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Evaluation of Truck Parking Needs in a Changing Regulatory Environment

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EXECUTIVE SUMMARY

Commercial driver hours-of-service rules were created to ensure that operators of heavy vehicles on US roads have opportunities to receive adequate rest during and between trips. The use of electronic logging devices to replace handwritten logs, along with the implementation of automated vehicle tracking systems, has created a potential opportunity to track the location of truck drivers with respect to their hours-of-service status. It is envisioned that this real-world driving data can inform the siting of new facilities to address a critical, national shortage of safe and convenient truck parking.

This investigation sought to provide proof-of-concept for the use of electronically logged hours-of-service data to determine where additional truck parking areas are needed. A sample of this data was purchased from a commercial telematics provider, and a trusted partner was contracted to transform the acquired raw data into a format that could be used within geographic database system to identify where drivers were located as they neared the end of their allowed driving time. This database would also include the locations of existing truck parking facilities so that gaps in coverage could be identified.

Unfortunately, the native format of the hours-of-service data as collected and provided was not conducive to creating a continuous record of a driver's trips that could be synchronized in time with location data. Also, the sample set of real driving data that was provided in line with the project budget contained too few records to be of practical use. Therefore, proof-of-concept was not validated with this effort. It is likely, though, that the evolution of telematic and electronic logging systems, and the perceived value of this type of information, will result in data quality improvements that will enable the type of analysis envisioned. Examples of the problems encountered are described, and lessons learned and suggestions for future efforts have been provided.

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LIST OF ABBREVIATIONS AND SYMBOLS

ATA	American Trucking Associations
ATRI	American Transportation Research Institute
DOT	Department of Transportation
ELD	electronic logging device
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carriers Safety Administration
GIS	geographic information system
GPS	Global Positioning System
HOS	hours of service
I-81	Interstate 81
UTC	University Transportation Center
VDOT	Virginia Department of Transportation
VTTI	Virginia Tech Transportation Institute

CHAPTER 1. INTRODUCTION

BACKGROUND

In 2002, the Federal Highway Administration's (FHWA's) Study of the Adequacy of Truck Parking Facilities documented a national shortage of truck parking.[(1)] Subsequent studies conducted by state Departments of Transportation (DOTs) further characterized the inadequacy of truck parking, considering the primary public safety interests of reducing driver fatigue and ensuring that truck drivers may park safely.[(2)] Yet, as a 2019 survey conducted by the FHWA prompted by Jason's Law indicates, more than 75% of truck drivers continued to report difficulties finding safe places to park, often instead utilizing road shoulders, exit ramps, and vacant lots. Jason's law is a provision of Section 1401 of the Moving Ahead for Progress in the 21st Century Act (MAP-21) that became effective on October 1, 2012, in response to a grassroots advocacy effort following the murder of Jason Rivenburg, a truck driver who parked in an abandoned gas station due to a lack of safer truck parking opportunities. [(3)]

The search for a safe and suitable truck parking space has also been complicated by new hours of service (HOS) requirements mandating electronic logging devices (ELDs). The Federal Motor Carrier Safety Administration (FMCSA) regulations were updated to require the in-vehicle recording of commercial driver HOS using ELDs by December 18, 2017. This change resulted in increased driver compliance with HOS regulations,[(4)] but currently most truck parking is located at large commercial truck stops, which are typically spaced widely along highways, or at major crossroads. With electronic reporting required at a 15- minute resolution,[(Error! Bookmark not defined.)] or approximately 17.5 travel miles at 70 mph, spacing between parking facilities may significantly impact a driver's compliance with HOS if suitable parking is not located nearby. A relatively insignificant number of parking spaces are provided at public facilities such as rest stops, but these are not normally intended for overnight usage. Of the 313,000 designated truck parking spaces identified in the Jason's Law 2019 update survey, 40,000 (12.7%) were public and 273,000 (87.3%) were private. [(3)]

Large truck facilities also experience high levels of air pollution that endanger resting drivers, as well as nearby residents, and inhibit regulatory compliance in Environmental Protection Agency air quality non-attainment zones.[(5)] Thus, the current model for providing parking space may not match current needs when regulatory compliance, driver health, environmental compliance, and operational efficiency are considered.

OPPORTUNITY

The advent of ELDs to collect driver HOS data, assuming potential access to that data, offers an opportunity to apply commercial vehicle operating data to decisions regarding the locating of truck parking facilities. ELD data typically includes time stamps, geographic position, and vehicle/driver status from engine speed and vehicle movement.[(6)] Thus, the analysis of real-world ELD driving data indicating drivers' locations when approaching the end of their allowable HOS driving time should provide heretofore unavailable insight on hotspots of truck parking demand.

OBJECTIVE AND SCOPE

The availability of driver HOS data from onboard ELDs provides a unique opportunity to determine where truck parking is needed. The purpose of this project was to work with fleet safety partners and/or fleet management system providers to acquire a sample of real-world ELD data for subsequent analysis to determine its usefulness for locating geographic hotspots of truck parking demand. The geographic scope of this investigation was limited to Interstate 81 (I-81) in Virginia to align with sponsor needs and other related efforts. The ultimate goal of this proof-of-concept was to demonstrate the need for additional investigation of this issue in a larger spatial and temporal context. Ultimately, the finding of this and prospective follow-on work will inform the decisions made by truck parking providers, planners, DOTs, and other stakeholders with respect to future truck freight information systems, integration of ELD data, and the potential for registration-ensured parking.

CHAPTER 2. METHODS

The Virginia Tech Transportation Institute (VTTI) contracted with Trimble, Inc., also known as PeopleNet, to purchase the raw ELD data and Yahara Software (Yahara) to reduce and transform the data. Due to the proprietary nature of the ELD data, Yahara, a trusted Trimble partner, acted as an intermediary to perform data transformation and remove personally identifiable information from the raw data provided. Yahara acquired a sample dataset they deemed sufficient in size to provide accurate and meaningful results. The targeted data would include geofenced vehicle locations along with respective driver (HOS) duty times for a time period sufficient in length to yield a sample size large enough to provide an acceptable level of confidence.

The reduced dataset provided by Yahara, along with truck parking facility location information, was used to create a geographic information system (GIS) database using Esri's ArcGIS© software (ArcGIS Desktop 10.8.1). GIS data layers were created for subject vehicle locations and the locations of public truck parking areas. The GPS locations of vehicles included in the dataset were used to map the truck locations along I-81 at various time intervals as an example method of analysis of the use of truck parking locations along an interstate. The goal was to understand what information was provided by the data, whether there were possible useful applications of the data, and, if so, how to utilize the information to determine where truck parking facilities should be located along I-81 to best accommodate the driver rest requirements mandated by HOS regulations.

The original dataset provided by Yahara comprised 5,661 records that contained time, location, and HOS data. Using the Buffer tool, a geospatial analysis tool within ArcGIS that creates areal polygon areas around a given input feature, a 200-meter offset area around I-81's road centerline was created to search for vehicle GPS locations near the interstate; 298 location points were found within the buffer zone (Figure 1). A 200-meter offset was chosen to find any truck datapoints that fell within the area of I-81, including trucks which had potentially found parking locations near the interstate, but not necessarily at the public parking locations that currently exist along I-81. An additional data layer was then added that included all VDOT rest areas along I-81 to view along with the remaining data points.[7] This helped to visualize where the points within the provided data were in relation to designated truck public and private parking facilities. This was done to create a method to visualize where truck drivers were parking, potentially how many were using commercial and public (i.e., VDOT) rest stops, and which were parking elsewhere.

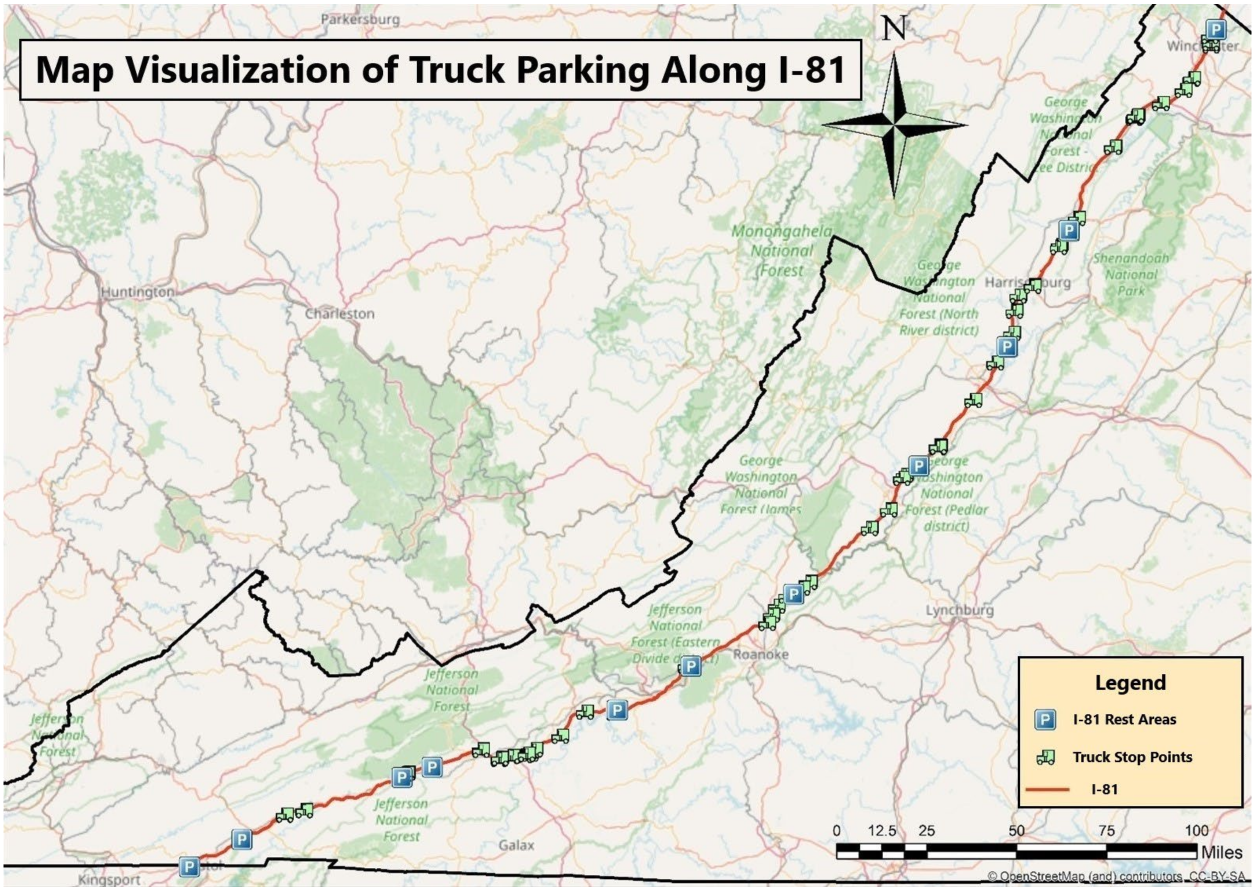

Figure 1. Map. View of the I-81 corridor in Virginia showing public and commercial truck parking areas located within 200 meters of I-81's centerline.

The Buffer tool was used again to create areas with a radius of 300 meters around each truck stop (Figure 2) to determine the number of truck data location points that fall within the truck rest areas. The number of trucks that fell within these 300-meter-radius buffer areas, which may indicate the total number of trucks that parked near or within these rest areas, totaled 31, or about 10% of the total number of points along I-81 that fell within the 200-meter buffer area created along I-81 in the previous step.

Commercial drivers have an 11-hour driving and a 14-hour on-duty limit, after which they then must be off-duty at least 10 hours before returning to work.[8] Using this information, the analysis continued by looking at the various attributes of the data, looking for potential truck stop data points with drive times ending at or near this 11-hour driving timeframe.

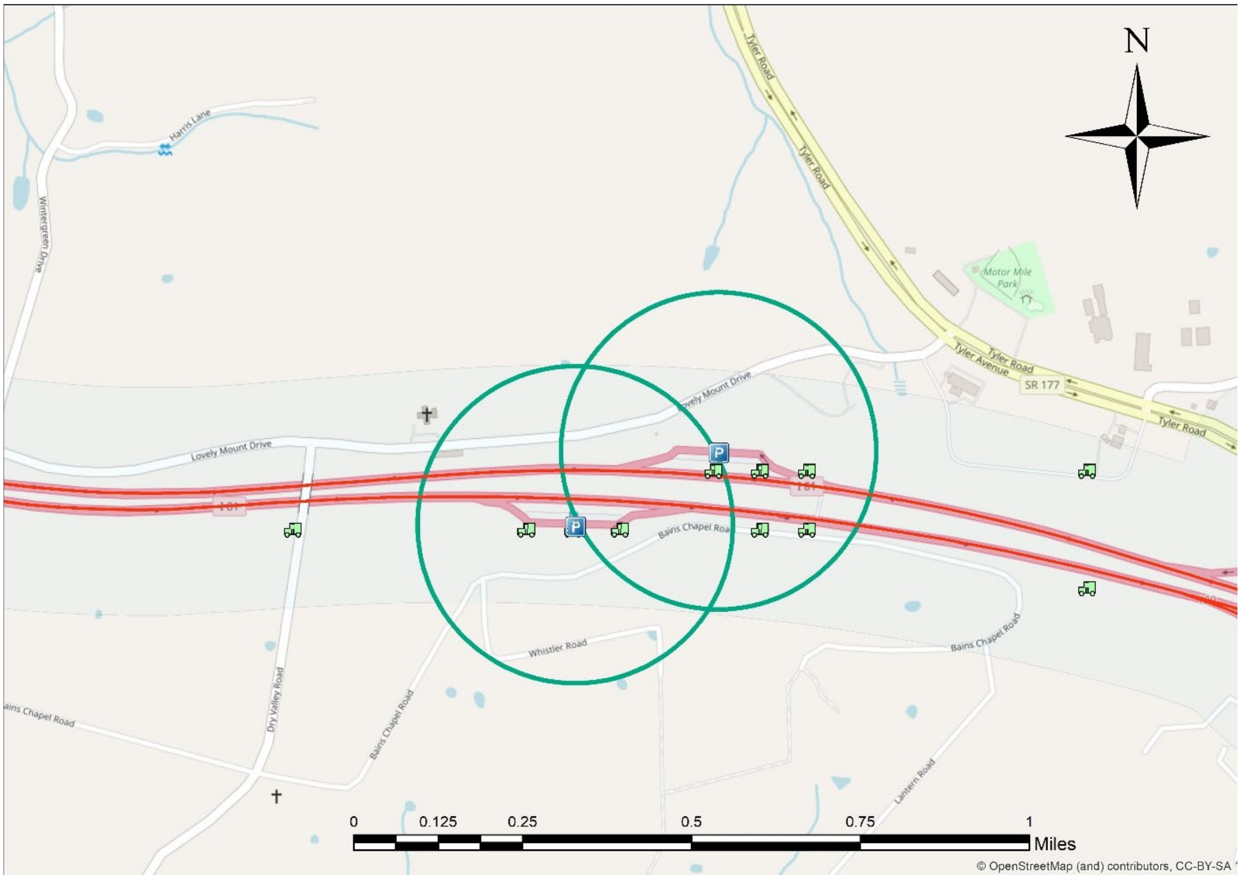

Figure 2. Map. View of an example parking area showing subject trucks parked within the 300-meter radius of interest.

CHAPTER 3. RESULTS AND DISCUSSION

If the DriveHours field in the dataset is assumed to be valid, out of the 300 truck location data points lying along I-81, over 100 truck drivers would have been exceeding their daily limit of 11 driving hours. Some trucks indicated less than 1 hour of driving time before stopping, making it difficult to determine which of these were only for breaks and which were for overnight parking. Further, some trucks had NULL values or values of zero in the DriveHours or TotalMiles fields. If a focus is placed only on points in which the DriveHours values are between 10 and 11 hours, to attempt to find trucks that were near or at the end of their daily driving limit, there are fewer than 30 points of interest within the study area. At this level it is difficult to make any definitive assumptions on the validity of the rest areas, as the number of data points is too few to make any determinations. Without more information or data, such as including break times or whether other on-duty time is included within the data, it is difficult to determine whether these data are valid. Additionally, it is likely there is either some corruption of the data or the data was collected improperly, as there are several notable issues.

For instance, when considering the entire dataset of 5,661 data points, 512 points contained NULL values, and 53 contained zeroes for both DriveHours and TotalMiles, 157 had TotalMiles values below zero (the lowest value being -241,987) and 245 were over 1,000 miles (the highest value being 88,929,351), and roughly 2,400 had DriveTime values of over the daily maximum of 11 hours (the largest being 565.866). Table 1 provides a small sample of the various data values for each data point, including null values, drive times over 11 hours, and unusually high and low values for certain data, indicating possible corruption or other unsuitability.

Table 1. Sample of the dataset showing the issues with the data, such as NULL values, high or negative TotalMiles, and DriveHours under 1 hour or over the 11-hour maximum.

DriverId	SleepDate	DriveHours	TotalMiles	Latitude	Longitude
93766	4/3/19 8:54	24.833333	350	37.393	-76.527
167940	8/1/19 20:03	6.766666	348	37.698	-77.553
169580	2/25/19 0:36	11.566666	598	37.761	-77.463
228943	4/25/19 20:56	11.316666	598	37.207	-77.376
228943	5/28/19 23:02	7.35	349	37.209	-77.373
307961	3/31/19 3:14	6.25	298	37.697	-77.551
357800	5/31/19 19:28	15.166666	-536	38.348	-77.497
474873	6/1/19 23:07	12.583333	599	38.706	-77.223
551549	2/28/19 20:53	6	288	38.48	-78.816
602236	7/9/19 1:43	30.05	351	39.159	-78.153
602236	8/13/19 1:48	52.516666	-265	39.061	-78.14
640514	11/8/18 6:32	10.416666	351	38.349	-77.498
749012	10/2/18 7:59	22.95	283	37.604	-77.452
844293	4/5/19 18:09	22.733333	88929351	38.348	-77.495
844293	3/22/19 10:14	18.85	350	38.592	-77.318
905801	6/1/19 4:10	30.333333	-393	38.848	-77.098

DriverId	SleepDate	DriveHours	TotalMiles	Latitude	Longitude
905801	6/27/19 7:36	15.033333	-807	38.347	-77.494
1006138	7/31/19 9:03	18.116666	244	37.384	-76.534
1070103	8/27/19 2:36	5.933333	350	38.997	-78.166
1070103	5/30/19 3:54	5.983333	349	38.995	-78.167
1141648	10/1/18 9:37	11.75	240079	36.572	-79.311
1149089	4/4/19 19:24	40.766666	132873	38.348	-77.497
1228478	7/21/19 23:50	10.65	678	38.966	-78.44
1375762	5/23/19 4:47	4.75	227	37.886	-75.553
1411296	5/13/19 2:31	0.033333	0	37.76	-77.462
1431410	12/26/18 6:51	0	0	38.349	-77.497
1431410	6/4/19 0:50	0.466666	0	38.315	-77.473
1431853	5/14/19 18:16	0.45	0	36.856	-76.237
1476802	8/14/19 12:31	NULL	NULL	38.786	-77.556
1476802	8/11/19 18:17	13.133333	599	37.887	-75.556

Further details are needed for the DriveHours and SleepDate fields to fully understand their meaning. It could be possible that some of the trucks in this dataset drove a certain number of hours, took a break, and then drove the remaining hours to complete their 11 hours for the day. This may especially be the case, as drivers are required to take at least a 30-minute break if they have driven for 8 consecutive hours.[8] If so, the analysis could be expanded to include any trucks that drove under 11 hours if more information on the status of the driver, such as on-road time versus break times, was provided. Further clarification of the data provided was not available from the vendors. However, as the data is being presented in its current state, it is not clear, and therefore we are not able to conclude which data points are moments when the truck went out of service for the day or if the driver was taking a break. And, if this determination could be made, it does not account for the roughly 200 DriveHours entries that are an hour or less, with some being as little as less than a minute, or as mentioned earlier, zero.

CHAPTER 4. CONCLUSIONS

Problems encountered with the quantity and quality of the ELD data provided to VTTI for this investigation significantly limited the success of this work. Yahara Software personnel reported multiple issues with obtaining usable data from Trimble through multiple iterations of data requests, preparation, and delivery. Problems related to the quantity of data available stemmed from project budget restrictions and the vendor's unfamiliarity with selling this data and respective pricing. Although VTTI was not privy to the raw data provided by Trimble to Yahara, it is clear that there were numerous issues with the data as it was provided and with the subsequent transformation processes that were used in an attempt to create a reduced and usable dataset.

Given the difficulties encountered during this project with respect to acquiring ELD data of sufficient quality and quantity to enable our analyses, planners, DOTs, and other stakeholders wishing to utilize ELD data for truck parking planning may want to work with large-scale aggregators of this type of information, such as the American Transportation Research Institute (ATRI) or the American Trucking Associations (ATA).

As part of a study conducted through the Safe-D University Transportation Center (UTC), this research team performed a similar analysis with a focus on the interstates and highways within Howard County, Maryland, to determine the level of demand for and supply of designated parking areas for trucks. In this analysis, truck probe data from the INRIX Trips dataset, provided by the Maryland DOT, was sourced to determine whether the demand for truck parking could be reliably predicted and where clustering is occurring, if possible. Two months of data were included in the analysis, March and May of 2019. The March and May datasets contained 2,739,674 and 2,908,362 points, respectively.[(9)] With this level of records to analyze, a much more robust analysis, utilizing complex algorithms, could be completed. Several key areas were identified as locations where truck parking demand may be higher and trucks appeared to be clustering. With these clustering locations in mind, a further analysis on the potential supply of truck parking locations in these areas could be conducted at a much more granular level, with the goal of locating potentially suitable unused land parcels that could be utilized by trucks for overnight parking.

The research team believes that the concept of using electronically recorded driver HOS data to inform the locating of new truck parking facilities is sound in principle. However, this conclusion is predicated on the availably of HOS data that meets the requirements described below.

- Trip data should be continuous from origin to destination and include time, duty status, engine status (running, not running), vehicle speed, and odometer. This will allow for determination of whether the driver is actively operating the vehicle, is resting, or has stopped for other activities such as refueling and loading/unloading.

- Breaks for rest or otherwise should be identified in the trip timeline. This is useful for confirming driving time.

- Data from trucks driven by teams should not be used. The ELD technology in current use does not prevent one member of a team from driving under their partner's HOS.

- Data should not contain null and outlier values.

- Global navigation satellite system location data should preferably be accurate to 5 decimal places (0.00001 m), which corresponds to a resolution of approximately 1.1 m (dependent upon latitude). Lower resolutions may result in the incorrect locating of vehicles with respect to parking area boundaries. This level of accuracy will also assist with the identification of parking that often occurs adjacent to designated parking areas.

- The data should be acquired from an entity that is willing to provide support with its interpretation.

- The use of vehicle location data not integrated directly within the ELD data, such as that from an automatic vehicle locating system, should be avoided.

It should be noted that although ELD regulations have not materially changed during the course of this project, ELD technology and corresponding reporting system technologies have continued to progress. Many of the problems encountered during this investigation may have already been addressed as these systems have evolved.

The research team has also identified several improvements in methods for future potential work.

- Due to the data issues encountered during this work, the methods included only public (i.e., VDOT) parking facilities as an example of how the analyses could be performed. Commercial truck parking facilities should be included in the analysis.

- An initial geofencing task should be performed to ensure that enough vehicle locations lie within the area of interest to provide a sufficiently robust analysis.

- Truck parking facility outer boundaries should be used in lieu of center points when performing geospatial analyses. These facilities vary widely in size, and the use of center points with radii of inclusion may result in vehicles being wrongly identified as outside area boundaries.

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