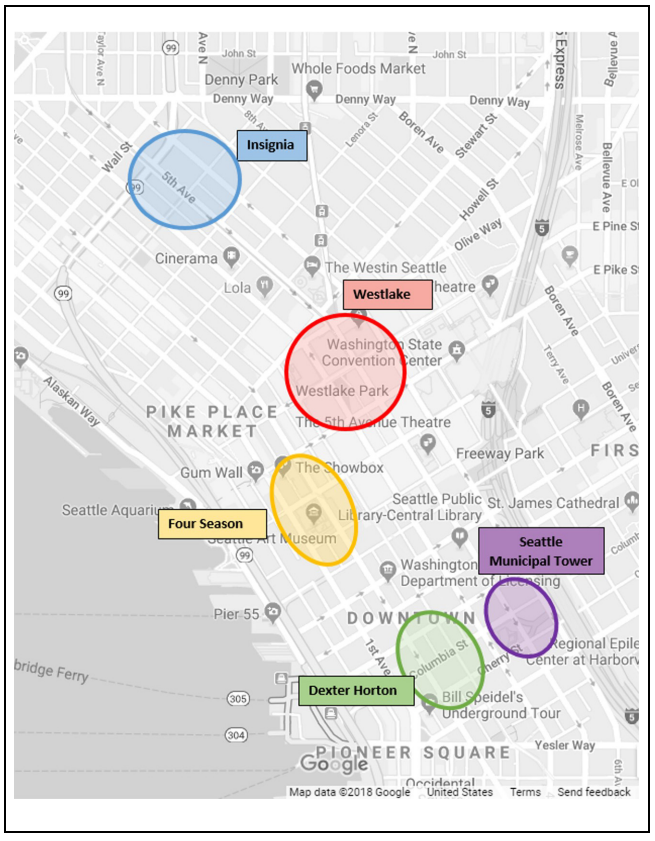


Figure 3. Study areas in downtown Seattle.

commercial vehicles (with delivery vehicles constituting the biggest share) parked in unauthorized locations. These results are detailed in Table 3.

Observed unauthorized behavior included double parking, and commercial vehicles parked in PLZs, bus lanes, tow-away zones, and no-parking zones. Commercial vehicles parking in PLZs (26%) was the largest category of unauthorized commercial vehicle behavior. Delivery vehicles represent the largest share of these commercial vehicles (18%). Additionally, 22% of commercial vehicles (with service vehicles constituting most of those commercial vehicles) chose to park in metered parking spaces, which is considered an authorized space to park.

Finding 2: Commercial and Passenger Vehicle Drivers Use CVLZs and PLZs Fluidly. Passenger vehicles made up more than half of all vehicles observed stopped in CVLZs (52%). Delivery vehicles made up just 26% of all vehicles parked in CVLZs; see the pie chart in Figure 4. This finding suggests that commercial and passenger vehicles use marked load/unload spaces fluidly.

It is worth noting that Seattle parking policies allow passenger vehicles to hold commercial vehicle permits. This study does not distinguish between passenger vehicles with or without permits, however.

Finding 3: Most Commercial Vehicle Demand Is for Short-Term Operations, but Some Commercial Vehicles Clearly Need Longer Parking at the Curb. Across all study areas and curb uses, more than half (54%) of all commercial vehicles parked for 15 min or less. Furthermore, one third of all observed commercial vehicles were delivery vehicles parked for 15 min or less. Nearly one-third (28%) parked for 30 min or more, with service vehicles being the largest share of commercial vehicles parking at the curb for 30 min or longer (16% of all observed commercial vehicles). See Table 4.

Most vehicles parked in CVLZs for short-term operations. Across all vehicles, 63% parked for 15 min or less;

Table 2. Distribution of CVLZs and PLZs by Building Area

Building area	Overall land use	Times of day	Total length of CVLZs (ft)	Count of CVLZs	Total length of PLZs (ft.)	Count of PLZs
Four Seasons Hotel and Harbor Steps Area	Hotel, retailers, art museum, restaurants and residential buildings	8:30 to 12:30 a.m.	197.3	6	424.8	13
Seattle Municipal Tower	Offices and government offices	9:00 a.m. to 1:00 p.m.	258.9	4	267.4	5
Dexter-Horton	Offices and hotels	One day from 8:00 a.m. to 12:00 p.m. Two days from 8:00 a.m. to 1:00 p.m.	643.4	17	525.3	9
Westlake Center	Retail center, hotel, commercial and office buildings	8:00 a.m. to 12:00 p.m.	90.7	3	370.7	6
Insignia Towers	Residential and university buildings	8:30 a.m. to 4:30 p.m.	117.3	4	88.8	3

Note: CVLZ = commercial vehicle loading zone; PLZ = passenger load zones.

Table 3. Where Are Commercial Vehicles Parking across Study Areas?

Commercial vehicle type	Number of vehicles observed	CVLZ	PLZ	Meter parking	Other unauthorized parking	Other		Total share of parked vehicles
Delivery vehicles (trucks, cargo vans and cargo bikes)	694	19.7%	17.8%	8.1%	9.0%	0.5%	0.3%	55.3%
Service vehicles	456	11.3%	7.3%	12.0%	3.5%	1.3%	0.9%	36.4%
General vans	81	3.5%	1.2%	1.0%	0.6%	0.2%	-	6.5%
Other commercial vehicles (including garbage trucks, construction vehicles)	23	0.1%	-	0.3%	0.4%	0.2%	0.8%	1.8%
CV parked by type of curb use	1254	34.6%	26.3%	21.4%	13.6%	2.2%	2.0%	100.0%

Note: CVLZ = commercial vehicle loading zone; PLZ = passenger load zones; CV = commercial vehicles.

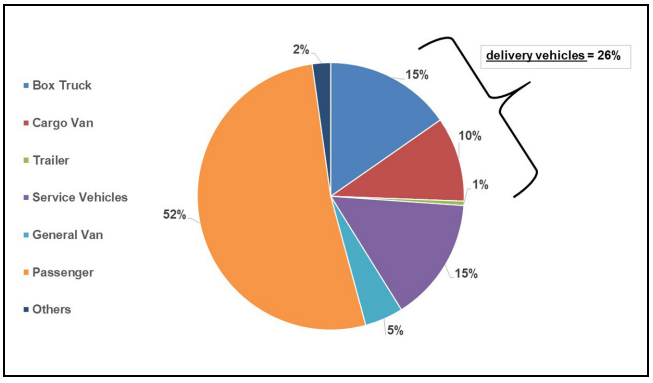


Figure 4. Distribution of vehicles types using CVLZs across all study areas.

78% parked for 30 min or less; which is in compliance with the time restriction policy defined by the City of Seattle.

When passenger vehicle drivers parked in CVLZs, they made very short-term use of them. Passenger vehicles made up the largest share of vehicles parking for 15 min or less (38.3%) in CVLZs. Delivery vehicles made up the second-largest share of vehicles parking for 15 min or less (14.1%) in CVLZs.

Finding 4: About One Third (36%) of All Commercial Vehicles Which Parked on the Curb Were Service Vehicles. In contrast to delivery vehicles, which predominantly parked for 30 min or less, parking behavior of service vehicles was bifurcated. While 56% of them parked for 30 min or less; 44% parked for more than 30 min, and more than one-quarter (27%) of the service vehicles parked for an hour or more. Because service vehicles make up such a big share of total commercial vehicles at the curb, this may have a disproportionate impact on parking space turn rates at the curb

Urban towers require ongoing maintenance for heating, ventilation, and air conditioning; plumbing; electrical; and other systems.

Finding 5: Variation in the Distribution of Vehicle Types and Curb Uses Relates to the Spatial Distribution of the Current Infrastructure and Land Use. The study areas showed significant differences regarding the most frequent locations

Table 4. How Long Did Commercial Vehicles Park in All Types of Curb Spaces in the Five Locations?

Commercial vehicle type	Total commercial vehicles by vehicle type	15 min or less	15–30 min	30–60 min	>1 h
Delivery vehicles (trucks, cargo vans and cargo bikes)	55.3% (694)	33.7% (422)	11.2% (141)	6.8% (85)	3.7% (46)
Service commercial vehicles	36.4% (456)	15.1% (189)	5.4% (68)	6.1% (76)	9.8% (123)
General van	6.5% (81)	3.9% (49)	1.6% (20)	0.8% (10)	0.2% (2)
Other commercial vehicles (including garbage trucks, construction vehicles)	1.8% (23)	1.2% (15)	0.2% (2)	0.2% (3)	0.2% (3)
Total commercial vehicles by time parked	100% (1,254)	53.8% (675)	18.4% (231)	13.9% (174)	13.9% (174)

Note: Percentages indicate percent of total commercial vehicles. Parenthetical numbers indicate number of commercial vehicles.

Table 5. Where Commercial Vehicles Parked per Study Area

Type of curb	Four Seasons	Seattle Municipal Tower	Dexter Horton	Westlake	Insignia
CVLZ	19%	60%	58%	20%	16%
PLZ	52%	21%	18%	34%	10%
Meter parking	15%	5%	13%	9%	57%
Other unauthorized parking	13%	9%	9%	21%	18%
Other	0%	5%	1%	7%	0%
Construction zone	2%	0%	0%	10%	0%
Total of commercial vehicles observed	256	152	359	215	272

Note: Totals per column are 100%. CVLZ = commercial vehicle loading zone; PLZ = passenger load zones.

Table 6. Vehicle Type Distribution by Study Area.

Type of curb	Four Seasons	Seattle Municipal Tower	Dexter Horton	Westlake	Insignia
Delivery vehicles	31%	12%	26%	59%	24%
Service vehicles	12%	28%	12%	2%	17%
General van	2%	7%	6%	0%	1%
Passenger vehicles	49%	52%	54%	38%	56%
Others	6%	1%	2%	1%	2%
Total of vehicles observed parked in CVLZs	106	195	476	71	100

Note: Totals per column are 100%. CVLZ = commercial vehicle loading zone.

for parking operations by commercial vehicles (see Table 5). For example, the Seattle Municipal Tower and Dexter Horton study areas had the most significant amount of curb length dedicated to CVLZs, with 259 ft and 643 ft, respectively. These buildings also showed the highest proportion of commercial vehicles in CVLZs. Conversely, the Four Seasons Hotel and Westlake Center areas had the largest share of commercial vehicles parked in PLZs (52% and 34%, respectively), both areas had the most curb length dedicated to PLZ (424.8 ft and 370.7 ft, respectively)., The Insignia study area showed the most significant proportions of commercial vehicles parked in meter parking spaces (57%). Perhaps unsurprisingly, this area has the longest share of meter parking along the curb.

In addition to differences in where vehicles parked across the five study areas, this study also revealed significant differences in what kind of vehicles parked across the five study areas (see Table 6). Delivery vehicles were the largest share of vehicles parked in CVLZs for the Four Seasons and Westlake Center study areas (56% and 58%, respectively). Both areas have a dense concentration of commercial land use. The Four Seasons Hotel is surrounded by businesses such as Target, Pike Place Market, and several restaurants. Westlake Center is a four-story shopping center and 25-story office tower surrounded by a hotel and myriad of nearby retail shops and restaurants.

In contrast, the Seattle Municipal Tower and Insignia study areas showed the highest share of service vehicles of all observed commercial vehicle parking operations (32% and 37%, respectively). These two areas also showed the highest proportion of passenger vehicles with approximately 40% in each area. This may be explained by the dense concentration of offices in the former area, and of residential and educational land use in the latter.

Discussion and Conclusions

The Seattle-specific data collected provided a sample of 1,816 on-street parking operations with a granular vehicle typology.

Researchers found that the observed commercial vehicles and passenger cars were using the CVLZs and PLZs fluidly. High levels of unauthorized parking were found in all five study areas, ranging from 27% to 65%. Interestingly, in almost all of the study areas, the most recurrent unauthorized behavior was parking in the PLZs space. Conversely, passenger vehicles made up more than half of all vehicles observed parking in CVLZs (52%).

Observed dwell times in CVLZs showed considerable variability between users. More than half of the delivery vehicles, but three-quarters of observed passenger vehicles, stayed for up to 15 min. Approximately 20% of the parking operations lasted 30 min or more, with the

largest share of these vehicles being service vehicles. When looking at all recorded commercial vehicle parking operations, this percentage is larger, with almost one-third of vehicles parking for more than 30 min.

Buildings and equipment in the urban center in need of servicing and maintenance will often require providers to be on-site, as a van or other vehicle is generally required to carry parts and tools (*19*). Based on interviews with staff of service companies, Allen et al. (*20*) classified servicing activities in four categories: (i) quotation, (ii) installation, (iii) planned servicing/maintenance, and (iv) ad hoc servicing/emergency maintenance (*20*). Overall, servicing activities have received little research attention even though these operations are an important share of commercial operations. The Seattle data shows that they represent between 20% and 40% of parking operations across the five study areas. Furthermore, the Seattle data showed that servicing trips could skew the dwell time distribution of all commercial vehicles and tend to take over most commercial vehicle parking operations of 30 min or longer.

Finally, where commercial vehicles chose to park and the distribution of commercial vehicle types varied significantly from study area to study area, reflecting the fact that the service and freight demand is directly related to the land uses that generate them. An adequate supply of spaces, or the inability to meet demand, affects the levels of unauthorized behavior.

The authors echo the popular opinion that, without an adequate and available supply of loading zones, on-street and off-street, drivers of commercial vehicles are forced either to spend more time looking for parking or to park in unauthorized spaces. These parking behaviors reduce the capacity of the roadways, causing inconvenience to pedestrians and conflicts with other modes, and ultimately lead to congestion and safety issues.

The paper provides a thorough evaluation of curb behavior in key Seattle locations and shows a diverse commercial vehicle demand for load/unload spaces. The insights drawn suggest a need to revise Seattle's existing parking policies, and a data-based foundation for doing so. While these insights are unique to a place, they likely reflect behaviors in other locations. However, because of the heterogeneity and complexity of the urban freight system, as Marcucci et al. (*5*) points out, approaches taken to develop policies and initiatives to improve curb management must be developed based on site-specific data.

The authors hope this research will encourage data collection efforts, such as this one, to help reduce the gap in understanding commercial vehicles' use of the curb. The data collection approach developed and described in this paper can and should be implemented in other cities, allowing for tailored solutions to improve curb operations and management.

Finally, further research is necessary to understand the nature of the activities which drivers of passenger vehicles are performing when they park in CVLZs. Moreover, with the increase of crowdsourcing of last-mile transportation services, future data collection methods should capture the magnitude and behavior of passenger vehicles used for delivery and pickup of goods (e.g., Uber Eats, Amazon Prime Now, Amazon Fresh).

Author Contributions

The authors confirm contribution to the paper as follows: study conception and design: GG-V, JM-L, AG; data collection: GG-V, JM-L; analysis and interpretation of results: GG-V, JM-L; draft manuscript preparation: GG-V, JM-L, AG. All authors reviewed the results and approved the final version of the manuscript.

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