Safe Fleet Transition Plan: Private Vehicle Crashes and Vehicle Safety Technology

Preliminary Report: Expanding the NYC Safe Fleet Transition Plan to Trade Waste Industry and Private Truck Fleets

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Executive Summary

Private trade waste carting vehicles were involved in 43 reported fatalities and hundreds of self-reported crashes that resulted in injuries in New York City between January 2010 through May 2019, accounting for roughly three percent of all road user fatalities.[1] In coordination with the City of New York's Vision Zero initiative, the New York City Business Integrity Commission's (BIC) oversight of the private trade waste industry expanded in November 2019 to include traffic safety.[2]

In their role managing the city's fleet of over 30,000 vehicles, the Department of Citywide Administrative Services (DCAS) has implemented safety measures on fleet vehicles including truck sideguards, telematics, and changes to vehicle design. DCAS has worked with the Volpe Center on a series of reports including "Truck Sideguards for Vision Zero", the "2017 Safe Fleet Transition Plan" and the "2018 Safe Fleet Transition Plan Update." Funded by DCAS, this report is the fourth in this series of reports and is the first report to be issued in accordance with Mayoral Executive Order 53 that calls for DCAS to assess opportunities to transition to safe and clean fleets for private as well as for public fleets. The Executive Order also calls for DCAS to work with various city agencies, including BIC, to create a partner network to discuss and promote best practices in fleet safety and sustainability. This report will serve as a discussion tool with both private trade waste fleets and other fleets operating large trucks in New York City.

The U.S. Department of Transportation's John A. Volpe National Transportation Systems Center (Volpe) is supporting BIC in its expanded traffic safety mission by building on prior research and best practices developed for the Safe Fleet Transition Plan (SFTP), a systematic framework to implement safety strategies on the City's Fleet. This report is intended to provide BIC with an initial analysis of vehicle design factors and safety technologies that could potentially reduce or mitigate serious crashes involving BIC licensees and registrants; identify preliminary best practices that may be implemented by BIC; and propose priorities for potential future analysis as more comprehensive crash data is collected.

The analysis produced three actionable findings. First, of the 43 reported fatal crashes involving BIC-regulated vehicles from 2010 to 2019, at least ten were found to be start-from-stop visibility-related crashes. All ten of these crashes involved conventional cab vehicles, while none involved a cabover truck. The finding implies a need for improving the driver's direct vision, in particular forward visibility of vulnerable road users. Given the long replacement cycle of trucks, addressing aftermarket direct vision obstructions that are currently used and that appear to play a role in at least some of the reviewed fatal crashes is a near-term opportunity. Volpe identified several private-sector policy and regulatory precedents for prohibiting aftermarket vision-obstructing devices. In the long term the replacement of conventional truck cabs with high vision truck cabs will reduce visual obstructions for drivers.

Second, whereas fatal and injury crashes involving a truck without side guards were fatal 17.2 percent of the time, such crashes involving a side guard-equipped truck were fatal 12.9 percent of the time. While

[1] Data as of May 31, 2019.

[2] Local Law 198 of 2019, Enacted on November 20, 2019. https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=3963903&GUID=A0D12570-7673-4E49-B5B8-4B00387EDD42&Options=&Search=

confounding factors could not be accounted for with currently available data, this is consistent with 25 percent reduction in the crash fatality rate on side guard-equipped trucks.

Third, several of the New York City Safe Fleet Transition Plan (for government fleet vehicles) technologies appeared to be potentially relevant for addressing the largest fraction of the 43 analyzed fatal crashes. These technologies deserve additional consideration in future analysis, including accounting for their potentially different levels of expected effectiveness in preventing or mitigating fatal and injury crashes. Surround cameras, safety lights, and pedestrian automatic emergency braking systems look to be the most promising for trade waste vehicles based on the data studied. Other strategies whose potential applicability could not be screened using the methodology, but which are likely to have high safety value across all crash types, include telematics and driver training.

Introduction

BIC is authorized to issue trade waste removal licenses and registrations. Private carting companies that hold BIC licenses are permitted to collect any type of trade waste including refuse, traditional recyclables, food waste, medical waste, and construction and demolition debris (also known as C&D), among other types of waste. Private carting companies that solely collect C&D material hold BIC Class 2 registrations. Lastly, companies that haul their own waste hold BIC Class 1 registrations.

All combined, these companies have thousands of trucks. A subset of BIC licensees[3] collect waste from approximately 100,000 commercial businesses in New York City each night.[4] By day, over four thousand C&D-hauling vehicles service construction sites across the City. At an average of about four total fatalities per year, this represents about three percent of the 125 vulnerable road user fatalities in NYC in 2018.[5]

National and Local Context

Since 2012, refuse collection trucks across the United States have been involved in an increasing number of fatalities, injuries, and major crashes. Fatalities across the U.S. were 40 percent higher (107) in 2017 than they were in 2012 (77), as seen in Figure 1.[6] In 2017, 75 percent of refuse truck fatalities across the U.S. and Canada involved a private sector refuse vehicle.[7]

[3] Refers only to BIC-licensed carters that collect putrescible waste—refuse, recycling and organics.
[4] https://dsny.cityofnewyork.us/wp-content/uploads/2018/11/CWZ_Plan-1.pdf
[5] https://www1.nyc.gov/assets/visionzero/downloads/pdf/vision-zero-year-5-report.pdf
[6] U.S. Department of Transportation Federal Motor Carrier Safety Administration (FMCSA) (2014). *Large Truck and Bus Crash Facts 2012-2017 editions*. https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/Large-Truck-Bus-Crash-Facts-2012.pdf
[7] Solid Waste Association of North America (2018). *SWANA Releases Sobering Solid Waste Industry Fatality Data for 2017*. https://swana.org/News/NewsDetail.aspx?nc=373

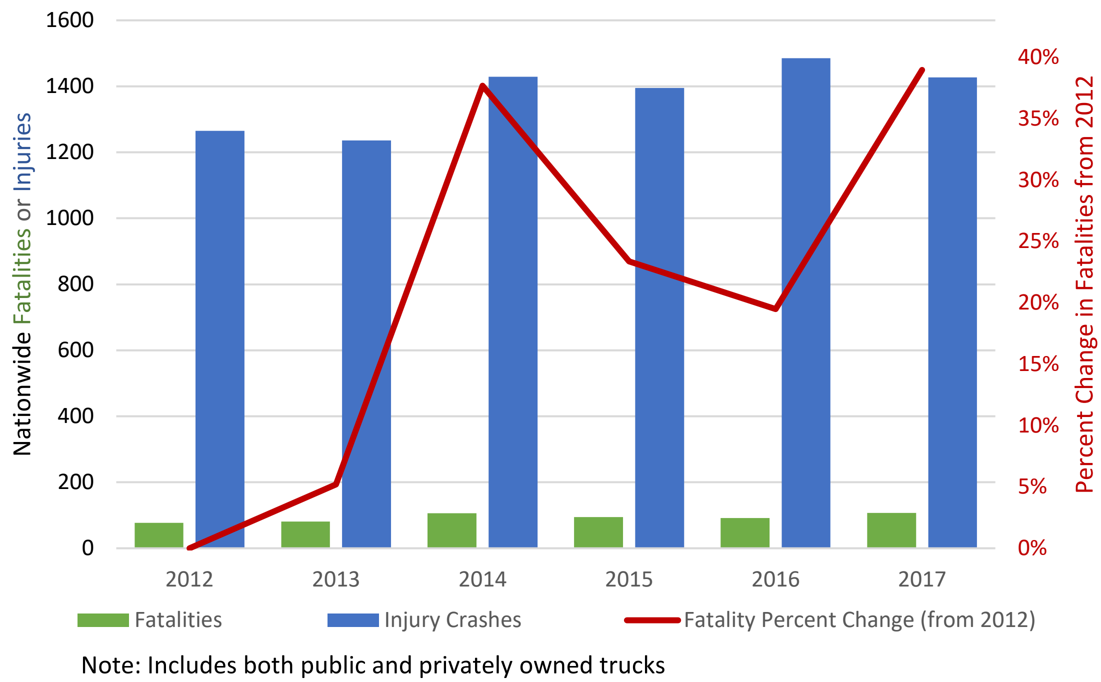

Figure 1. Fatalities and Injuries for Refuse Trucks in U.S. (2012-2017)

Cities and states across the U.S. are pursuing Vision Zero plans, aiming to eliminate fatalities and serious injuries from roadways.[8] Addressing the hazards posed by BIC-regulated vehicles presents another opportunity to advance this goal.

One approach that is underway to improve private carter safety in New York City is the implementation of commercial waste zones across the five boroughs.[9] The plan, which was signed into law in November 2019[10], will divide the city into 20 zones[11], each served by up to three companies selected through a competitive process. According to the NYC Department of Sanitation (DSNY), it will reduce truck traffic associated with commercial waste collection by 50 percent (Figure 2)[12].

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[8] Vision Zero Network (2018). *Vision Zero Cities Map*. https://visionzeronetwork.org/resources/vision-zero-cities/

[9] https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=3963901&GUID=6D5F166D-1834-4EDD-BF64-DA5D1DD88C61&Options=ID%7CText%7C&Search=1574

[10] Local Law 199 of 2019. https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=3963901&GUID=6D5F166D-1834-4EDD-BF64-DA5D1DD88C61&Options=&Search=

[11] Notice of Adoption of Final Rule Establishing 20 Commercial Waste Zones. https://a856-cityrecord.nyc.gov/RequestDetail/20200210107

[12] New York City Department of Sanitation (2018). *Commercial Waste Zones: A Plan to Reform, Reroute, and Revitalize Private Carting in New York City*. https://dsny.cityofnewyork.us/wp-content/uploads/2018/11/CWZ_Plan-1.pdf

Figure 2: New York City Department of Sanitation Commercial Waste Zones

Vehicle Safety Technologies & Strategies

Whereas the commercial waste zone law is intended to improve safety by changing the current operational model, thus reducing exposure of road users to trade waste trucks, this analysis investigates the complementary strategy of improving fleet vehicle safety to prevent and mitigate serious crashes for all private trade waste carting vehicles. This report builds on prior development of the Safe Fleet Transition Plan for the City of New York Fleet, which applies to DSNY and other City agencies and related vehicles and provides a model for this initiative in the private sector.

DCAS Safe Fleet Transition Plan

Under the NYC Vision Zero Action Plan, Recommendation #58 charged DCAS through NYC Fleet with "recommend[ing] safety related devices and designs, such as high visibility vehicles, back-up cameras, and rear wheel side guards, for City vehicles and other vehicles under City regulation." With its 30,000-vehicle City Fleet, DCAS provided a model for potential broader adoption of life-saving safety technologies in other fleets operating in the City via procurement and policy approaches.[13] DCAS had already implemented the nation's largest truck side-guard program and continues to assess and pilot

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[13] City of New York (2014). Vision Zero Action Plan. http://www.nyc.gov/html/visionzero/assets/downloads/pdf/nyc-vision-zero-action-plan.pdf

new approaches and technologies that may enhance safety. NYC Fleet has supported the efforts of BIC in ensuring that side guards are installed on all private waste hauling trucks and continues to work to expand the mandatory use of side guards on trucks.

Volpe partnered with DCAS beginning in 2017 to broadly review and prioritize applicable safety technologies for the full spectrum of City-owned vehicles. The resulting original Safe Fleet Transition Plan formalized a set of NYC Fleet technology and vehicle requirements and best practices to help prevent and mitigate crashes. This SFTP was updated in November 2018. Volpe supports DCAS's regular update process for this document at least once every two years to reflect evolving safety technologies and to guide safer vehicle procurement.

Purpose of this study

In coordination with the City of New York's Vision Zero initiative, under Year Six initiative 6.25, BIC has expanded its oversight of the private trade waste industry to include safety in the trade waste industry.[14] Funded and sponsored by DCAS through NYC Fleet, Volpe is supporting BIC in its expanded traffic safety mission by building on prior research and best practices developed for the Safe Fleet Transition Plan. This report is intended to provide BIC with an initial analysis of vehicle design factors and safety technologies that could potentially reduce or mitigate serious crashes involving licensees and registrants; identify preliminary best practices that may be implemented by BIC; and propose priorities for potential future analysis as more comprehensive crash data is collected and as the safety-related authorities of the agency evolve.

[14] City of New York (2019). *Vision Zero Scorecard*. https://www1.nyc.gov/site/visionzero/initiatives/initiatives.page; https://legistar.council.nyc.gov/LegislationDetail.aspx?ID=3963903&GUID=A0D12570-7673-4E49-B5B8-4B00387EDD42&Options=&Search=

Analysis

The analysis focused on identifying vehicle design factors and safety technologies that could potentially reduce or mitigate serious crashes. Several data sources were used in the analysis. First was BIC's database of vehicles operated by both licensees and registrants, called the "Vehicle Portal". This self-reported database contains the BIC license or registration number, operating company, presence of side guard, among other related data. Second was BIC's crash database, which contains details such as the crash severity, manner of collision, and the vehicle(s) involved. Importantly, the vehicles involved in the crash could be cross-referenced to the Vehicle Portal data. Lastly, in-depth crash investigation information was available for a limited number of crashes, which contained crash reports, photographs of the vehicle and scene, and other information.

There are four main parts to the analysis. First, we analyzed cab type and their relationship to crashes, and found that cabovers have a much lower likelihood to be involved in visibility-related crashes. Second, we analyzed aftermarket products that may obstruct driver vision and found some resources and policy precedents that may be helpful for BIC. Third, we analyzed crash severity and found that crashes involving trucks with side guards are less likely to be fatal. Finally, we completed a screening-level analysis to help prioritize a subset of the most relevant SFTP technologies to further consider for BIC-regulated trucks.

Cab Type and Crash Visibility Analysis

Volpe first compared cab type proportions from the BIC vehicle portal dataset to cab type proportions in the BIC crash dataset to determine whether certain cab types were overrepresented in crashes.[15] Given data limitations that were encountered (as described in the Appendix), a more detailed, crash-level approach was used to determine whether certain cab types were represented in subsets of crash types that appeared to be visibility-related.

The hypothesis was that, while cabover crashes appear more often relative to their fraction of the fleet population (potentially utilization and exposure), these crashes are not as frequently visibility-related as crashes involving conventional cabs.

The approach and results of the latter analysis are summarized here.

Data and method

The vehicle dataset represents BIC-regulated vehicles that were on New York City roads between 2016 and 2019. The dataset was created by selecting all distinct vehicles by vehicle identification number (VIN) from data snapshots of BIC's Vehicle Portal in 2016, 2017, 2018, and 2019. Vehicles that became inactive during or after 2016 were included.

To obtain data on vehicles' cab types, vehicle VINs were run through NHTSA's VIN decoder, which returns manufacturer-submitted information such as make and model.[16] Cab types were coded manually by searching for photographs of the vehicle model. Of the post-2016 crashes, seven percent were missing VINs and could not be matched to a vehicle model. Additionally, not every vehicle was matched to a cab

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[15] Note: Due to more complete nonfatal crash reporting starting 2016, the cab type analysis only used 2016 and later crash data.

[16] National Highway Traffic Safety Administration (2019). *Catalog Vehicle Listing Application Programming Interface*. https://vpic.nhtsa.dot.gov/api/

type due to time constraints. Ultimately, over 80 of the most common vehicle models were coded. This was enough to match 84% of the vehicle portal entries (10,374 of 12,408) and 91% of the post-2016 crashes (206 of 226) to a cab type category.

The cab type categories coded for are identical to the descriptions shown in Figure 3. Smaller vehicles such as vans and pickup trucks were coded as "not applicable."

Licensee and registrant vehicles were examined separately, because the two populations generally operate under different conditions and at different times of day.

Conventional square *Conventional sloped* *High entry cab over* *Low entry cab over*

Figure 3: Truck cab types

In a comparison of all crashes, it can be difficult to control for confounding factors. Therefore, crash narratives were reviewed and coded to inform a quantitative analysis of how often limited driver visibility due to truck cab design appears as a factor in the reported fatal crashes, and the cab types involved in this subset of crashes were considered. Prior Volpe research indicates that the near-field forward visibility of Class 8 cabover refuse trucks can be significantly better than that of conventional cab Class 8 refuse trucks.[17]

Table 1: Data used in Cab Type & Crash Propensity Analysis

	Source Name	Data	Notes
Data Provided by BIC	BIC Vehicle Portal	• BIC registered vehicle population • Licensees or registrants • Vehicle VIN	• Includes data from past four years • Includes currently inactive companies
	BIC Crash Data	• Vehicle VIN	
Data Gathered by Volpe	NHTSA VIN Decoder[18]	• Vehicle make/model obtained by decoding VIN	
	Cab type data	• Cab type manually coded based on pictures of vehicle models	• 84% of vehicle portal entries coded

[17] https://www.volpe.dot.gov/news/VIEW

[18] National Highway Traffic Safety Administration. *VIN Decoder*. https://vpic.nhtsa.dot.gov/decoder

Visibility-related coding

Crashes were manually coded to be “visibility related” or “visibility unrelated.” Crashes were generally labeled as “visibility related” when a decreased field of vision likely contributed to the crash. These were usually instances where the crash narrative:

- indicated that the driver was unable to see the crash victim,
- indicated that the driver was going forward, turning, or starting from a stop, or
- indicated that an increased field of vision would have plausibly helped prevent the crash from occurring.

There are shortcomings in this method, because the coding is based on the crash narrative, and crash narrative recording is not standardized regarding the mention of whether visibility was a factor in the crash. There may be crashes that were visibility related but that we were unable to identify with this method.

Results

Among the cabover fatal and injury crashes, none were determined to be visibility-related. However, 15 of the 70 fatal or injury conventional cab-involved crashes were visibility-related, as seen in Figure 4. Nearly all visibility-related crashes were fatal rather than injury crashes. The involved truck cabs in these 15 fatal visibility-related crashes were about evenly split between sloped and square hoods (Figure 5).

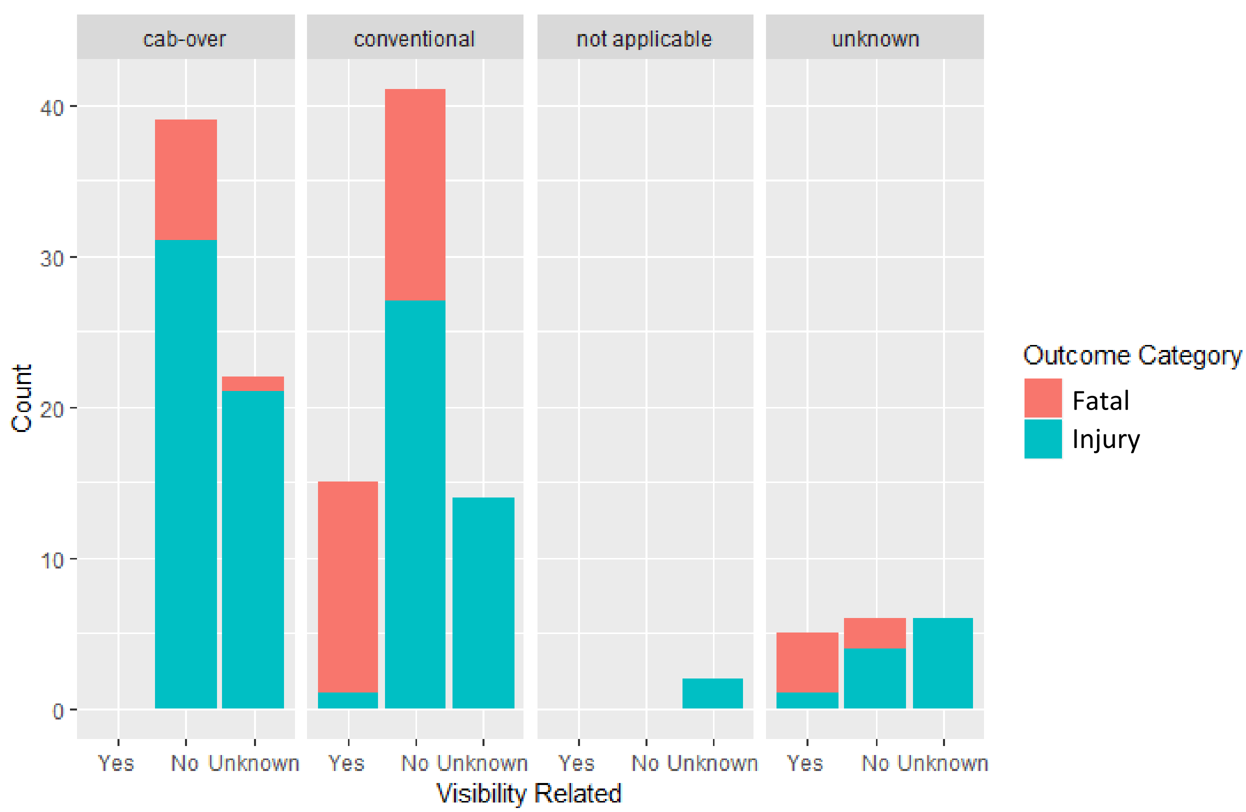

Figure 4. Crash outcome by visibility relevance and by involved truck cab type.

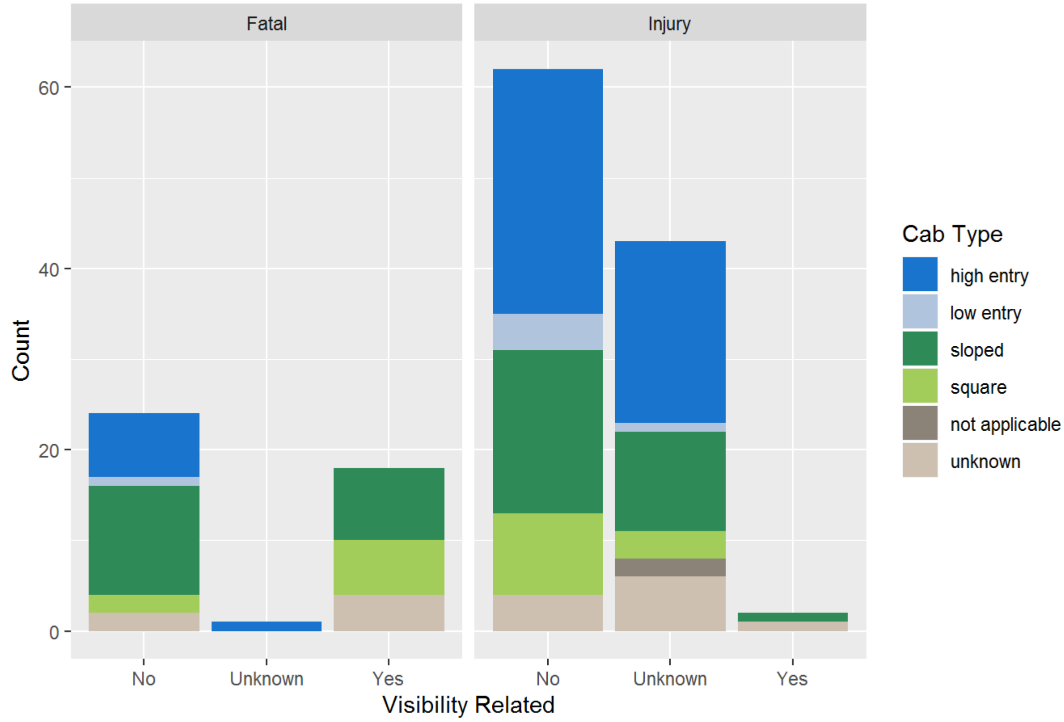

Figure 5. Involved truck cab type in fatal and injury crashes by visibility relevance.

Examples of crashes involving visibility

There is a distinction between a driver who is unable to see a crash victim, and a driver who could have seen them, but did not look. In this analysis, crashes where the driver's view seemed likely to have been obscured by their own truck were coded as "visibility related." Such crashes are likely to be bicyclist or pedestrian crashes because smaller parties are easier to obscure from view.

Crashes involving poor visibility included incidents between a vehicle colliding with another party directly in front of it, often a pedestrian at a crosswalk. If these parties were moving slowly and directly in front of the vehicle, this analysis assumed that the collision was because the operator could not see the other party. Visibility relevance was only coded for fatal and injury crashes.

Starting from stop

One of the most prevalent fatal crash truck actions found was "Starting from Stop", which was the second most common truck action after "Going Straight Ahead". Of 43 fatal crashes, 10 were categorized as "Starting from Stop", which means the crash occurred as the truck accelerated out of a stopped position such as in traffic or parking.

Cab type information was matched for the "Starting from Stop" crashes with VINs, and all 10 of these vehicles were found to have conventional cabs. The conventional cab vehicles were split evenly between square- and sloped-nose shapes.

The common narrative is that a pedestrian began crossing in front of a vehicle stopped at a red light, which then began to move when the light turned green. The cases are about evenly split on whether the pedestrian was crossing in a marked crosswalk or not; some of the cases involve a pedestrian walking several vehicle lengths away from the intersection and directly in front of a truck.

No cabovers were involved in the ten “starting from stop” fatal crashes identified between 2011 and 2018 (Table 2). This suggests that forward visibility plays a large role in preventing these crashes. Cabovers may have encountered similar situations (pedestrian crossing in front) but avoided the crash because the driver saw the pedestrian.

Table 2. Visibility-related starting-from-stop fatal crashes and truck cab type involved

Cab type	Number of crashes
Conventional square	5
Conventional sloped	5
High entry cab over	0
Low entry cab over	0

Aftermarket Vision Obstruction

In addition to direct vision varying between different cab styles, makes, and models, direct vision can be affected by aftermarket equipment placed on or in the truck cab. Commercial vehicle owners and operators sometimes install aftermarket devices on trucks to perform various functions. A data source was not available to determine the prevalence of these devices on BIC-regulated vehicles.

Bug deflectors, one such device, are marketed as reducing the number of bugs that strike the windshield during operation (Figure 6)[19]. These devices measure 6 or more inches in height, are commonly opaque, and attach to the top front edge of a truck hood. Bug deflectors can increase the size of the blind spot in front of the vehicle, decreasing the probability that a pedestrian or bicyclist will be seen by the driver (Figure 7), large “sun visors” that are sometimes installed over the top portion of the windshield may obscure overhead traffic signals or signage, and the driver’s forward view may be obscured where the roadway curves upward, such as at the base of a hill. The crash safety risks of aftermarket visual obstructions, including large bug deflectors and external sun visors in particular, have previously been

[19] American Truck Sales & Salvage. https://images.truckpartsinventory.com/p/51/2008-Freightliner-Cascadia-Miscellaneous-BD3G2J0lUmHU_f.jpg?h=60&w=100&crop=auto

documented by the National Institute for Occupational Safety and Health and by the Commercial Vehicle Safety Alliance.[20]

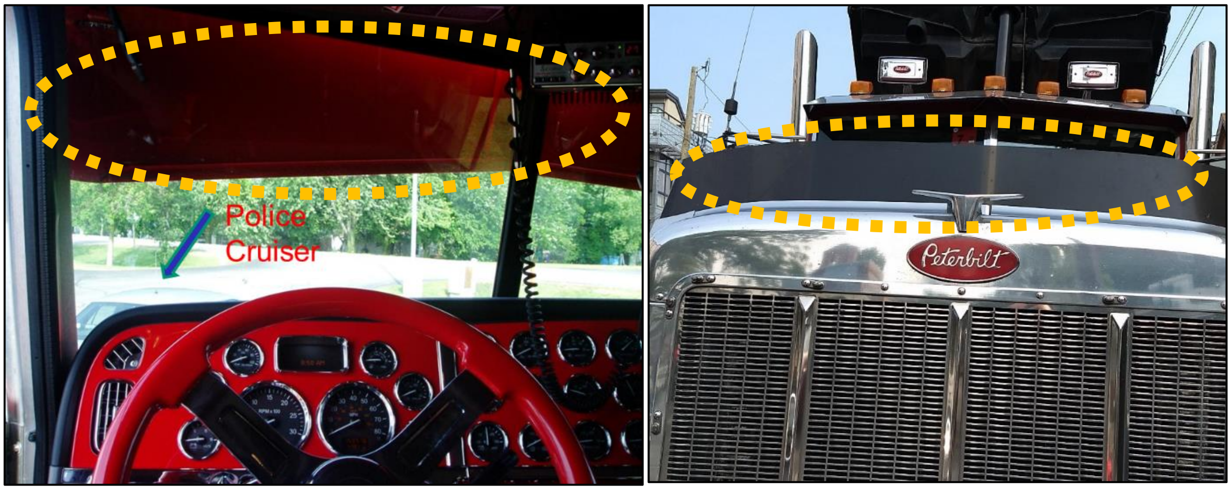

Figure 6. Vision obstruction by aftermarket sun visor (left) and a modified low seat; vision obstruction by bug deflector (right).[21]

In at least one crash, it appears that a large bug deflector may have occluded the driver's view of a pedestrian in front of the truck and contributed to the fatal crash (as schematically illustrated in Figure 7). Without bug deflectors, the heights of conventional cab truck hoods can already obscure pedestrians, as noted in a number of police crash report narratives that Volpe reviewed,[22] and this hood obstruction becomes significantly higher with a tall, opaque bug deflector.

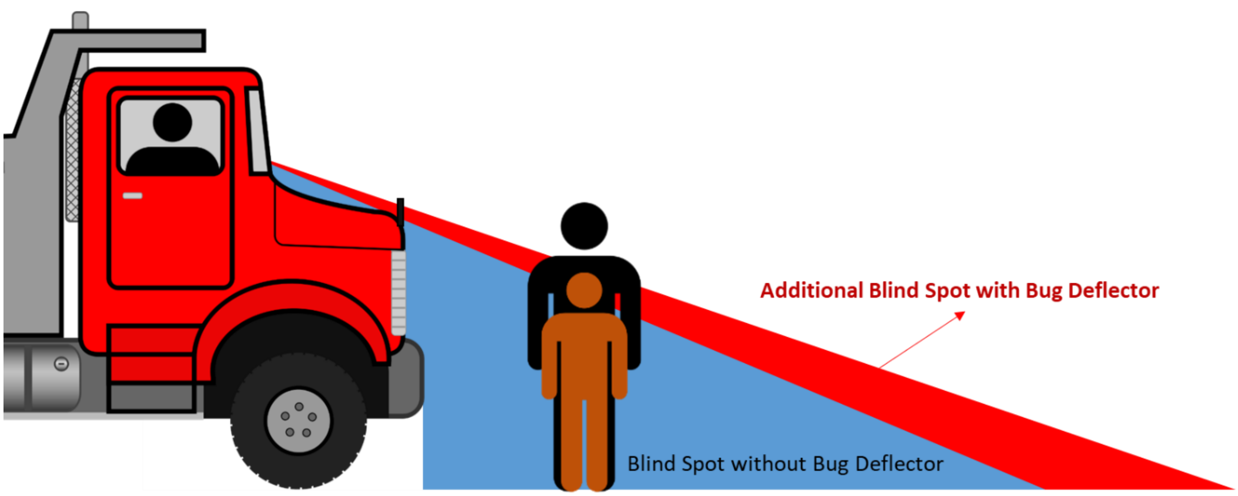

Figure 7. Bug deflector field of vision obstruction schematic

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[20] https://www.workzonesafety.org/files/documents/news_events/wz_conference_2004/heavy_equipment.pdf - see slides 91-94; CVSA Windshield Obstruction Symposium 2013, email communication with William Schaefer.

[21] Sources: Commercial Vehicle Safety Alliance (left); Volpe (right). These are not examples taken from BIC-regulated vehicles.

[22] Example: "…the height of Vehicle #1 being so high off the ground did limit the visibility of the Operator to notice the pedestrian crossing in front of his vehicle."

Policy precedents

As a resource for BIC, Table 3 summarizes selected regulatory precedents as well as industry guidance that Volpe has identified pertaining to bug deflectors, sun visors, and other after-market truck accessories that may obstruct the driver's vision and increase the risk of a crash.

Table 3. Selected Truck Vision Obstruction Statutes and Voluntary Guidance

	Issuing Entity	Rule Excerpt	Scope of Rule
Public (U.S.)	**City of Denver**[23]	"It shall be unlawful for any person to operate any… motor vehicle on or in which: • The operator's vision through any windshield or side wing or window is not both normal and unobstructed; or • Any windshield or side wing or window… is wholly or partially composed, covered, treated or altered in any way with any material, substance, system or component which presents an opaque or nontransparent or a metallic or mirrored appearance, when viewed from outside the vehicle…"	• General vision, including bug deflectors and sun visors • Hanging objects in cab
	State of New York[24]	"It shall be unlawful for any person to operate a motor vehicle with any object placed or hung in or upon the vehicle, except required or permitted equipment of the vehicle, in such a manner as to obstruct or interfere with the view of the operator through the windshield, or to prevent him from having a clear and full view of the road and condition of traffic behind such vehicle."	• General vision
	State of Wisconsin[25]	"Nothing may be placed or suspended in or on the vehicle or windshield so as to obstruct the driver's clear vision through the windshield."	• General vision, including bug deflectors and sun visors
	State of Maryland[26]	"…a person may not drive a vehicle on a highway with any object, material, or obstruction so located in or on the vehicle as to interfere with the clear view of the driver through the windshield."	• General vision, including bug deflectors and sun visors

[23] Revised Municipal Code of the City and County of Denver, Colorado (2017). *§54-76. Windshield and window obstructions.* http://denver-co.elaws.us/code/coor_apxid51335_ch54_artiv_sec54-76

[24] New York State VAT §375-30: http://public.leginfo.state.ny.us/lawssrch.cgi?NVLWO:

[25] Wisconsin Administrative Code Trans 305.34 - Windshields

[26] Maryland Transportation Code (2017). *§21-1004. Obstruction to driver's view or driving mechanism.* https://law.justia.com/codes/maryland/2017/transportation/title-21/subtitle-11/section-21-1104/

	Issuing Entity	Rule Excerpt	Scope of Rule
	State of Ohio[27]	"The director of public safety… shall adopt rules governing the use of transparent, nontransparent, translucent, and reflectorized materials in or on motor vehicle windshields, side windows, sidewings, and rear windows that prevent a person of normal vision looking into the motor vehicle from seeing or identifying persons or objects inside the motor vehicle."	• Bug deflectors • Possibly sun visors
Private (U.S.)	**Republic Services**[28]	"…we do not purchase vehicles with bug defectors and division management is not permitted to add any aftermarket products to our vehicles. Although we understand the purpose of bug deflection devices, these products can add visibility concerns."	• Bug deflectors
Private (International)	**Australia Truck Industry Council**[29]	"The following modifications are deemed to be unacceptable, in that such modifications are likely to have a negative impact on the safe operation of the vehicle: • Fitting of chrome or other opaque **bug deflectors**, name plates, etc, that reduce the drivers forward field of view, and conceal close in vehicles or pedestrians, • Non-original equipment manufacturer **external sun visors** that protrude below the tinted band across the top of the windscreen, • Non-original equipment manufacturer **internal sun visors** that reduce field of view."	• Bug deflectors • Sun visors

Side Guard Analysis

Truck side guards or lateral protective devices (LPDs) are vehicle-based safety devices designed to keep pedestrians, bicyclists, and motorcyclists from being run over by a large truck's rear wheels in a side-impact collision. Since 2015, BIC has partnered with NYC DOT and NYC DCAS to administer incentive partial rebates to eligible licensees and registrants to voluntarily purchase and install side guards. In this

[27] Ohio Revised Code (2013). *Chapter 4513.241. Using tinted glass and other vision obscuring materials.* http://codes.ohio.gov/orc/4513.241v1

[28] Quote from Republic Services company policy. Republic Services is not regulated by BIC.

[29] Australia Truck Industry Council (2015). *Voluntary Code of Practice to Ensure an Adequate Field of View*. https://docs.wixstatic.com/ugd/14b5b1_5d65223fcf354ed3991eeb101f9ebede.pdf

analysis, Volpe sought to determine whether the available crash data could be used to understand how the severity of crashes is being affected by side guard use on BIC-regulated vehicles.

Method

To analyze how lateral protective device presence on vehicles affects crash severity, the severity proportions were compared among injury and fatal crashes involving vehicles either equipped or not equipped with side guards. For this analysis, Volpe only considered crash data from 2016 onward, because in 2016 improvements were made to BIC's data reporting that led to more accurate collection of non-fatal injury crashes. Volpe also excluded any crashes where the previous cab type analysis had identified the vehicle model as a small pickup or van, for which side guards would be less likely to play a crash mitigation role (shorter wheelbase, lower ground clearance). One of the self-reported fields included in the BIC Vehicle Portal indicates whether a given licensee and registrant vehicle is side guard-equipped.

Results

Comparing the absolute numbers of each crash severity among the side guard-equipped and non-equipped vehicles, it can be seen in Table 4 that non-equipped vehicles have more fatal and injury crashes than equipped vehicles. This could suggest that the presence of a side guard shifts crash outcomes to decreased severities. The numbers of equipped and non-equipped vehicles are unequal, so the absolute crash outcome numbers for each population should not be directly compared. The "Unknown" row reflects crash outcomes involving vehicles with unspecified side guard status in the Vehicle Portal. Note that property damage crashes were excluded because the side guards implemented on BIC-regulated vehicles are designed to protect vulnerable road users, not motor vehicles. The reported property damage crashes generally involved damage to motor vehicles, not injury to VRUs.

Table 4. Crash population by side guard presence and by outcome severity

	Fatality	Injury	Total
No side guard	11	53	64
Yes side guard	4	27	31
Unknown	3	17	20
Total	18	97	115

To control for the unequal numbers of equipped versus non-equipped vehicle, severity proportions between fatal and injury crashes were instead compared. As can be seen in Table 5, among crashes involving at least an injury and a truck without side guards, 17.2% were fatal. Among such crashes involving a side guard-equipped truck, 12.9% were fatal. While the analysis relies on a small sample size, the decrease from 17.2% to 12.9% percent fatal severity suggests a 25 percent decrease in the fatality rate of crashes involving side guard-equipped trucks.

Table 5. Proportion of crash population by sideguard presence and by crash severity

	Fatality	Injury
No side guard	17.2%	82.8%
Yes side guard	12.9%	87.1%
Unknown	15.0%	85.0%
Total	15.7%	84.3%

It should be noted that a large number of unknown side guard status trucks were present in the Vehicle Portal and crash data due to the self-reporting nature of the BIC vehicle database. Three sensitivity analyses were performed with the assumptions that unknown vehicles were either all side guard equipped, none equipped, or equipped at the same ratio as the known vehicles. The magnitude of the fatality rate decrease for side guard-equipped trucks varied in the three scenarios, but the finding did not qualitatively change. Additionally, an attempt was made to identify side guard presence on outcome severity in only the crash scenarios most relevant for side guards (pedestrian or bicyclist impacts the side of the truck), based on coding crash data, but a number of data challenges were encountered that limited such finer grained analysis. Further details are provided in the Appendix.

SFTP Technology Relevance for Trade Waste Crashes

The DCAS Safe Fleet Transition Plan was developed for a fleet of over 30,000 diverse vehicle types across all weight classes. In contrast, the fleets of BIC licensees and registrants are relatively homogeneous, consisting mostly of heavy-duty refuse, dumpster, box trucks, as well as a small number of vans and pickups. Any implementation of safety technologies for the BIC-regulated fleet needs to account for the types of vehicles in the fleet and the types of fatal and injury crashes in which these vehicles are involved.

Using the provided crash data, Volpe completed a screening-level analysis to help prioritize the most relevant SFTP technologies to further consider for BIC-regulated trucks.

Method

All reported fatal crashes involving BIC--regulated vehicles between 2010 and 2019 were coded by truck action prior to collision and by impact point, based on review of the police crash reports (MV-104). Additionally, fatal crashes were coded by victim type: bicyclist, pedestrian, or motorist.

Volpe reviewed and filtered the full list of 2018-2019 SFTP technologies[30] for relevance to medium- and heavy-duty trucks with gross vehicle weight ratings over 10,000 pounds. Excluding technologies applicable only to light-duty vehicles reduced the list from 33 to 30. Each technology was also categorized as original equipment manufacturer (OEM, available only on new vehicles), aftermarket, or both.

[30] http://www.nyc.gov/html/dcas/downloads/pdf/fleet/Safe-Fleet-Transition-Plan-Update-2018.pdf

Using best professional judgment, Volpe staff coded which types of crash victims, pre-crash truck actions, and impact points would likely be addressed by each technology. A detailed summary of this coding is shown in the Appendix as **Error! Reference source not found.**.

The historical fatal crashes that were *potentially* addressable by each SFTP technology were totaled, yielding an upper bound number of fatal crashes from 2010 to 2019 that each countermeasure *may* have been able to prevent or mitigate. Due to their broad applicability across all crash types, safety-supporting strategies such as telematics, event recording cameras, and driver training do not appear in this analysis; however, these broad strategies would be important to consider in any future safety initiatives for BIC regulated vehicles.

Results

In ranked order from greatest to least, Figure 8 displays the SFTP technologies by the number of potentially addressable reported fatal crashes from 2010 to 2019. Nineteen of the technologies were matched to at least one fatal crash, while eleven could not be matched to specific crash types based on their indirect influence (e.g., telematics or driver training) or their exclusive relevance to truck driver safety (e.g., seatbelt assurance), considering that no BIC-regulated truck drivers were killed in crashes over the period. The top three technologies, by potential relevance to the largest number of fatal crashes, were safety lights, high vision truck cabs, and pedestrian automatic emergency braking.

Among the aftermarket technologies which could be implemented on existing vehicles, safety lights, pedestrian collision warning systems, surround cameras, and additional mirrors ranked highest. Reflecting the trend that the victims in BIC-regulated vehicle crashes have not generally included the driver, safety technologies such as seat belt assurance systems ranked lowest. An unexpected finding was that backup alarms and backup cameras rated relatively low, even though trade waste trucks are reported to frequently back up during collection routes. Four of the 43 fatal crashes involved a reversing truck.

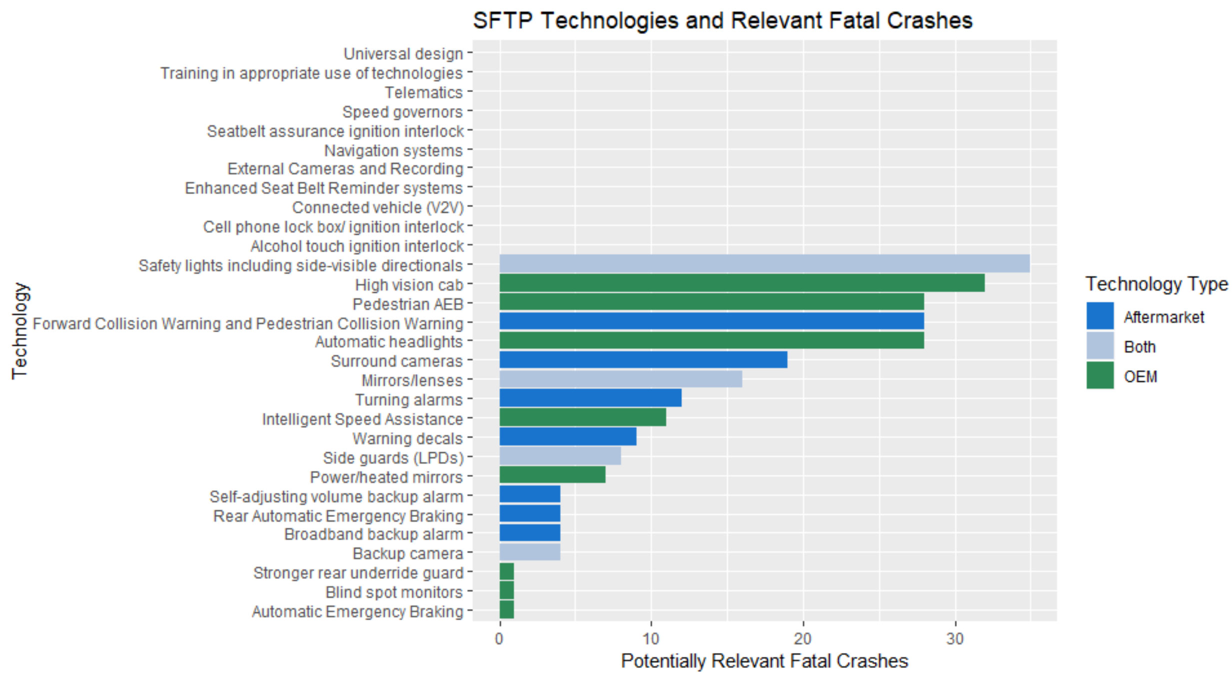


Figure 8. Number of historical fatal crashes potentially addressable by SFTP technologies

Table 6. Truck actions and area of impact in reported fatal crashes

Truck action (below) Impact point (right)	FRONT	OTHER OR UNKNOWN	REAR TIRES OR AXLES	SIDE	Grand Total
BACKING UP			3	1	4
CHANGING LANES			1		1
GOING STRAIGHT AHEAD	7	1	1	3	12
LEFT TURN	4			1	5
OTHER OR N/A	2				2
OVERTAKING	1				1
RIGHT TURN	5	1		2	8
STARTING FROM STOP	9		1		10
Grand Total	**28**	**2**	**6**	**7**	**43**

The above screening analysis should not be interpreted as a definitive ranking or as a recommendation, but rather as a way to focus future assessment of promising countermeasures for BIC-regulated vehicles. The analysis comes with two significant caveats:

- The ranking is based on *potential* technology relevance to crashes, since actual relevance could not be determined from the available data, which do not include presence or absence of any of the technologies (except side guards);

- The ranking does not account for how *effective* any technology would be for preventing or mitigating a given type of relevant crash, i.e., how many lives they may be expected to save. For example, a technology that is 80% effective in addressing a given fatal crash type would be more beneficial for one relevant crash than a different technology that is only 30% effective in two relevant crashes. To compare the relative expected benefit of implementing each technology, relevant crashes would need to be multiplied by how effective the safety technologies are in those situations, while accounting for overlap between the crash types they can address.

It should be noted that implementing some of the SFTP technologies would require consideration of operator training (to ensure effective use and reduce the chance of misuse, deactivation, etc.), product availability, and enforceability related to maintaining equipment in working order.

Conclusion

Actionable Findings

A number of actionable findings emerge from the initial analysis described in this report.

First, of the 43 reported fatal crashes involving BIC-regulated vehicles from 2010 to 2019, at least ten were found to be start-from-stop visibility-related crashes. All ten crashes involved conventional cab vehicles, while none involved a cabover truck. The finding implies a need for improving the driver's direct vision, in particular forward visibility of vulnerable road users, encouraging fleet purchase and use of best-in-class cabs. However, additional data and research is needed to determine whether certain types of cabover trucks have a lower crash risk compared to conventional trucks. Moreover, given the long vehicle replacement cycle of licensee and registrant trucks, addressing aftermarket direct vision obstructions that appear to play a role in certain reviewed fatal crashes is an immediate opportunity to potentially reduce such fatal crashes. A number of private-sector guidance and regulatory precedents have been identified that may be referenced as starting points.

Second, whereas fatal and injury crashes involving a truck without side guards were fatal 17.2 percent of the time, such crashes involving a side guard-equipped truck were fatal 12.9 percent of the time. While confounding factors could not be accounted for with currently available data, this is consistent with 25 percent reduction in the crash fatality rate on side guard-equipped trucks.

Third, several of the New York City Safe Fleet Transition Plan (for government fleet vehicles) technologies appeared to be potentially relevant for addressing the largest fraction of the 43 analyzed fatal crashes. These technologies deserve additional consideration in future analysis, including accounting for their potentially different levels of expected effectiveness in preventing or mitigating fatal and injury crashes. Surround cameras, safety lights, and pedestrian automatic emergency braking systems look to be the most promising for trade waste vehicles based on the data studied. Other strategies whose potential applicability could not be screened using the methodology, but which are likely to have high safety value across all crash types, include telematics and driver training.

Finally, certain self-reported Vehicle Portal data fields such as vehicle miles traveled (VMT) and side guard status are currently sparsely populated. Taking steps to collect additional data on these points from licensees and registrants—including potentially requiring telematics-based data to be collected and reported—would make expanded and more accurate future safety analysis possible.

Recommended Future Analysis

Volpe's initial analysis suggests a number of future areas of data collection and research to further inform BIC's safety role for the trade waste industry. These future data needs and proposed future analysis include:

- Better understanding crash rates normalized by collecting vehicle-level exposure data, including annual VMT and streets traveled. BIC-regulated vehicles and companies have different operations with different safety risks, and this exposure denominator is needed to understand where certain vehicle configurations are indeed more likely to be in fatal or injury crashes.
- Incorporating more detailed vision-related cab configuration data, such as size of windows on each side, narrow versus wide cab,[31] to understand which cab design factors are associated with higher crash risk. This could help overcome confounding factors that render the initial cab-type analysis across all crash types inconclusive (as described in the Appendix).
    - The analysis approach may be either qualitative or quantitative.
        - Qualitative: based on typical make and model configuration for OEM condition, and driver point of view photos to assess aftermarket vision obstructions in fatal and injury crashes.
        - Quantitative: measuring blind spot widths due to the A-pillars of selected models and collecting onsite data using a camera and seat stand to quantify blind spot volume ratings of actual trade waste vehicles, including any aftermarket visual obstructions, such as hood-mounted bug deflectors, sun visors, and dash-mounted devices.
- Data on mirror configurations of trucks involved in fatal and injury crashes (may be coded via external vehicle photos from crash investigation records) to assess where these safety features were notably absent or defective in crashes where *indirect* vision was a possible factor.
- More complete data on truck point of impact in PARs, to refine SFTP technology prioritization.
- Research and estimate potential effectiveness of the most relevant SFTP technologies for addressing their respective crash types on the licensee and registrant fleets. This analysis could help inform future BIC initiatives to implement certain additional safety technologies, building on previous requirements concerning side guards.

Related safety support opportunities include:

- Attend or otherwise engage BIC's Interagency Collision Review Panel, to baseline how post-crash analysis is currently conducted and provide feedback as appropriate.
- Identify additional BIC vehicle and crash database fields that should be considered to improve future safety evaluation of trade waste vehicles based on identified gaps in the crash analysis.
- Train one or more partner fleet staff to use the smartphone-based blind spot measurement methodology, and support BIC in obtaining driver feedback validation on the perceived accuracy of the ratings compared to drivers' experience operating these truck models.

[31] Cab width can vary widely, with the distance from a driver's eyes to the passenger side window ranging from 54 inches to 71 inches in two common refuse models Volpe has measured.

- Work with BIC to adapt an existing, well-received truck operator training video[32] to drivers in the NYC trade waste industry.

Appendix

Data sources

- Removed crashes that occurred outside of BIC's jurisdiction:
  - Crashes that took place outside of New York city's five boroughs
  - Crashes at the time of which the company did not have a valid BIC license or registration
- Data "gaps" and "opportunities" were noted for obtaining an accurate snapshot of both the vehicle and fleet states at the time of a given crash; one solution would be to save and archive a copy of these data every month.

Summary of self-reported crash data that is used in the analyses above:

- 265 total crashes involving BIC-regulated vehicles
- 226 of which were in 2016 or later
- 18 of which were fatal (post-2016-May 2019)
- 43 were fatal crashes (2010-May 2019)
- 188 of which were licensee crashes (for all outcomes, post-2016)

VMT data from Vehicle Portal

- 82% of vehicles do *not* have VMT data, when considering the combination of multiple years of vehicle portal data and including the inactive vehicles (approx. 12,408 entries). Note: this is not currently a required field. Telematics systems could streamline and ensure more complete and accurate collection of this data.

New data that Volpe generated based on what BIC provided:

- Cab Type coding
  - Conventional sloped hood or square hood
  - Low/high entry cabover coding criteria: seat over wheel = high entry and seat in front of wheel = low entry. Note: Low-entry cabover can also be referred to as "cab forward."
- Additional crash coding
  - crash maneuver (fatals only)
  - impact location (fatals only)
  - visibility-related (fatals and injuries only)

[32] https://vimeo.com/307147180

Most Common Vehicle Models

	Vehicle Portal		Post-2016 Crashes	
	Vehicle Model	# Entries	Vehicle Model	# Entries
1	Mack RD	898	Mack MR	45
2	Mack GU	662	Mack MRU	26
3	Kenworth T880	625	Kenworth T8 Series	16
4	Kenworth T8 Series	583	Mack GU	16
5	Ford F-550	487	Peterbilt 567	12
6	Mack CV	400	Peterbilt 320	10
7	Peterbilt 567	367	Mack RD	9
8	Mack MR	345	Mack CV	8
9	Peterbilt 379	340	Peterbilt 520	8
10	Ford F-350	281	Kenworth T880	7

Licensee Breakdown

	Vehicle Portal (Licensees Only)		Post-2016 Crashes (Licensees Only)	
	Vehicle Model	# Entries	Vehicle Model	# Entries
1	Mack MR	316	Mack MR	45
2	Mack RD	315	Mack MRU	26
3	Mack GU	216	Mack GU	11
4	Mack CV	150	Kenworth T8 Series	10
5	International MA025	139	Peterbilt 320	10
6	Freightliner M2	115	Peterbilt 567	9
7	Mack MRU	104	Peterbilt 520	8
8	Peterbilt 567	102	Mack CV	7
9	Kenworth T880	96	Mack RD	6
10	Kenworth T8 Series	87	Autocar Xpeditor	5

Registrant Breakdown

	Vehicle Portal (Registrants Only)		Post-2016 Crashes (Registrants Only)	
	Vehicle Model	# Entries	Vehicle Model	# Entries
1	Mack RD	583	Kenworth T8 Series	6
2	Kenworth T880	529	Kenworth T880	6
3	Kenworth T8 Series	496	Mack GU	5
4	Ford F-550	449	Mack RD	3
5	Mack GU	446	Peterbilt 567	3
6	Peterbilt 379	323	Ford F-550	2
7	Peterbilt 567	264	International MA025 Cam Superline	2
8	Ford F-350	263	Cam Superline	1
9	Mack CV	250	Ford F-350	1
10	Peterbilt 389	187	Mack CTP	1

Note: Table less accurate towards end due to small *n*.

Side Guard Analysis – Additional Sensitivity Analysis

Scenario 1: Unknowns all have side guards

Percentage breakdown of outcome by row, now assuming that every “Unknown” is actually a “Yes”: When all unknown crashes are assumed to have been with side guard-equipped vehicles, “side-guarded" vehicles have a greater proportion of fatal crashes than vehicles lacking a side guard. However, they still have a smaller proportion of injury crashes and a larger proportion of property damage crashes than the “No” vehicles.

	Fatality	Injury
No side guard	17.2%	82.8%
Yes side guard (including Unknowns)	13.7%	86.3%

Scenario 2: Unknowns all do not have side guards

Percentage breakdown of outcome by row, now assuming that every “Unknown” is actually a “No”:

	Fatality	Injury
No side guard (including Unknowns)	16.7%	83.3%
Yes side guard	12.9%	87.1%

Scenario 3: Assume unknowns match proportion of known side guard entries

Assume that within each outcome category, the unknown companies’ side guard yes/no proportions match those of the known Side Guard entries for Class 8 trucks in the vehicle portal:

To calculate this proportion, use only vehicles at weight class 5 and above. These are most likely to be trucks that could actually benefit from side guards, unlike a Class 2 pickup truck, for example.

(Should be acceptable because in the crash data there is only 1 entry of 269 known to be below Class 5 (there are 23 with unknown weight classes). In fact, 205/269 (76%) are Class 8. This percentage rises to 83% (189/227) if filtering for post-2016. Of the post-2016 crashes, it’s 92% (159/173) for licensees and 81% (30/37) for registrants.)

For example, the proportion of known “Yes”s in the vehicle portal can be calculated as (Count of “Yes) / (Count of ”Yes" + Count of “No”).

This method does not account for the possibility that companies reporting their side guard status are a good representation of all companies in the vehicle portal. For example, there is a possibility that the “Unknown” vehicles are actually mostly “No”s, because those companies could have been reluctant to report that their trucks were missing safety features.

For now, the proportion is still a better estimate than assuming all “Yes” or all “No”’s. The calculations are as follows:

$$Yes_{weighted} = \frac{Yes}{Yes + No}$$

$$No_{weighted} = \frac{No}{Yes + No}$$

```
## Yes / (Yes + No) for Vehicle Portal Class 5 and Over =  0.168

## No / (Yes + No) for Vehicle Portal Class 5 and Over =  0.832
```

Scale the Unknown row by these weights and add resulting scaled rows to the Yes and No rows:

	Fatality	Injury
No side guard	11.504	55.856
Yes side guard	6.496	41.144

This is consistent with the following severity proportions:

	Fatality	Injury
No side guard	17.1%	82.9%
Yes side guard	13.6%	86.4%
Total	15.7%	84.3%

Coding and analysis of most relevant crashes

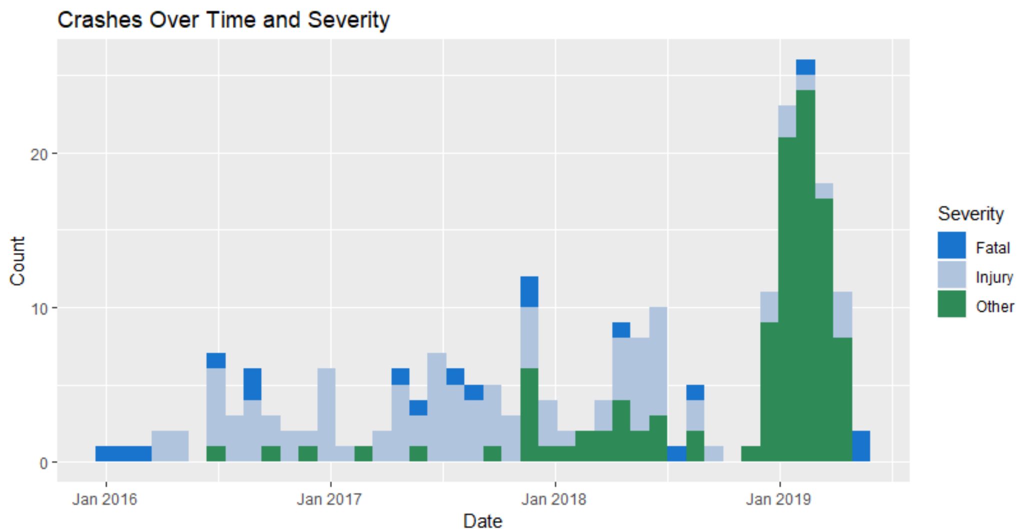
Volpe attempted to perform a more specific analysis to estimate side guard effectiveness by coding reported crashes for side guard relevance and only analyzing crashes in which the sideguard could have been a factor in reducing the crash severity. This required coding the crashes based on crash maneuver and impact location (using the same methodology as the SFTP technology analysis), and only using the crashes where the impact location is “Rear Wheel” or “Side” and the vehicle was moving forward or turning left or right.

This analysis may not be conclusive because of the small number of crashes where a side guard could be determined to be relevant based on the crash report narratives. Without video footage of a crash, the relevance of a side guard can be difficult to code with confidence from crash narratives—for example, whether the victim was struck by the front, the front of the side, or the middle of the side of a truck. Photos of the vehicles at the time of each crash would be needed to verify side guard presence, and a photo inventory of all BIC-regulated vehicles would allow for Vehicle Portal data verification. BIC has access to photos of vehicles that have been retrofit to comply with NYC’s Vehicle Emissions Law, Local Law 145 of 2013—but this represents a small fraction of the total vehicle population.

An additional limitation is that crash report data may not exist for incidents in which a pedestrian or bicyclist comes into contact with a side guard and suffers only minor injury or no injury. With comprehensive data on such minor injury crashes, more accurate comparison of injury severity would be possible.

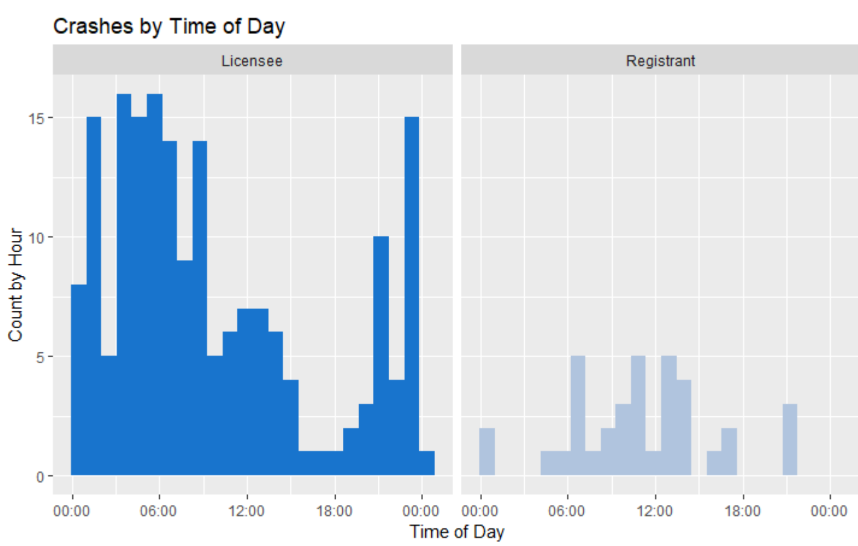
Descriptive Statistics

Reported crashes involving BIC regulated vehicles appear to be rising drastically over the last several years, particularly for less severe crashes. However, this trend most likely reflects evolving requirements for reporting crashes to BIC.



Licensees and Registrants

The difference between licensees' and registrants' operations becomes clear when each group's crashes are plotted by time of day. Licensee crashes peak at night, when haulers run their routes. Registrant crashes, on the other hand, occur primarily between 6:00 a.m. and 6:00 p.m., during typical working hours for a registrant company.

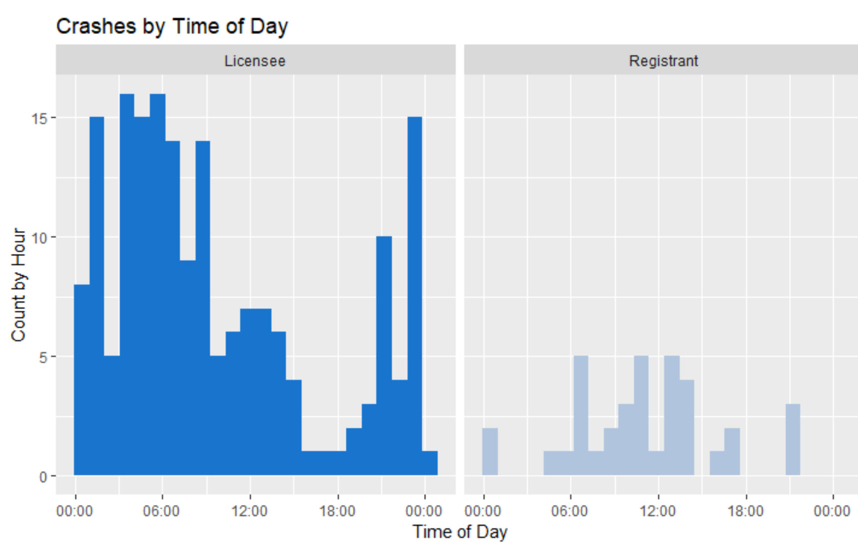


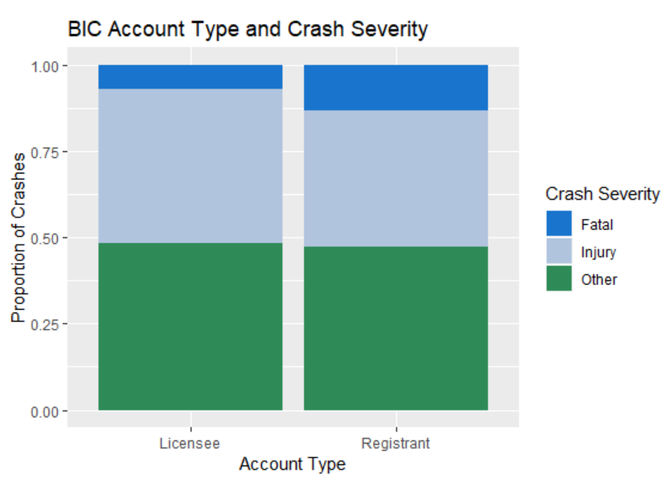
Additionally, while registrants make up 71% of the vehicle portal, only 17% of post-2016 BIC crashes involve registrant vehicles. Considering that they comprise less than a third of BIC vehicles, licensees are substantially overrepresented in the crash data, crashing at a rate over 10 times that of registrants. This may be partially explained by the reduced visibility that licensees face during nighttime drives, or the greater proportion of heavy-duty trucks in licensee vehicles (72% of licensee vehicles are Class 7 or above, compared with 62% of registrant vehicles).

Licensees crash at a rate ten times higher than registrants on a per-vehicle basis, but registrants' fatal proportion of crashes is substantially larger than licensees.

Table 7. Table calculating crash rates for BIC account types. While registrants operate more vehicles, licensees account for a majority of the post-2016 crashes.

	Vehicles Operated in 2016 to May 2019 (based on all vehicles in Vehicle Portal, both active and inactive)	**Crashes in 2016 to May 2019**	**Crashes Per Hundred Vehicles**
Licensee	3,557	188	5.29
Registrant	8,851	38	0.43
Licensee and Registrant	12,408	226	1.82





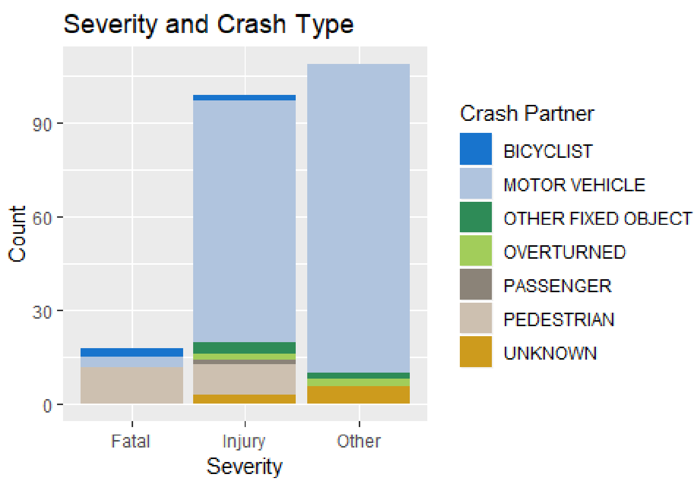
	Fatal	Injury	Other
Licensee	13	84	91
Registrant	5	15	18

Weight breakdown

Crash Victim

While nearly 4 in 5 (79%) post-2016 crashes are between a BIC-regulated truck and another motor vehicle, this proportion decreases as crashes become more severe. Pedestrians and bicyclists, which are heavily overrepresented in fatal crashes, emerge as particularly vulnerable road users. Fewer than two percent of motor vehicle crashes were fatal, compared with 55% of pedestrian crashes and 60% of bicyclist crashes. It is possible that non-injury (or minor injury) bicyclist/pedestrian crashes occurred over the time period but were not reported because there was no property damage.

	Fatal	Injury	Other	Sum
BICYCLIST	3	2	0	5
MOTOR VEHICLE	3	77	99	179
OTHER FIXED OBJECT	0	4	2	6
OVERTURNED	0	2	2	4
PASSENGER	0	1	0	1
PEDESTRIAN	12	10	0	22
UNKNOWN	0	3	6	9
Sum	18	99	109	226



Cab Type and Crash Propensity

The purpose of this analysis is to determine whether the type of cab (conventional vs. cabover) on a truck is associated with higher crash rates for BIC licensees and registrants.

Results

Cab-over types are a minority in both licensee and registrant populations

	cab-over	conventional	not applicable	unknown	Sum
Licensee	937	1866	211	543	3557
Registrant	607	5060	1693	1491	8851
Sum	1544	6926	1904	2034	12408

Figure 9. Table of BIC account types and cab types present in the Vehicle Portal. Cab-Over vehicles are a minority for both licensees and registrants, but make up a proportion of licensees nearly four times greater than that of registrants. Registrants, on the other hand, are more likely to be conventional-cab vehicles or smaller vehicles such as pickup trucks.

A comparison was made between the proportion of each cab type in the Vehicle Portal data and the same cab type's proportion in the crash data. If cab type did not impact crash risk, then one could expect the proportions of cab types to be about equal. For example, if 30% of vehicles are cabover, 30% of crashes could be expected to also be cabover. While this hypothesis is simplistic, as there may be significant confounding factors such as the varying utilization patterns of different cab types, the results may offer insight into the relationship between cab type and crash risk.

Figure 10 shows the analysis results. Licensees and registrants are analyzed separately, because they are known to have different behavioral patterns (type of material carried, time of day, etc.). For licensees, the proportion of cabover vehicles, especially high-entry cabs, is twice as high in crashes (56%) than in the Vehicle Portal (24%). On the other hand, for registrants the proportion of cabover vehicles is lower in crashes than in the Vehicle Portal (although this may not be unusual given there are only 38 post-2016 registrant crashes – a low *n* issue). For registrants, the sloped conventional cab type is the one overrepresented in the crash data.

Comparing the proportion of cab-over and conventional cab types between crash data and Vehicle Portal data, for licensees and registrants

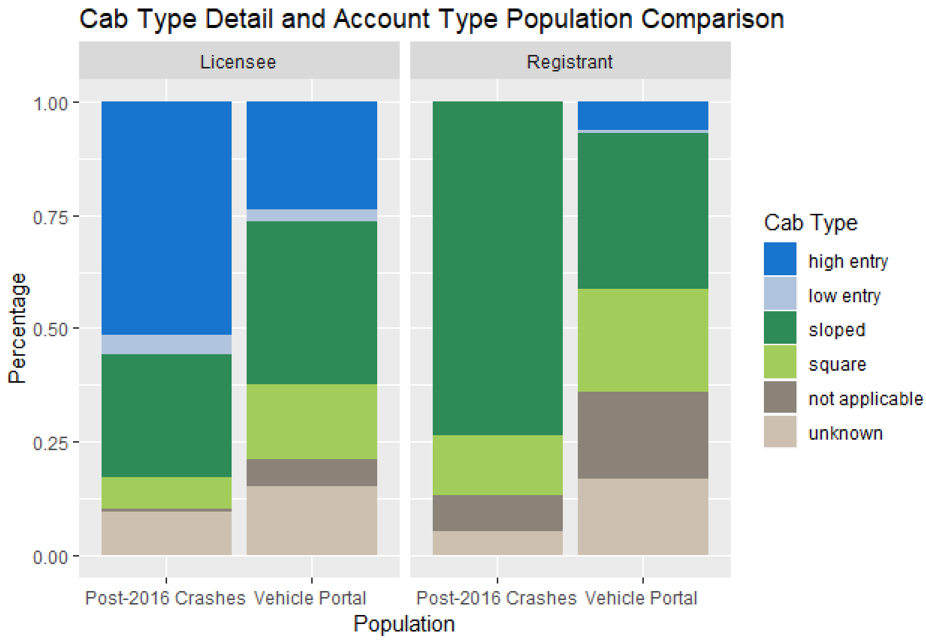


Figure 10: Cab Type Detail and Account Type Comparison.

	Licensee				Registrant			
	Post-2016 Crashes		Vehicle Portal		Post-2016 Crashes		Vehicle Portal	
High entry	97	52%	843	24%	0	0%	547	6%
Low entry	8	4%	94	3%	0	0%	60	1%
Sloped	51	27%	1,289	36%	28	74%	3,056	35%
Square	13	7%	577	16%	5	13%	2,004	23%
Not applicable	1	1%	211	6%	3	8%	1,693	19%
Unknown	18	10%	543	15%	2	5%	1,491	17%
Total	188		3,557		38		8,851	

Comparing severity proportions for each cab type's crashes

Within crashes, it appears that conventional crashes are more likely to be fatal. Six percent of cab-over crashes are fatal, compared with 12% of conventional ones. Cab-over crashes have a greater proportion of nonfatal injury crashes.

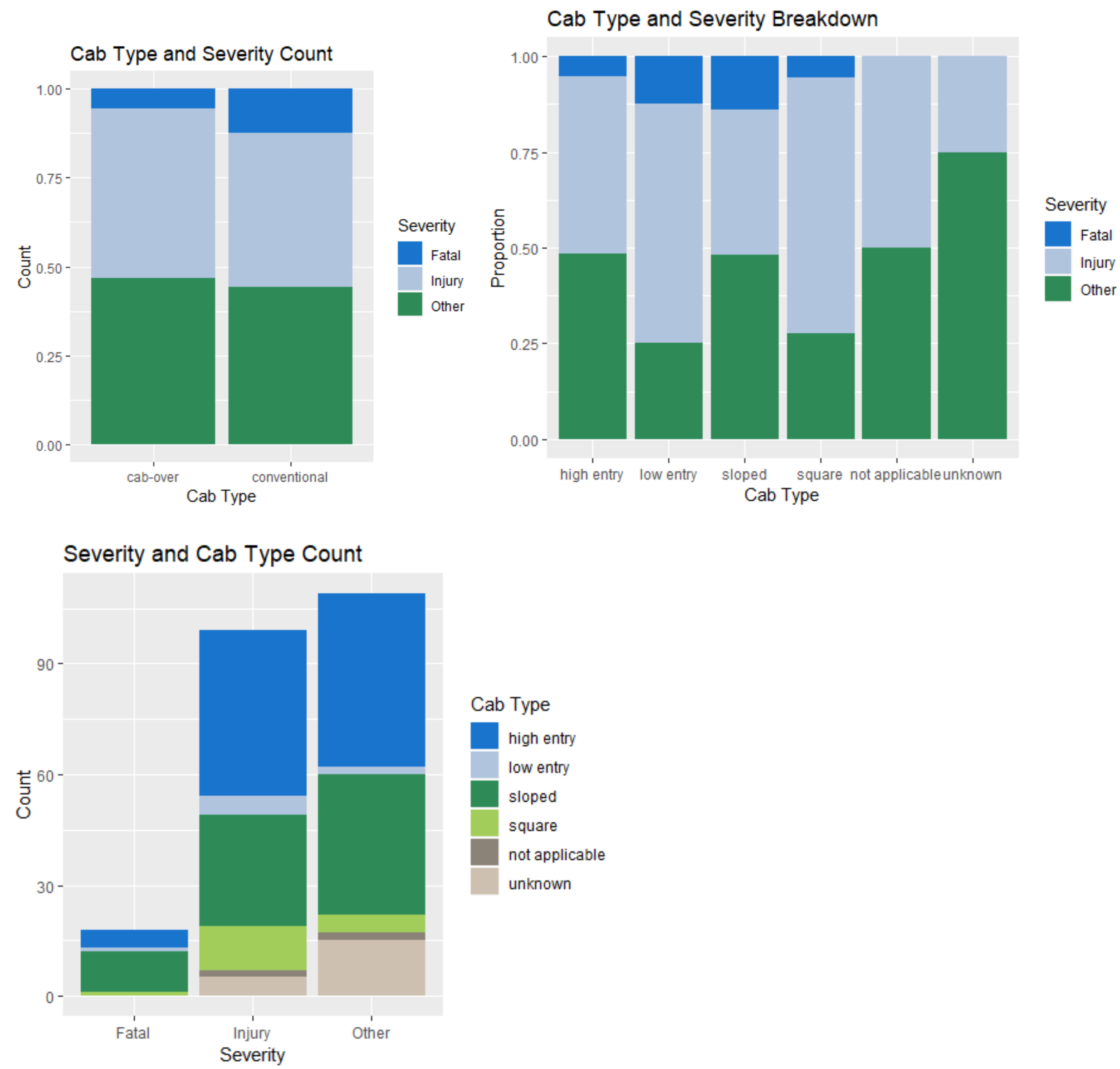


Figure 11. Conventional cabs—sloped cabs in particular—are more represented in fatal crashes.

Discussion

Depending on their design, cabover trucks, which lack the long cab nose of a conventional cab, can provide increased visibility and situational awareness to the driver in an urban environment. Therefore, decreased crash likelihood for cabover vehicles was tested as a hypothesis based on the provided data. The overrepresentation of cabover trucks in licensee crashes is surprising and suggests that those cab types actually have a higher crash risk (as measured by crashes per hundred vehicles). Within crashes, however, conventional-cab crashes are more likely to be fatal.

Additional data and research is needed to determine whether certain types of cabover trucks have a lower crash risk compared to conventional trucks.

There are potentially confounding factors not considered by this analysis that could explain this result.

One possibility is that the visibility benefits associated with cabover trucks only apply to front-visibility. These trucks may still have side visibility comparable to or even poorer than that of a conventional model, given that cabover cabs can be wider than conventional cabs, reducing sightlines to the passenger side even for same height passenger window. It is also possible that cabover trucks are driven more frequently, or used on roads that tend to be narrower, more crowded, or poorly-lit.

A helpful future improvement would be data on vehicle exposure, such as VMT. This would allow us to weight vehicles by how frequently they were driven, providing a more accurate image of the BIC vehicles on city streets. Currently, VMT data is missing from 82% of Vehicle Portal vehicles used in this analysis. However, since there is a per-vehicle cost for companies to register a vehicle with BIC (e.g. paying a $500 fee), it can be inferred that the Vehicle Portal database does represent vehicles that are actively used by the companies.

Another helpful future improvement that could reveal crash risk trends more accurately would involve coding separately for front, driver-side, and passenger-side visibility of each vehicle make and model. Currently, even two similar low-entry cabover models—the Mack LEU and Mack LR—can have very different door window sizes and may have different propensities to be involved in turning or other side collisions. Splitting the vehicle population by a measure of direct vision performance in each direction would be a more tailored, more accurate, and potentially more actionable approach than the current segmentation by cab type, given that makes and models are heterogeneous within each cab type.

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