

1 **A COMPARATIVE ANALYSIS OF TRUCK PARKING TRAVEL DIARY DATA**

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ABSTRACT

Critical information on the effects that truck parking shortages have on crucial stakeholders, truck drivers in particular, has historically been obtained through survey methods. However, survey methodologies rely heavily on generalizations, respondents' memory, the recency effect in memory recall, and/or experiences that evoked strong feelings. To investigate detailed truck parking shortage impacts using a method less reliant on historical recollections, the researchers developed and implemented a 14-day truck parking travel diary study. A total of 148 U.S. drivers participated, providing detailed data for 2,035 days of parking activity and 4,763 unique stops. The analysis focused on truck parking topics that have a nexus to previous survey findings that relate to drivers, state department of transportation (DOT) and enforcement activities, and other stakeholders, to facilitate the comparison of truck parking survey data with the diary data. Generally, the truck parking diary findings corroborated survey results. Almost 90 percent of drivers parked in an unauthorized location at least once a week – supporting survey findings that a majority of drivers find parking is difficult at least once a week. Data on unauthorized parking demonstrated that the time-of-day can impact the ease of finding available parking, with peak difficulty occurring during evening hours. Drivers primarily choose parking locations for the mandated 10-hour hours-of-service breaks based on practical needs – proximity to route, restroom and shower access, and expected parking availability. The research findings can provide policy, regulatory and infrastructure guidance to both private industry and public agencies.

Keywords: Truck Parking, Travel Diary, Truck Driver, Truck Stop, Rest Area

INTRODUCTION

Truck parking shortages have been documented for over 20 years – in the late 1990s a national survey of truck drivers revealed that commercial drivers had difficulty locating truck parking at least once a week (1). The survey results were supported by a supply/demand model that estimated a parking shortage of 52,700 spaces nationally (2). Subsequent analyses of truck parking adequacy have shown truck parking shortages persist (3, 4). Additionally, the truck parking shortage has been aggravated by the closure of public rest areas, changes in supply chains and industry operations that have shifted preferred parking locations toward urban areas, and difficulties in building new parking facilities caused by zoning and land values (5). Existing truck parking facilities seeking to expand often encounter similar obstacles (5).

Recent truck driver surveys have shown a majority of drivers experience difficulty finding parking at least once a week (5). Yet access to legal truck parking is critical to roadway safety and ensuring compliance with federal hours-of-service (HOS) regulations. Drivers may continue to drive while fatigued while searching for available parking, or park on roadway shoulders and ramps if parking is not available (6). The electronic logging device (ELD) mandate may aggravate existing parking shortage issues, as change-of-duty status will be automatically recorded. If available drive time is completely exhausted, drivers may be forced to decide between violating HOS and parking in an unsafe location.

Truck driver surveys have been the primary method of assessing parking shortage impacts on commercial drivers. While this approach is effective for collecting general information on truck parking issues, survey responses may be skewed toward recent experiences or experiences where strong emotional responses occurred. Due to this, survey results may not accurately represent truck parking shortage impacts. Additionally, survey methods may omit causes and nuances of truck parking shortage impacts.

To address the shortcomings of survey data collection methods, the American Transportation Research Institute developed and deployed 14-day truck parking travel diaries. This method collected continuous and more granular data on the effects of parking shortages on truck drivers. The truck parking travel diary analysis will inform public agencies and private industry of truck driver needs, behaviors and issues related to parking. This additional, detailed information can guide public agency and private industry policy, and regulatory and infrastructure decisions related to the parking shortage.

METHODOLOGY

Driver participants were recruited through satellite radio programs targeted to commercial drivers, the Mid-America Trucking Show, and trucking industry trade press. First, drivers completed a short online survey asking for information on operating region(s), the number of nights spent away from home each week, general information on industry sector, and contact information. Drivers who spent zero nights away from home each week were excluded from consideration, as one goal of the data collection was to better understand parking behavior surrounding 10-hour required HOS breaks.

Qualified drivers were then contacted by email for a shipping address. A package containing the 14-day diary, a short survey on parking and planning behaviors, and a postage-paid envelope were then sent to drivers. An incentive of \$50 was offered to the first 100 drivers to return a completed diary.

The diaries were developed with the goals of gauging the amount of time drivers spend searching for parking, estimating the prevalence of unauthorized truck parking, exploring how reasons for stopping impact location choices, and what factors affect stop location choices.

Drivers were asked to provide the following information for up to four stops per day:

- Arrival/departure time,
- Stop reason,
- Location (urban/suburban/rural, city, and state),
- Location type (rest area, ramp/shoulder, truck stop, other),
- Officially designated parking space,
- Number of locations searched, and,
- Total non-productive drive time spent searching for parking.

The diary also requested information specific to the 10-hour required HOS break. These questions related to remaining drive time, parking reservations, and the top five factors influencing stop location choice.

A total of 148 drivers returned completed parking diaries between June and September of 2016, representing 2,035 days of parking activity and 4,763 unique stops. Diary data included all states except Hawaii.

FINDINGS

Driver Demographics and Behaviors

Driver demographics were collected to assess the representativeness of the sample compared to the overall industry. The sample under-represented males (88.4%) relative to the industry-at-large, of which 94.4 percent are male (7). Most participating drivers were 45 to 64 years of age (71.4%) or 25 to 44 years of age (25.9%). Compared to the industry overall, the sample over-represented drivers 45 to 64 years of age (8).

Participants were primarily employee drivers (72.3%) operating in the truckload sector (56.1%) in large fleets of more than 1,000 power units (50.0%) that are paid on a per-mile basis (74.1%). Vehicle configurations operated in the sample are primarily dry van (41.2%), flatbed (30.4%), or refrigerated trailers (16.2%). The majority of participants (91.2%) drove irregular routes. HOS compliance was recorded by ELDs for the majority of drivers in the sample (85.0%).

The diary package sent to drivers also included a survey to gather information on participants' planning and parking practices. Drivers identified parking locations primarily through websites/applications (55.5%) or global positioning systems (53.4%). Nearly half of drivers had previously used a parking reservation system (45.6%). 7.0 percent of participants have been ticketed for parking on a road shoulder or ramp.

Free Responses

The supplemental survey in the diary package also included a free response question for additional input from drivers. Responses most frequently referenced the following topic areas:

- Time-of-day impacts on parking availability (61.6%).
- Public rest area challenges were referenced in 24.4 percent of responses – in particular, the closing of public rest areas and the distance between rest areas. Greater distances between parking facilities are associated with elevated crash risk (9). Drivers also noted the conflict

between public rest area parking time limits, which typically range from two to ten hours (5), and HOS compliance.

- Drivers described specific regions where finding available parking is difficult (20.1%).

Unauthorized Parking

Unauthorized parking is defined here as parking in a location where parking is illegal, such as a ramp or road shoulder, or “creating” an ad hoc parking space in a facility where parking may be permitted but not where the parking occurred. Parking in unauthorized locations creates safety risks by exposing parked trucks to risky traffic interactions. Most road shoulder crashes are the result of driver inattention, but there is an imperative to prevent these crashes by not parking on a road shoulder (11). “Created” parking spaces also pose hazards, as “created” spaces do not consider the space requirements to safely maneuver a truck, increasing the risk of property damage. Surveys of truck stop operators found that roughly one half to three quarters of truck stop operators are aware of unauthorized parking at or near their facility (5, 10). Unauthorized parking is primarily the result of no available nearby parking, lack of awareness of available nearby parking, or HOS constraints (1, 3, 10, 12).

In surveys, drivers report that HOS compliance and fatigue are top reasons for seeking parking (13, 14, 15). However, state DOTs and state troopers typically approach unauthorized parking as an issue for the rest of the motoring public, without consideration for why commercial drivers park in unauthorized locations. Nearly half of all state DOTs reported problems with trucks parking on freeway interchange ramps (47.1%), freeway shoulders (45.1%), and highway roadsides (35.3%) (5). A survey of state troopers found that the majority ask drivers to move if they are parked on a road shoulder or ramp (10). Asking drivers to move from unauthorized parking locations will likely present other safety or compliance issues if a driver parked in a location for fatigue-related reasons, or if the driver was out of available HOS.

In the parking diaries, unauthorized parking was identified by respondents when “unauthorized space” was marked or if the location was a road shoulder or ramp. In the truck parking diary dataset, three percent of total parking stops were unauthorized. This may underestimate the total prevalence of unauthorized parking, as identifying unauthorized parking in the diaries often relied on the respondent indicating a space was unauthorized. For example, if a driver parked in a public rest area, but not in a marked space and did not indicate it was an unauthorized location, this instance of unauthorized parking would be missed. In a survey of drivers operating in North Carolina, drivers estimated they parked on road ramps/shoulders for 15.4 percent of total parking stops in North Carolina (16). The disparity between the frequency of unauthorized parking reported in the North Carolina survey and the three percent observed in the diary data is significant. The observed disparity may have a variety of causations, such as, the survey drivers overestimated the frequency of unauthorized parking in North Carolina, driver experiences in North Carolina are not characteristic of other regions, or the diary sample underestimated the frequency of unauthorized parking nationally.

While the percentage of total unauthorized parking stops is low (3%), it is easier to understand the issues drivers face through the frequency that each respondent engaged in unauthorized parking over the 14-day period (Figure 1). Nearly 11 percent of drivers never parked in an unauthorized location over the two week period, possibly due to company policy prohibiting roadside parking or an individual’s risk aversion to legal consequences, such as being ticketed or asked to move in conflict with HOS requirements. Drivers most frequently reported parking in an unauthorized location one to two times per week (25.7%) or 3 to 4 times per week (36.5%). Over 20 percent of drivers parked in an unauthorized location five times or more per

week. The frequency that most drivers in the sample utilize unauthorized locations supports survey findings that a majority of drivers experience difficulty locating available parking at least one to two times a week, if not more (5).

FIGURE 1 Frequency Drivers Parked in an Unauthorized Location.

Unauthorized parking peaked during evening (7:00 p.m. to midnight) and early morning (midnight to 5:00 a.m.) hours. The relationship between time-of-day and parking scarcity is also reflected in truck driver survey results (5, 16). Both private truck stop operators and drivers report that time of day significantly impacts parking availability; available truck parking is scarce during evening and early morning hours (5, 16). The time-of-day impacts draw attention to the importance of addressing truck parking issues at the supply chain level; peak parking demand periods are not solely the result of driver choices and preferences. Parking shortage issues may be improved if alternative solutions, such as more flexibility in HOS regimen or shipper/receiver appointments were possible.

Unauthorized parking also varied by whether a location was urban, suburban, or rural. Drivers parked in an unauthorized location 26.5 percent of the time in urban locations, 21.3 percent of the time in suburban locations and 16.5 percent of the time in rural locations. This reflects survey findings that locating available parking is more difficult in urban areas (5, 14). State DOT representatives have noted that the highest demand for truck parking is typically within a 20 mile radius of urban areas, but increasing urban parking capacity is difficult due to land use issues and the scarcity of land parcels near major business centers. Expanding truck parking availability near residential land use is even more problematic (5). The shortage of parking in urban areas likely explains the high prevalence of unauthorized parking.

Overall, unauthorized parking reported in the diaries reinforces driver parking survey findings. The frequency drivers have difficulty locating parking, time-of-day impacts, and issues in urban areas reinforce and provide more detail to driver survey findings.

Productivity Impacts: Search Time

The diaries were designed to collect details on the productivity impacts of truck parking shortages. Numerous surveys have asked drivers about how much time they spend searching for parking. Table 1 displays driver-reported search times in U.S. regions and states. A majority of drivers reported spending at least 30 minutes searching for parking in surveys of drivers operating in Kansas (80.0%) (13), states represented by the Mid America Association of State Transportation Officials (60.2%) (17) and North Carolina (86.9%) (16). As most drivers in the sample and in the industry are compensated on a per-mile or per-load basis, devoting revenue time to locate available parking has a tangible effect on driver compensation.

TABLE 1 Driver-Reported Search Times by Region (13, 17, 16)

However, driver diary entries for the “search time” field – the drive time drivers devoted to locate available parking rather than drive revenue-earning miles – were frequently zero minutes. This disparity suggests that search time may be overestimated in surveys, search time was underestimated in the diaries, or drivers conceptualize the sacrificed drive time differently when asked in the two separate methods. Alternatively, drivers may sacrifice available drive time by stopping early to avoid uncertainty (e.g. a destination has no available parking and they must keep searching with limited HOS). Given the interest drivers have in truck parking – the

third highest ranked industry issue by drivers in 2016 (18) – it is unlikely that drivers would systematically underestimate the lost productivity resulting from inadequate parking. Therefore, in line with findings from multiple, robust driver surveys, search times of less than 5 minutes were excluded from consideration here.

Figure 2 displays the total daily search time reported by drivers in the diaries. The search times from the driver diaries are low compared to the typical search times of 30 minutes or more reported by drivers in the surveys.

FIGURE 2 Daily Search Time.

Individual parking search times were used to assess location, day of week, and time-of-day relationships to search times. Drivers were more likely to spend 15 minutes or more searching for parking from 7:00 p.m. to midnight (34.8%) or from 4:00 p.m. to 7:00 p.m. (28.6%). This reflects the findings of other surveys related to time-of-day impacts on parking availability (5, 16).

The reason for a stop also impacted driver search times. When drivers stopped for 10-hour HOS breaks, search times exceeded 15 minutes 8.6 percent of the time, while search times for other stops exceeded 15 minutes only 1.3 percent of the time. Drivers may dedicate more time to find parking for 10-hour HOS breaks for a number of reasons, such as finding parking at a facility with specific amenities or to find a parking space with adequate room to easily exit the space after the required 10 hours.

Additionally, the willingness to use reserved parking spaces, by typical search times was examined. Drivers willing to reserve parking were more likely to spend more than 15 minutes searching for parking (16.2%) relative to drivers that do not use reserved parking (11.9%). The observation that parking reservations do not have lower search times suggests that parking reservations are used when no other parking is available. Individual driver preferences, such as willingness to park in an unauthorized location if no free parking is available, may also play a significant role the use of parking reservation systems. Use of parking reservation systems peaked during the hours of 7:00 p.m. to 4:59 a.m., suggesting that the reason for reservation system use relates primarily to the lack of available free parking. In a survey focused on parking reservations (Table 2), 48.2 percent of drivers were not willing to pay for parking reservations (19). 57.1 percent of drivers indicated they were willing to pay \$1 to \$10 for a reservation, however, this amount is less than the average reservation fee of \$12.86 at TA Petro (19, 20). Other surveys have found similar results (6).

TABLE 2 Driver Willingness to Pay for Parking Reservations (19)

The search times reported in the driver diaries were generally lower than the typical search time of 30 minutes or more reported in driver surveys. The reason for this disparity is unknown. However, despite differences in average search times, the diary search time data corroborates survey data in confirming that the time-of-day can impact parking availability, more time is devoted to finding parking for 10-hour required HOS breaks, and that reserving parking does not result in lower search times.

Productivity Impacts: Remaining Drive Time

Another approach to assessing parking impacts on productivity was to examine the amount of remaining revenue drive time in relation to variables of interest. Drivers park prior to exhausting

available drive time if they anticipate difficulty locating available parking if they continue driving. Parking before drive time is exhausted decreases revenue-earning miles, negatively impacting driver compensation. Motor carriers are also adversely impacted if trucks do not maximize their revenue-earning miles and may have to hire additional drivers or purchase additional equipment to meet customer demands. Remaining drive time figures do not include stops where the location was marked as a shipper or receiver, as it was assumed drivers had reached their destination if they were parked at a shipper or receiver.

FIGURE 3 Participant Average Remaining Drive Time.

In the diary sample, drivers averaged 31 to 60 minutes (39.9%) of remaining drive time per day, followed by 61 to 120 minutes (32.4%) of remaining drive time. A median of 56 minutes of remaining drive time was observed in the diary sample. Using the median remaining drive time of 56 minutes per day and assuming an average speed of 39.98 miles per hour and 250 days worked per year, over 9,300 additional revenue-earning miles could be driven per driver per year (21). As most drivers are compensated on a per-mile or per-load basis, stopping before available drive time is exhausted has a significant and tangible effect on driver compensation.

Other factors, such as ELD use and parking reservation system use were investigated in relation to remaining drive time, and no relationships were observed.

Driver Location and Amenity Preferences

Location and amenity preferences for 10-hour HOS breaks were also investigated through the diary data. Drivers predominantly spent 10-hour HOS breaks at private truck stops (71.4%), followed by public rest areas (9.6%) and customer facilities (8.9%). More amenities and the large supply of private truck stop parking spaces relative to public rest area parking spaces likely explains the prevalence of parking at a private truck stop for the 10-hour HOS breaks – private truck stops have an average of 7.63 spaces for every parking space at a public rest area (5). Drivers have also indicated a preference for private truck stops for long breaks in numerous surveys (6, 22).

Drivers were asked to indicate what factors were most important in their stop location choice (Table 3). Drivers placed highest priority on proximity to their route (96.5%), restrooms/showers (79.8%), and expected parking availability (75.5%). Most top amenities influencing stop choice are typically available at both private truck stops and public rest areas. Drivers also prioritized parking space width and ease of access (31.9%) and restaurants (30.5%). Driver amenity preferences for showers and restaurants supplement the supply explanation for why private truck stops are the preferred location for 10-hour HOS breaks. Public rest areas are prohibited from offering commercial services (23) and parking space design may not be suited to current vehicle sizes/configurations (24).

TABLE 3 Factors Influencing Stop Location Choice

CONCLUSIONS

Truck parking travel diaries provide more detailed information about the effects of the truck parking shortage on the trucking industry. The diary data can inform the decisions of public agencies and private industry to address truck parking shortages through numerous areas including policy, regulatory, and infrastructure. For example, states can examine existing caps on how long drivers are allowed to park in public rest areas to more closely align with federal

HOS rules requiring that drivers take a 10-hour break.

Most diary-derived information corroborated existing knowledge obtained from survey data collection methods. However, unauthorized parking was estimated to occur in three percent of all parking stops in the diaries, which contrasts with an estimated prevalence of 15.4 percent from a North Carolina driver survey (16). This disparity may be attributable to numerous causes. However, the use of survey and diary methods provide a baseline range in the frequency of unauthorized parking.

Most drivers parked in an unauthorized location regularly – three to four times per week (26.5%) or one to two times per week (25.7%). The driver-level prevalence of unauthorized parking demonstrates that difficulty finding safe and legal parking presents an issue for most drivers at least once a week (5). However, some drivers were able to avoid unauthorized parking entirely (10.8%). Drivers may have used a variety of methods to avoid having to park in an unauthorized location, such as reserving parking or extensive knowledge of a geographic region.

Unauthorized parking was most prevalent in the late evening (7 p.m. to midnight) hours, followed by early morning (midnight to 5 a.m.), similar to survey results (5, 16). Unauthorized parking was more prevalent in or near highly populated areas – unauthorized parking comprised 26.5 percent of all parking in urban areas, 21.3 percent of parking in suburban areas, and 16.5 percent of all parking in rural areas. This reflects state DOT survey findings that the highest parking demand is within 20 miles of an urban area but these are also areas that are difficult to develop or expand truck parking in (5).

Productivity impacts related to truck parking scarcity were examined in the areas of remaining drive time and search time. Drivers had a median of 56 minutes of remaining revenue drive time left per day, which represents an additional 9,300 revenue-earning miles that could be driven per year, assuming an average speed of 39.98 miles per hour and 250 days worked per year. This has a tangible impact on driver compensation, as many drivers are compensated on a per-mile or per-load basis.

Productivity in terms of search time related to multiple survey findings that drivers, on average, spend at least 30 minutes searching for parking in a variety of regions (14, 16, 17). However, the diaries varied from the surveys in that stops frequently involved no search time. As the survey results are supported by thousands of truck drivers rather than a sample of 148 drivers, researchers focused on non-zero responses. The pattern of greater difficulty finding parking in the evening was reflected in search times peaking in the evening (7 p.m. to midnight) hours (5). Drivers who used reservation systems typically spent more time searching for parking than those who don't use reservation systems, suggesting that reservation systems are a "last ditch" solution when there is no available free parking. Surveys specifically about reservation systems have found drivers are generally unwilling to pay for parking, which is similar to the unwillingness to pay for parking observed in the diary sample (6, 19). Finally, drivers tended to devote the most search time to finding parking for 10-hour HOS breaks relative to stops made for other reasons.

Finally, the diaries validated the findings of driver surveys through gathering information about amenity and location preferences of drivers when searching for parking, focusing on 10-hour HOS breaks in particular. Drivers in the sample predominantly used private truck stops (71.4%) for 10-hour HOS breaks. This reflects the composition of facilities with truck stops, which have 7.63 parking spaces for every parking space at a public rest area (5). Drivers in the sample primarily parked at locations for practical reasons, such as proximity to route (96.5%), restrooms/showers (79.8%) and expected parking availability (75.5%). Parking space width and ease of access (31.9%) and restaurants (30.5%) were often noted to be important factors.

The authors confirm contribution to the paper as follows: study conception and design: RB, CB; data collection: RB, CB; analysis and interpretation of results: RB, CB; draft manuscript preparation: RB, CB. All authors reviewed the results and approved the final version of the manuscript.

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TABLE 1 Driver-Reported Search Times by Region (13, 17, 16)

Search Time	Kansas	Mid America Association of State Transportation Officials States	North Carolina
Less than 30 Minutes	21.9%	39.9%	13.2%
30 Minutes to 1 Hour	46.6%	42.1%	46.7%
More than 1 Hour	31.4%	18.0%	40.2%

TABLE 2 Driver Willingness to Pay for Parking Reservations (19)

Search Time	Percent of Responses
I would not be willing to pay any amount	48.2%
\$1-\$5	20.0%
\$6-\$10	19.8%
\$11-\$15	9.0%
\$16-\$20	2.1%
\$21+	0.9%

TABLE 3 Factors Influencing Stop Location Choice

Important Factor	Percent of Responses
Proximity to Route / Destination	96.5%
Restroom / Showers	79.8%
Expected Parking Availability	75.5%
Width of Parking Space / Ease of Access	31.9%
Restaurant	30.5%
Security	20.3%
Company Policy / Loyalty Program	18.1%
Internet	6.9%
Laundry	4.0%
Maintenance / Service Center	3.7%
Weather Conditions	3.6%

FIGURE 1 Frequency Drivers Parked in an Unauthorized Location.

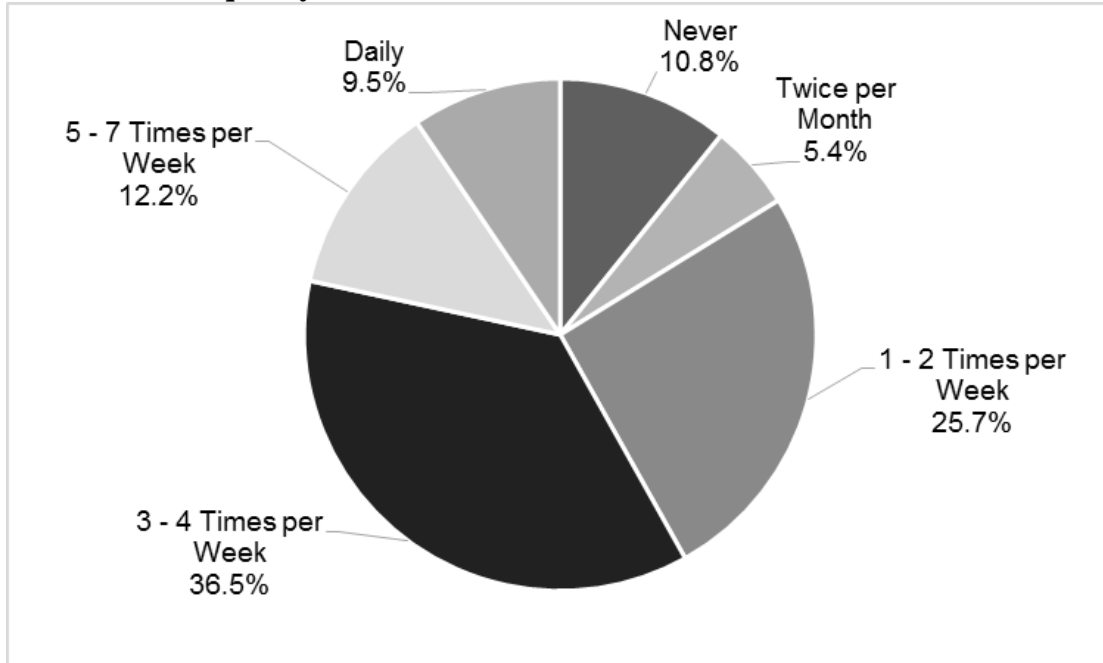


FIGURE 2 Daily Search Time.

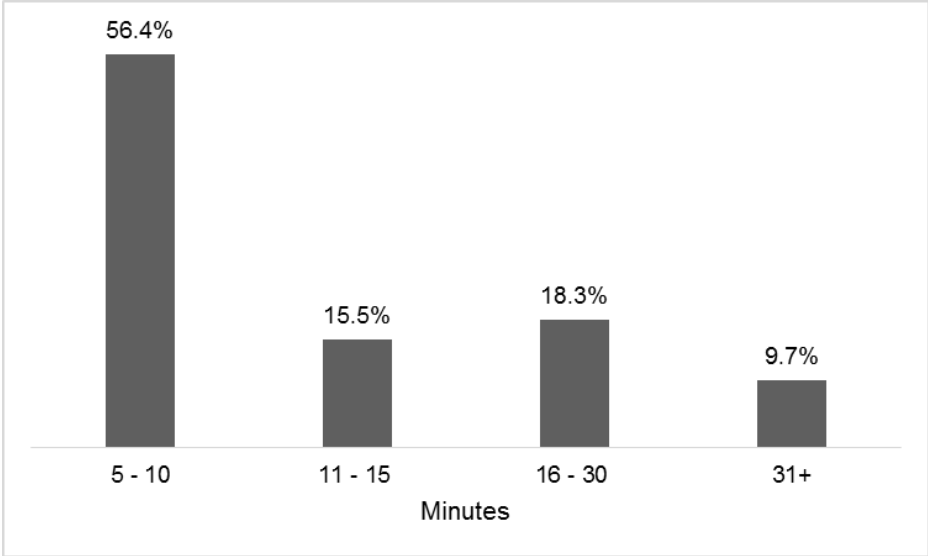


FIGURE 3 Participant Average Remaining Drive Time.

