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16. Abstract

NHTSA periodically evaluates current and past market trends and crash data to understand how the Federal Motor Vehicle Safety Standards (FMVSS) affect motor vehicle safety. NHTSA requested a crash data and market survey analyses of selected vehicle and equipment categories; this report describes that research. Battelle and UMTRI evaluated market size for each specific vehicle classification or equipment type, which all have some form of unique relevance in the FMVSS. The crash data and market survey covers (1) large passenger vehicles 8,500 to 10,000 lbs GVWR, trucks, and SUVs excluded from FMVSS No. 208 air bag requirements (Class 2B); (2) limousines over 10,000 lbs GVWR or longer than the FMVSS No. 214 wheelbase exclusion; (3) “entertainer” buses and motor homes over 26,000 lbs GVWR; (4) medium buses that carry 11 or more occupants with GVWR from 10,000 lbs to 26,000 lbs; and (5) motorcycle helmets. A market survey was conducted for all five vehicle and equipment categories, while the crash data analysis was conducted only for Class 2B large passenger vehicles of GVWR 8,500 lbs to 10,000 lbs.

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Introduction

The National Highway Traffic Safety Administration periodically evaluates current and past market trends and crash data to understand how the Federal Motor Vehicle Safety Standards (FMVSS) affect motor vehicle safety in the United States. NHTSA issued a task to conduct crash data and market survey analyses of selected vehicle and equipment categories.

This report describes the research efforts for each vehicle and equipment type specified in this task. Battelle and the University of Michigan Transportation Research Institute (UMTRI) conducted research to evaluate the scope of the market size for each specific vehicle classification or equipment type, which all have some form of unique relevance in the FMVSS. This report outlines the available data sources investigated for analysis of crash data and market survey of the selected vehicle and equipment categories.

Project Objectives

The overall objective was to conduct a thorough review of vehicle production, sales, registration, and crash data of selected vehicle and equipment categories that are referenced in the FMVSS. The research team developed and implemented study methodologies to evaluate the prevalence of the following five vehicle or equipment categories in the U.S. automotive market.

1) Large passenger vehicles (greater than 8,500 lbs but under 10,000 lbs gross vehicle weight rating [GVWR]), trucks, and SUVs that are excluded from FMVSS No. 208 air bag requirements (Class 2B).
2) Limousines greater than 10,000 lbs GVWR or longer than the FMVSS No. 214 wheelbase exclusion.
3) Entertainer buses and motor homes over 26,000 lbs GVWR.
4) Medium buses that carry 11 or more occupants with GVWRs between 10,000 lbs and 26,000 lbs.
5) Motorcycle helmets.

In addition, a crash data analysis was performed for Class 2B vehicles (i.e., large vehicles excluded from FMVSS No. 208) to examine the crash involvement, occupant fatality, and belted/unbelted rates for the vehicles identified in this classification.

The research team specifically implemented the following analysis:

- ***Market Survey Analysis:*** In this project, "market survey" refers to evaluating the annual sales volume of the specified vehicle or equipment categories and documenting other specific characteristics such as vehicles' make and model, seat belt installation rates, seating positions, presence of air bags, and other safety features. Each vehicle classification and equipment type have specific safety features of interest that are identified and discussed in this report.

- ***Crash Data Analysis:*** This analysis focused on extracting meaningful trends in the number of vehicle crashes and occupant injuries. Examining crash trends is important as it provides a sense of the rate of increase or decrease in the number of crashes, injuries, and fatalities over time possibly resulting from the introduction of a specific regulation or strategy. Such information can be used to explain or describe what happened in the past, predict what could happen in the future, and determine what course of action can be implemented to decrease the crash rates and harm caused by the crashes in the future.

Project Scope

A market survey was conducted for all five vehicle and equipment categories, while the crash data analysis was conducted only for Class 2B large passenger vehicles of GVWR from 8,500 lbs to 10,000 lbs.

Technical Approach

The technical approach to define the crash data and market size of the select vehicle and equipment categories included reviewing existing literature, analyzing existing vehicle registration data, analyzing vehicle fatality and injury data, disseminating survey questions, and conducting structured stakeholder interviews.

Given the objective is to evaluate crash data and market size of the five vehicle and equipment categories identified earlier, separate processes for crash data and market survey were followed as discussed below. Note that the crash data process is applicable only to Class 2B vehicles, while the market survey process is applicable to all five vehicle and equipment categories.

Since the project deals with very specific vehicle types and equipment categories, data scarcity was a prime challenge, as market size information was not readily available. In some cases, the equipment manufacturers and/or modifiers do not publish market size information due to its proprietary nature. In cases where published data is difficult to obtain in the literature, the research team attempted to gather information by conducting targeted stakeholder outreach and interviews.

Crash Data Analysis Process

The purpose of the crash data analysis was to evaluate the safety performance of Class 2B vehicles. To achieve this, the research team examined the crash distribution, injury distribution, restraint use, and fatality distribution found in Class 2B vehicles. Comparisons to distributions for other weight classes were performed, as described in methods.

Datasets

The National Automotive Sampling System General Estimates System (NASS-GES) is a three-stage national probability sample of police crash reports that is often used to study the scope of crashes. Each case in the dataset includes a weight that allows estimations of national crash trends. The NASS Crashworthiness Data System (NASS-CDS) is collection of in-depth crash investigations that includes more detailed injury information and is used to assess risk of injury in crashes. In 2016 these two datasets were replaced with the Crash Report Sampling System (CRSS) and Crash Investigation Sampling System (CISS), respectively. Data is currently available for CRSS for 2016 and 2017, while CISS data is available only for 2017. While the replacement datasets offer many improvements, methods were not yet developed to allow analysis of data merged from CDS and CISS at the time this study was conducted (just recently, methods for combining these datasets were developed; see Zhang et al., 2019).

Although these datasets include vehicle types, they do not include sufficient data to differentiate between Class 2A and Class 2B vehicles. NASS-GES has a GVWR variable with coarse bins, of which the lowest is <10,000 lbs. Even though these datasets include vehicle makes and models, they do not reliably document different versions of vehicles that would be in different weight classes. For example, the datasets have one code for the Dodge Ram pickup, which includes the Ram 1500, 2500, and 3500 plus all trim levels of each. The 1500s would be Class 2A, the 2500s would be in Class 2B, and the 3500s would be in Class 3 (10,000–14,000 lbs) While VINDICATOR software[1] can be used to determine whether a vehicle is Class 2A or 2B, an initial review to identify potential vehicles for analysis in NASS-GES and NASS-CDS (and their replacements) indicated that there are not many raw cases that may be Class 2B vehicles.

UMTRI has agreements with 11 States (listed below) to access their datasets of police-reported crashes. Because these datasets are not available to the public, they include the full VIN and can be used to

[1] The Highway Loss Data Institute's software called VINDICATOR uses VINs to determine the differences between distinction between light-duty trucks and light-duty autos. It is updated twice a year.

identify the vehicles of interest. Also, they are a census of crashes in each State, rather than a sample. A check of the Michigan dataset for 2012–2017 found that approximately 5 percent of vehicles have a maximum or minimum GVWR from 8,500 lbs to 10,000 lbs, for a total of vehicles in this weight range near 160,000. This number of vehicles is a significantly larger count than what is recorded in the NASS datasets, and a larger case count provides for more robust statistical analysis. Thus, the decision was made to perform the analysis of crash and injury patterns using the State datasets. The goal was to use the most recent 5 years of data available from each State, which was the timeframe available for UMTRI's use.

- Florida
- Idaho
- Kansas
- Maryland
- Michigan
- Missouri
- Nebraska
- New York
- Tennessee
- Utah
- Washington

The first step in the analysis was to review the State datasets to confirm that each State reports variables needed to conduct analyses. The research team used the VINDICATOR software to extract cases and sort the vehicles into weight categories of 6,000–8,500 lbs and 8,500–10,000 lbs using the maximum GVWR for each vehicle. The software was also used to identify the type of occupant protection equipment (e.g., optional air bags) that is included in each vehicle. The crash analysis included vehicle model years 2000 and later so that a relatively larger sample size could be obtained. After selecting cases of interest based on GVWR, the team developed a harmonized dataset, as each State may use different classification categories for a variable (e.g., crash type.) The goal was to align classifications with those used in the Fatality Analysis Reporting System (FARS) as much as possible. However, most States have fewer crash types, so it was not possible to exactly match FARS categories for some variables. FARS is a census of fatal motor-vehicle crashes in the United States, which includes sufficient data to identify Class 2A and Class 2B vehicles. For this dataset, the research team analyzed data from 2009 to 2018 (i.e., the most recent 10-year period available) but limited vehicle MY to 2000 and later. The difference in the State data versus FARS data time frames is that the State data was available over the last 5 years, but 10 years of FARS were used because of sampling size concerns.

Crash and Injury Analysis

For the crash analysis, the research team compared distributions of crashes involving Class 2B and other classes per the following factors.

- Crash direction (frontal, near-side, far-side, rear, rollover, pedestrian, cyclist, other)
- Crash type (rear, sideswipe, head-on, etc.)
- Vehicle MY
- Alcohol involvement
- Number of occupants
- Vehicle type (van, SUV, pickup)
- Air bag deployment
- Belt or child restraint use
- Driver age and sex
- Occupant age and sex

For the injury analysis, the research team classified injury outcome in the State datasets using the KABCO injury scale used by law enforcement officers to code injury on police reports. Fatal, incapacitating injury, and non-incapacitating injury (KAB) cases were grouped and compared with the group of possible and no injury (CO) cases.

Fatality Analysis

Analysis of fatality data used 2009–2018 FARS data and considered the same factors used in the injury analysis.

Market Survey Process

The market survey examined the sales, production, makes and models, and/or registrations of vehicles under the following vehicle categories (detailed in the Project Objectives section, above): Class 2B, limousines, motor homes/entertainer buses, medium buses, and motorcycle helmets. The survey also documented other safety-critical characteristics of these vehicles such as seat belt installation rate, seating positions, and the presence of driver- and front-passenger air bag restraints. The market survey was conducted based on analysis of existing datasets, review of related literature, and targeted equipment manufacturer and modifier outreach.

Analysis of Existing Datasets

Analysis of existing datasets involved the detailed examination of vehicle sales, registration, crash data, and vehicle features obtained from public or government agencies. To find data regarding sales volume of vehicles under this category, the research team visited the websites and publications of vehicle manufacturers, dealers, and automobile groups and associations. Vehicle registration data from R. L. Polk & Co. was also examined to obtain additional data. Whenever possible, attempts were made to break down the sales volume under each category by vehicle make, model, and year. In addition, the market survey estimated the installation rates of safety critical restraints and features (e.g., seat belts and air bags, as well as seating positions) from data reported in publications and webpages of manufacturers and other organizations.

Review of Related Literature

The research team reviewed related literature to the market survey analysis. Literature reviewed included government reports, academic journals, sales marketing materials (e.g., magazines, brochures, and flyers), and other published data/information on websites of manufacturers and business associations. The team used advanced library resources, which included indexing and abstract retrieval services (e.g., National Technical Information Services, and Transportation Research International Documentation), research and scientific journals (e.g., RightFind, full-text access to Elsevier's Corporate Edition ScienceDirect and WorldCat online databases), reports from the U.S. Department of Transportation and other government agencies, as well as general internet searches (e.g., Google, Google Scholar). In addition, market segment reports, crash investigation reports (e.g., from the National Transportation Safety Board), and academic research papers were investigated.

Targeted Stakeholder Outreach (Interviews)

To supplement the market survey information gathered from literature searches and dataset analyses, the research team reached out to vehicle manufacturers, industry experts, and other stakeholders (e.g., manufacturers of specialized seats). The research team gathered and synthesized anecdotal information from the interviews to develop meaningful and actionable market survey findings. The research team developed a structured interview process and guide that was followed for the interviews.

Stakeholders are organizations or groups of people that directly or indirectly have interests or concerns, as well as information, related to the market size of each vehicle or equipment category identified in this project. The research effort identified stakeholders from five categories of candidate interviewees as appropriately applicable to the different vehicle categories.

a. ***Agencies:*** Private or publicly owned organizations that provide services including local and State DOTs, State DMVs, State and regional law enforcement agencies, first responders, insurance companies, and others.
b. ***Manufacturers:*** Organizations that produce or manufacture a specified vehicle or equipment category, including domestic and international automotive and motorcycle helmet manufacturers.
c. ***Businesses:*** Organizations that sell or buy specified vehicles or equipment including distribution centers, vehicle dealerships, service providers, and fleet operators.
d. ***Associations:*** Groups of vehicle or equipment users who share common interests and are organized for a joint purpose, including car clubs, trade groups, lobbying groups, and labor unions.
e. ***Experts:*** People who have extensive knowledge based on past research activities, experience, or occupation as related to a specific vehicle or equipment category.

To prepare for the interviews, the research team created an interview guide that includes primary questions, probing questions, and guiding objectives for the interviewer. One guide per vehicle or equipment category was created. Each guide included:

- Introduction and background to the candidate interviewee (obtained from the dataset and literature review, when available);
- Introductory remarks – history of the project, importance to NHTSA, specific vehicle classification or equipment type;
- Key research questions to be addressed;
- Guide on how to address various situations that may be encountered, such as if the interviewee is reluctant to share information requested (e.g., if having difficulty obtaining information, ask what information the interviewee is willing to share); and
- Closing remarks.

Targeted stakeholder outreach was the only means of information/data collection for those cases where no information was found from existing data sources or literature search. In some cases, when stakeholders were willing to provide information that is proprietary in nature, the stakeholders asked for a non-disclosure agreement. In these cases, they permitted sharing of information provided that it is reported anonymously and in aggregation with information obtained from other stakeholders.

The research team identified potential stakeholders, and each stakeholder was contacted at least one time by phone and one time by email. Non-responsive stakeholders were contacted a second time by phone and a second time by email. Unfortunately, due to the COVID-19 pandemic, it was extremely difficult to speak to representatives on the phone. Many call centers were closed. Voicemails were left for each phone call, and if a directory was available to contact sales departments, a voicemail was left there as well. Most email addresses posted on the company websites were either to a customer service information request mailbox, or through a contact form filled out on the website.

Analysis of Vehicle Crash Factors by Weight Class for Pickups, Vans, and SUVs

The purpose of this analysis is to evaluate the safety performance of vehicles with GVWRs from 8,500 lbs to 10,000 lbs, particularly with respect to child occupants. This vehicle class is called Class 2B and includes some pickups, full-size vans, and SUVs. Many Federal safety regulations, including air bag requirements, unbelted crashworthiness, child out-of-position, advanced air bag requirements, and installation of LATCH hardware, do not apply to this vehicle class. However, manufacturers may choose to voluntarily install safety systems that are not required in these vehicles. Although safety performance of child occupants in Class 2B vehicles was originally part of the project objectives, the research team did not find anything of particular significance related to child occupants.

To achieve understanding of safety in these vehicles, the research team examined the crash distribution, injury distribution, restraint use, and fatality distribution found in Class 2B vehicles. For comparison, the analysis was repeated for pickups, SUVs, and vans in other weight classes (Class 1 and Class 2A) that are required to meet more Federal safety standards. The analysis was repeated as well for Class 3+ vehicles.

Method: FARS Analysis

Case Selection

FARS data from 2010 to 2018 was extracted. These years were selected because they are the newest available and there were substantial coding changes from 2009 to 2010, creating challenges for merging data from pre-2010 with later years. VINDICATOR software was used to decode the VIN listed for each occupant, and variables derived from the VIN were appended to the FARS dataset. Data was restricted to cases with vehicle model years of 2000 and later and limited to occupants who died in the crash. The resulting dataset contained 186,691 fatalities.

Vehicle Body Type

The VINDICATOR and FARS manuals use two different methods for coding vehicle body type. Table 1 shows how each variable was collapsed to construct five vehicle type categories.

Table 1. Body type classification in FARS and VINDICATOR

Vehicle Type	FARS: BODY_TYPE Description (Attribute Code)	VINDICATOR: Vehicle_Class_Description
Cars	Cars (1-13, 17)	2-Door 4-Door Luxury Sports Station Wagon
Pickups	Pickups (30-49)	Pickups
Vans	Vans (20-29)	Vans Minivans
SUV	SUV (14-19)	Utility Luxury Utility
Other	Bus (50-59) Truck (60-79) Motorcycle (80-89) ATV/Snowmobile (90-91) Other (92-97) Unknown (98-99)	Other Unknown

Both methods were used to classify vehicle by body type. Table 2 shows a cross-tabulation of the two body type classification schemes. As shown on the diagonal, they agreed in 96.8 percent of cases. For consistency with the analysis of State datasets, the VINDICATOR classification was selected to be used for analysis.

Table 2. Cross-tabulation of vehicle body type using FARS and VINDICATOR coding

FARS / VINDICATOR	Car	Other	Pickup	SUV	Van
Car	37.7%	0.0%	0.0%	0.1%	0.0%
Other	0.2%	20.9%	0.2%	0.1%	0.6%
Pickup	0.0%	0.2%	11.3%	0.1%	0.0%
SUV	1.2%	0.0%	0.5%	12.7%	0.0%
Van	0.0%	0.0%	0.0%	0.0%	14.0%

Vehicle Weight Class

Because the GVWR categories provided in the FARS dataset are too broad to sort vehicles into classes, the GVWR was extracted from the VIN. VINDICATOR reports GVWR to the nearest 500 lb or 1000 lb increment. Vehicles were sorted into classes using the following criteria.

- Unknown, Class 1 <6,000 lbs
- Class 2A 6000–8,500 lbs
- Class 2B 8,501–10,000 lbs
- Class 3+ 10,001 lbs and higher

VINDICATOR codes GVWR only for light trucks and multipurpose vehicles (i.e., passenger cars). The distribution of weight class by the three body types is shown in Table 3. Because the proportion of unknown weight classes was consistently 11 to 12 percent for each of the three vehicle types, the selected dataset from FARS was further restricted to include only fatalities of occupants in a vehicle of known weight class. This brings the number of fatalities to 54,693. The distribution of vehicle type by weight class for these fatalities is shown in Table 4. For Class 1 vehicles, most vehicles are SUVs, while pickup trucks predominate for the three higher weight classes. The next greatest proportion is SUVs and vans for Class 2A and Class 2B, respectively. Class 3+ is essentially all pickup trucks, and there is no difference in the other body types for Class 1.

Table 3. Number of fatalities by vehicle weight class and vehicle type

Vehicle Type	Unknown	Class 1	Class 2A	Class 2B	Class 3+
Pickup	2,810	4,022	12,519	4,310	761
SUV	3,627	18,181	8,142	275	1
Van	786	4,219	1,239	1,021	4

Table 4. Proportion of fatalities by vehicle body type for each weight class (column percentage)

Vehicle Type	Class 1	Class 2A	Class 2B	Class 3+
Pickup	15%	57%	77%	99%
SUV	69%	37%	5%	0%
Van	16%	6%	18%	1%

To compare distributions of different variables by class type for FARS, a chi-square test was conducted. If the chi-square value was less than 0.05, standardized residuals were examined to understand how the distribution of observed values was higher or lower than expected statistically.

Results: FARS Analysis

Results of the chi-square analysis for the variables of interest are provided in the following tables of this section. For each case in which the chi-square test was significant, the table cells for which the standardized residual was greater than 2 are indicated in blue and bold, while the cells for which the standardized residual was less than -2 are indicated in orange and italics. Unmarked cells are close to the values expected statistically.

Vehicle Factors

VINDICATOR includes information about the occupant restraint system available in a vehicle using the following categories.

- Driver air bag (DAB)
- Driver and passenger air bag (PAB)
- Driver and passenger air bags and optional side air bags (OSAB)
- Driver and passenger air bags and side air bags (SAB)
- Manual belt
- Unknown or no restraints

For occupants who died in crashes, the distribution of available restraints is shown in Table 5. Almost all vehicles MY2000 and later are equipped with driver and passenger air bags. Side air bags, as either standard or optional equipment, are available in just over half of Class 1 and Class 2A pickups, SUVS, and vans. However, they are available in only 13 percent of Class 2B and 23 percent of Class 3+ vehicles. Statistically, the distributions of side air bag are different than expected only for Class 2B vehicles.

Table 5. Distribution of available restraints for occupants who died in crashes

Air Bag Type	Class 1	Class 2A	Class 2B	Class 3+
DAB	100%	100%	99%	100%
PAB	100%	100%	99%	100%

Air Bag Type	Class 1	Class 2A	Class 2B	Class 3+
OSAB	14%	14%	*2%*	10%
SAB	37%	36%	*11%*	13%
None	0.1%	0.0%	0.9%	0.0%

Vehicle age was calculated by subtracting the vehicle MY from the crash year. Fatalities were grouped into 4-year age increments. The proportions of vehicles by age group for each weight class are shown in Table 6. The proportions by vehicle age are generally similar for Class 1, 2A, and 2B vehicles, but Class 3 and higher vehicles tend to be newer.

Table 6. Fatalities by vehicle age and weight class

Vehicle Age (years)	Class 1	Class 2A	Class 2B	Class 3+
0-3	14%	15%	14%	26%
4-7	19%	22%	24%	31%
8-11	34%	34%	34%	30%
12-15	27%	24%	24%	11%
16-19	6%	6%	4%	2%

Crash Factors

Although FARS includes a variable to classify the road use as urban or rural, it is missing in half of the cases. As a result, the United States Department of Agriculture Rural-Urban Continuum Codes (RUCC) were used to determine road use. Last updated in 2013, the RUCC classifies counties by the metro area population, and nonmetropolitan counties by the level of urbanization and whether they are adjacent to a metro area. The nine classifications listed below were labeled as rural/suburban/urban large/medium/small according to these definitions.

1. Large Urban (UL): Metro - Counties in metro areas of 1 million population or more.
2. Medium Urban (UM): Metro - Counties in metro areas of 250,000 to 1 million population.
3. Small Urban (US): Metro - Counties in metro areas of less than 250,000 population.
4. Large Suburban (SL): Nonmetro - Urban population of 20,000 or more, adjacent to a metro area.
5. Large Rural (RL): Nonmetro - Urban population of 20,000 or more, not adjacent to a metro area.
6. Medium Suburban (SM): Nonmetro - Urban population of 2,500 to 19,999, adjacent to a metro area.
7. Medium Rural (RM): Nonmetro - Urban population of 2,500 to 19,999, not adjacent to a metro area.

8. Small Suburban (SS): Nonmetro - Completely rural or less than 2,500 urban population, adjacent to a metro area.
9. Small Rural (RS): Nonmetro - Completely rural or less than 2,500 urban population, not adjacent to a metro area.

The latitude and longitude coordinates of the crashes were mapped for all States (except Idaho, for which no latitudes/longitudes were provided in the dataset) to ZIP Codes using Census shapefiles. Previous analysis of fatalities by RUCC (Klinich et al., 2019) showed that trends in fatality rates and vehicle crash types were similar for categories 2 to 3 and 4 to 9, so distributions for Large Metro, Small/Medium Metro, and Nonmetro were compared, as shown in Table 7. In large metro areas, the proportion of Class 1 vehicles is highest and Class 3+ is lowest, while the opposite is true for nonmetro areas.

Table 7. Distribution of fatalities by Rural/Urban Classification and vehicle weight class

RUCC	Class 1	Class 2A	Class 2B	Class 3+
Large Metro	38%	35%	32%	28%
S/M Metro	37%	37%	37%	36%
Nonmetro	24%	28%	31%	35%

Crash types were collapsed into 25 categories using the methods described by Najm et al. (2007). Table 8 shows the proportion of fatalities by crash type and vehicle class, sorted by proportion seen in Class 2B vehicles. The last column of Table 8 indicates the difference in proportion between Class 2B and Class 2A vehicles. For most of the crash types involving a fatality, the proportions are similar across vehicle classes. The largest differences where Class 2B vehicles have a higher proportion than Class 2A are control loss/no vehicle action and vehicle failure. The crash types where proportions of fatal crashes are smaller for Class 2B vehicles compared to Class 2A are opposite direction and intersections without signals. In Table 8, “Low N” represents a miscellaneous category of low-count crash types.

Table 8. Proportion of Crash Types by vehicle class, plus difference between Class 2B and 2A vehicles

Crash Type	Class 1	Class 2A	Class 2B	Class 3+	2B-2A
Road Depart/No man	30.5%	34.0%	32.9%	38.7%	-1.1%
Ctl Loss/No veh action	*18.8%*	22.3%	**26.6%**	19.5%	4.3%
Opp direction	**16.9%**	14.9%	*10.9%*	12.0%	-4.0%
XPaths@Non-Signal	**9.5%**	*7.0%*	*5.8%*	5.4%	-1.2%
Veh Failure	1.6%	1.8%	**3.6%**	1.6%	1.8%
Rear End/LV Slower	2.8%	2.6%	2.7%	2.6%	0.1%

Crash Type	Class 1	Class 2A	Class 2B	Class 3+	2B-2A
Rear End/LV Stopped	2.7%	2.2%	2.4%	2.4%	0.1%
Ctl Loss/Veh action	1.9%	2.0%	2.1%	1.8%	0.1%
Change lanes	1.6%	1.5%	1.7%	1.8%	0.2%
Run light/stop	**3.2%**	2.2%	1.7%	1.7%	-0.5%
Non-collision	0.9%	1.2%	1.5%	**3.4%**	0.3%
Other	1.6%	1.5%	1.3%	2.0%	-0.2%
Road Depart/Man	1.0%	1.1%	1.3%	0.8%	0.2%
Rear End/LV Decel	1.0%	0.8%	1.1%	1.6%	0.3%
Object	1.0%	1.1%	1.0%	1.4%	-0.1%
Drifting	0.9%	0.9%	0.9%	0.7%	0.0%
Animal	0.5%	0.6%	0.6%	0.7%	0.0%
Turning/same dir	0.5%	0.5%	0.6%	0.7%	0.2%
Rear End/Other	0.5%	0.4%	0.5%	0.4%	0.1%
Rollover	0.5%	0.4%	0.4%	0.5%	0.0%
XPaths@Signal	**1.3%**	0.6%	0.3%	0.0%	-0.3%
Backing	0.1%	0.1%	0.1%	0.0%	0.0%
Low N	0.0%	0.0%	0.1%	0.3%	0.0%
Parking	0.3%	0.2%	0.1%	0.3%	0.0%
Avoidance	0.1%	0.1%	0.0%	0.0%	-0.1%
Cyclist	0.0%	0.0%	0.0%	0.0%	0.0%
Pedestrian	0.0%	0.0%	0.0%	0.0%	0.0%

Crash Type	Class 1	Class 2A	Class 2B	Class 3+	2B-2A
Road Depart/Backing	0.0%	0.0%	0.0%	0.0%	0.0%

While Table 8 shows the distribution of fatalities by crash type, Table 9 shows the distribution by the manner of collision and the vehicle weight class. The proportion of deaths in single-vehicle crashes increases with weight class, while the proportions in front-to-front and angle crashes is higher for Class 1 vehicles compared to the higher vehicle weight categories.

Table 9. Distribution of fatalities by manner of collision and vehicle weight class

Manner of Collision	Class 1	Class 2A	Class 2B	Class 3+
Single	*55%*	63%	68%	69%
Front-to-rear	8%	6%	7%	7%
Front-to-front	15%	12%	*9%*	10%
Angle	**19%**	14%	12%	10%
Sideswipe-Same	1.8%	1.8%	1.8%	2.4%
Sideswipe-Opposite	1.5%	1.6%	1.5%	2.1%
Rear-to-side	0.1%	0.1%	0.1%	0.0%
Rear-to-rear	0.0%	0.0%	0.0%	0.0%
Other	0.4%	0.3%	0.3%	0.5%
Unknown	0.1%	0.1%	0.1%	0.3%

Table 10 shows the distribution of fatalities by location of most severe damage and vehicle weight class. Proportion of fatalities by damage location is fairly consistent across vehicle class. Statistically, Class 1 vehicles have more rear crashes than expected.

Table 10. Distribution of fatalities by damage location vehicle and vehicle weight class

Damage Location	Class 1	Class 2A	Class 2B	Class 3+
Frontal	68%	71%	73%	72%
Left	11%	10%	9%	9%

Damage Location	Class 1	Class 2A	Class 2B	Class 3+
Right	10%	8%	8%	7%
Rear	**6%**	4%	4%	4%
Top	0.3%	0.3%	0.4%	0.3%
Undercarriage	2%	2%	2%	2%
Noncollision	0.0%	0.0%	0.0%	0.1%
Unknown	3%	4%	4%	5%

The distribution of fatalities by light condition and vehicle weight class is shown in Table 11. Class 2B and Class 3+ vehicles have a greater proportion of crashes in the dark (not lit) conditions. These proportions are higher than expected for Class 2B. Class 1 vehicles have more fatal crashes during lighted conditions than the heavier weight classes.

Table 11. Distribution of fatalities by light condition and vehicle weight class

Light Condition	Class 1	Class 2A	Class 2B	Class 3+
Light	56%	50%	49%	48%
Dark, not lit	*27%*	33%	**37%**	40%
Dark, lit	12%	12%	*7%*	7%
Dawn	2.0%	2.2%	3.3%	1.7%
Dusk	2.0%	2.0%	1.8%	2.0%
Dark, unknown lighting	0.5%	0.7%	0.5%	0.1%
Other	0.0%	0.0%	0.0%	0.0%
Not reported	0.0%	0.0%	0.1%	0.0%
Unknown	0.3%	0.4%	0.4%	0.0%

Table 12 shows the distribution of fatalities by weather conditions and vehicle weight class. Proportions are fairly constant across vehicle weight class, although Class 2B and Class 3+ have a higher proportion of crashes in sleet/hail. When comparing observed and expected values, Class 2B vehicles have a higher proportion of fatalities in sleet/hail, fog/smoke, and blowing snow conditions.

Table 12. Distribution of fatalities by weather conditions and vehicle weight class

Weather Condition	Class 1	Class 2A	Class 2B	Class 3+
Clear	68%	69%	67%	65%
Rain	7.8%	7.7%	8.2%	8.0%
Sleet/hail	0.4%	0.5%	**0.9%**	0.8%
Snow	2.3%	*1.7%*	2.7%	2.4%
Fog/smoke	1.2%	1.6%	**2.0%**	1.3%
Wind	0.2%	0.2%	0.3%	0.1%
Blowing sand/dirt	0.1%	0.1%	0.1%	0.1%
Other	0.2%	0.1%	0.2%	0.3%
Cloudy	16%	16%	16%	18%
Blowing snow	0.2%	0.1%	**0.4%**	0.4%
Freezing rain	0.1%	0.1%	0.2%	0.4%
Not reported	2.6%	2.1%	2.4%	2.1%
Unknown	0.4%	0.4%	0.5%	0.4%

Occupant Factors

The distribution of fatalities by vehicle weight class and occupant age group is show in Table 13. Class 1 and 2A vehicles have higher proportions of children, teens, and seniors compared to Class 2B and Class 3+ vehicles, which have the highest proportion of fatalities 31 to 65 years old. When comparing observed and expected values, the only significant variation involved the 65+ group, where Class 1 vehicles have more than expected and Class 2B vehicles have fewer than expected.

Table 13. Distribution of fatalities by occupant age group and vehicle weight class

Occupant Age	Class 1	Class 2A	Class 2B	Class 3+
0-10	3.3%	3.2%	1.3%	1.0%
11-17	4.3%	4.6%	3.4%	2.0%

Occupant Age	Class 1	Class 2A	Class 2B	Class 3+
18-30	23.9%	26.3%	27.8%	29.0%
31-65	46.6%	49.6%	56.4%	56.9%
>65	**21.8%**	16.1%	*11.1%*	11.0%

Table 14 shows the distribution of fatalities by gender and vehicle weight class. The proportion of male increases with each weight class, with an 11 percent higher fraction of males in Class 2B compared to Class 2A vehicles.

Table 14. Distribution of fatalities by occupant gender and vehicle weight class

Occupant Gender	Class 1	Class 2A	Class 2B	Class 3+
Male	59%	73%	84%	87%
Female	41%	27%	16%	13%

The restraint use by fatally injured occupants for each weight class is shown in Table 15. Class 2B has the highest proportion of unrestrained fatalities, while Class 1 has the lowest. The proportion of occupants in child restraint systems (CRS) decreases with increasing weight class.

Table 15. Distribution of fatalities by occupant restraint use and vehicle weight class

Occupant Restraint Use	Class 1	Class 2A	Class 2B	Class 3+
CRS	1.5%	1.1%	0.4%	0.3%
Lap/Shoulder	51.0%	42.9%	37.7%	40.3%
None	*37.0%*	45.3%	51.1%	45.2%
Other	2.1%	1.5%	1.8%	1.7%
Unknown	8.4%	9.2%	9.1%	12.6%

The type of air bag deployment associated with fatalities and vehicle weight class is summarized in Table 16. Class 2B vehicles have the highest percentage of fatalities where the air bag did not deploy (higher than expected) or where the air bag was not available, but the lowest percentage of multi-air bag deployments (lower than expected). Because FARS does not include a measure of crash severity, we cannot determine possible differences between crash severity and weight class that may affect air bag deployment.

Table 16. Distribution of fatalities by air bag deployment and vehicle weight class

Air Bag Deployment	Class 1	Class 2A	Class 2B	Class 3+
Not available	6%	6%	8%	6%
Front only	33%	30%	28%	29%
Side only	2%	2%	1%	1%
Curtain only	0%	0%	0%	0%
Other only	0%	0%	0%	0%
Multiple	13%	12%	*6%*	10%
Deployed, unknown type	5%	5%	3%	3%
Not deployed	34%	37%	**46%**	42%
Not reported	1%	2%	2%	1%
Unknown deployment	4%	6%	6%	7%

Table 17 shows the distribution of fatalities by occupant seating position. Distributions are quite similar, except that Class 2B vehicles have the highest proportion in "other" seating positions, which includes cargo areas; this proportion is higher than expected, while the other seating position for Class 1 vehicles is lower than expected.

Table 17. Distribution of fatalities by occupant seating position and vehicle weight class

Occupant Seating Position	Class 1	Class 2A	Class 2B	Class 3+
Driver	72.2%	72.3%	71.5%	73.3%
Front Center	0.2%	0.4%	0.6%	0.5%
Front Other	0.0%	0.1%	0.1%	0.0%
Front Right	16.0%	14.9%	14.8%	16.2%
Other	*1.8%*	2.4%	**4.9%**	3.4%
Rear Center	1.4%	1.7%	1.6%	0.9%

Occupant Seating Position	Class 1	Class 2A	Class 2B	Class 3+
Rear Left	3.9%	3.8%	2.8%	1.8%
Rear Other	0.2%	0.3%	0.5%	0.7%
Rear Right	4.3%	4.2%	3.2%	3.1%

The distribution of fatalities by ejection status and vehicle weight class is shown in Table 18, while the reported ejection path is shown in Table 19. Class 2B vehicles have the highest percentage of fatalities with complete and partial ejections, and the lowest with none. The side window was the most common path for all vehicle classes, but the proportion was highest for Class 2B vehicles. Class 3+ and Class 2B had the highest proportions ejected from the cargo area of a pickup truck.

Table 18. Distribution of fatalities by occupant ejection status and vehicle weight class

Occupant Ejection Status	Class 1	Class 2A	Class 2B	Class 3+
None	72.7%	67.5%	61.3%	67.8%
Complete	*21.1%*	25.7%	**29.3%**	24.7%
Partial	5.3%	5.8%	8.1%	6.7%
Ejected, degree unknown	0.2%	0.3%	0.3%	0.0%
Not reported	0.1%	0.1%	0.0%	0.1%
Not applicable	0.2%	0.3%	0.3%	0.5%
Unknown	0.4%	0.4%	0.6%	0.1%

Table 19. Distribution of fatalities by known ejection path and vehicle weight class

Occupant Ejection Path	Class 1	Class 2A	Class 2B	Class 3+
Side door	19%	16%	17%	18%
Side window	56%	62%	65%	50%
Windshield	6%	8%	6%	8%
Back window	5%	6%	4%	3%

Occupant Ejection Path	Class 1	Class 2A	Class 2B	Class 3+
Back door/tailgate	1%	1%	1%	3%
Roof (sunroof, open convertible)	**8%**	4%	*1%*	8%
Roof (closed convertible)	2%	0%	0%	0%
Other (back of pickup truck)	3%	4%	6%	11%

The fatality extrication status by vehicle weight class is shown in Table 20. Proportions of fatalities requiring extrication from the vehicle are similar for all weight classes.

Table 20. Distribution of fatalities by extrication status and vehicle weight class

Extrication Status	Class 1	Class 2A	Class 2B	Class 3+
None	71%	76%	75%	72%
Extricated	26%	22%	23%	25%
Unknown	3%	2%	2%	2%

Table 21 shows the distribution of fatalities by driver age category and vehicle weight class. The most notable difference is that Class 1 vehicles in fatal crashes have a higher proportion of drivers greater than 65 years old in comparison to the higher vehicle weight classes. Distribution of drivers under 21 is fairly consistent.

Table 21. Distribution of fatalities by driver age and vehicle weight class

Driver Age	Class 1	Class 2A	Class 2B	Class 3+
<16	1%	1%	1%	1%
16-17	3%	3%	2%	1%
18-20	6%	6%	6%	5%
21-30	20%	23%	23%	23%
31-65	50%	53%	59%	60%
>65	**20%**	15%	*10%*	11%
Unknown	0%	0%	0%	0%

The distribution of fatalities by driver alcohol use are shown in Table 22 for each vehicle weight class. The three higher weight classes have a higher rate of reported driver alcohol use than Class 1 fatalities. Class 1 vehicles were the only category with fewer alcohol fatalities than expected.

Table 22. Distribution of fatalities by driver alcohol use and vehicle weight class

Driver Alcohol Use	Class 1	Class 2A	Class 2B	Class 3+
No	38%	32%	30%	30%
Yes	*14%*	19%	21%	22%
Not reported	32%	33%	33%	32%
Unknown	16%	16%	15%	16%

The distribution of fatalities by the number of total vehicle occupants is shown in Table 23. Results are similar except that Class 2B vehicles have a higher proportion of fatalities involving 9 or more occupants; this proportion is statistically different, as is the number of 9+ occupants in Class 1 vehicles. There are two cases of note, with 15 and 18 fatalities each. Details of these two cases are provided after Table 23.

Table 23. Distribution of fatalities by number of occupants and vehicle weight class

Number of Occupants	Class 1	Class 2A	Class 2B	Class 3+
1	54%	55%	55%	57%
2	24%	22%	22%	23%
3	10%	9%	8%	10%
4	6%	6%	6%	5%
5	3%	3%	3%	3%
6	1%	2%	2%	1%
7	1%	1%	1%	0%
8	0%	1%	1%	0%
9+	*0%*	1%	**3%**	0%
Unknown	0%	0%	0%	0%

The case with 15 fatalities (among 23 people involved in the crash) occurred in July 2012 on US-59 in Goliard, Texas. A 2000 Ford F-250 blew a tire and ran off the road, striking two trees. Four of the fatalities were seated in the front row, one in the second row, and 10 were in the cargo area. Only occupants in the driver, right front, and second-right positions were wearing seat belts. All the fatalities in the cargo area were ejected.

The case involving 18 fatalities (as well as 2 pedestrians) occurred in October 2018 in Schoharie, New York. The vehicle was a 2001 Ford Excursion stretch limousine. A National Transportation Safety Board report on the crash is available at https://dms.ntsb.gov/public/62500-62999/62797/628160.pdf.

Method: State Datasets

For non-fatal crashes, there are a limited number of raw cases involving a Class 2B vehicle in national datasets. For example, in NASS-GES years 2011 to 2015, there are 11,652 unweighted cases involving Class 2B vehicles, which was not considered sufficient to perform the level of analysis desired for the project. Therefore, the previously described State data from UMTRI was used for subsequent analysis. Table 24 summarizes the State datasets initially considered for this project.

Table 24. Initial list of States and years available to be considered for the project

State	Years available
Florida	2014–2018
Idaho	2014–2018
Kansas	2014–2018
Maryland	2015–2018 (until 2nd Quarter)
Michigan	2014–2018
Missouri	2014–2018
Nebraska	2014–2018
New York	2014–2018
Tennessee	2014–2018
Utah	2014–2018
Washington	2014–2018

The first step in creating a combined dataset of the available States was to develop a “data dictionary” for each State. This involved creating a list of all variables included in each dataset, as well as the possible values for each variable. During this process, Washington and New York crash datasets were eliminated from consideration because they do not include crash direction.

The next step was to develop a harmonized dataset, which involved creating a master codebook of key variables and their values and translating each State's variables to the master codebook. The VIN was used to identify vehicle weight, body style, and available restraint system. When restricted to the vehicle categories of pickups, SUVs, and vans, the dataset had 6,298,162 occupants in these types of vehicles. Vehicles were classified into GVWR categories using the same method used in the FARS analysis. Because each body type had a similar percentage of occupants in unknown vehicle weight class of 12 to 13 percent, suggesting a missing-at-random mechanism, remaining analyses excluded the unknown vehicles. The distribution of occupants by vehicle type and weight class is shown in Table 25. Among occupants in the combined datasets, SUVs predominate in Class 1 and pickups do in Class 3+. More than half of Class 2A occupants are in SUVs, while more than half of Class 2B occupants are in pickups.

Table 25. Distribution of combined State dataset by vehicle body type and weight class (column percent)

	Class 1	**Class 2A**	**Class 2B**	**Class 3+**
Pickup	9%	26%	58%	98%
SUV	90%	56%	4%	0.2%
Van	1%	17%	38%	2%

One question to address was how well the distribution of crashes and occupants in the available States represents the distribution of crashes in the entire United States. The research team performed a quick analysis of NASS-GES data from 2011 to 2015, the most recent years available. The distribution of occupants by vehicle type and weight class for the NASS-GES data is shown in Table 26, while a plot comparing the distributions in the combined State dataset and NASS-GES is shown in Figure 1. Because the distribution is similar to the distribution from the combined State dataset (Table 25) an analysis of the combined State dataset should provide a reasonable estimate of national trends.

Table 26. Weighted distribution of NASS-GES 2011–2015 by vehicle body type and weight class (column percent)

	Class 1	**Class 2A**	**Class 2B**	**Class 3+**
Pickup	11%	26%	63%	98%
SUV	89%	57%	4%	0%
Van	0%	17%	34%	2%

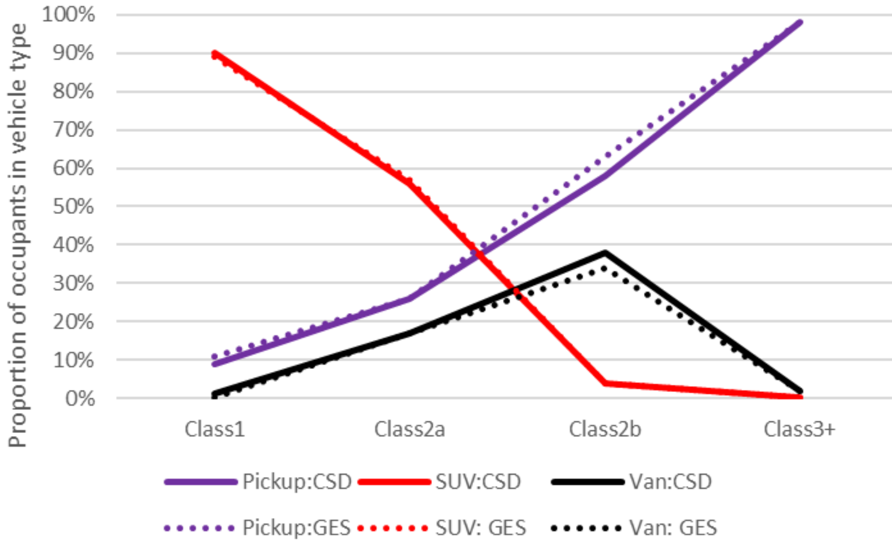

Figure 1. Comparison of occupants by vehicle type and weight class for combined State dataset (CSD) and NASS-GES

To compare distributions of different variables by class type for FARS, a chi-square test was conducted. If the chi-square value was less than 0.05, standardized residuals were examined to understand how the distribution of observed values was higher or lower than expected statistically. Because of the large size of the combined State dataset, this method showed that nearly every cell was different than expected statistically. As a result, no conclusions could be obtained from the chi-square analysis.

Results: Combined State Dataset

Vehicle Factors

Table 27 shows the distribution of occupants per the type of restraints available (i.e., DAB, PAB, OSAB, SAB). Nearly all occupants in crashes were traveling in vehicles equipped with frontal-impact air bags for the driver and right-front passenger. About three quarters of occupants in Class 1 and Class 2A vehicles were in vehicles where side air bags are standard or optional equipment. However, only about one-quarter of Class 2B and Class 3+ vehicles have side air bags as standard equipment, while 3 percent of Class 2B and 16 percent of Class 3+ vehicles have them as options.

Table 27. Distribution of available restraints for occupants in crashes

Air Bag Type	Class 1	Class 2A	Class 2B	Class 3+
DAB	100%	100%	99%	100%
PAB	100%	100%	99%	100%
OSAB	4%	10%	3%	16%
SAB	75%	62%	24%	26%

The distribution of occupants in crashes by vehicle age and weight class is shown in Table 28. The distribution by age is quite similar for Class 2A and Class 2B vehicles, with about 40 percent less than 8 years old. Class 1 and Class 3+ vehicles have a higher proportion of newer vehicles, at 60 percent and 50 percent, respectively, suggesting that fleet turnover may be comparatively faster for these class of vehicles.

Table 28. Occupants in crashes by vehicle age and weight class

Vehicle Age	Class 1	Class 2A	Class 2B	Class 3+
0-3	33%	21%	21%	26%
4-7	27%	21%	19%	24%
8-11	18%	24%	23%	24%
12-15	15%	26%	27%	19%
16-19	7%	8%	10%	6%

Crash Factors

The latitude and longitude coordinates of the crashes for all the States (except Idaho) were mapped to ZIP Codes using Census shapefiles. The ZIP Codes were then mapped to RUCC codes and classified as Large Metro, Small/Medium (S/M) Metro and Nonmetro as shown in Table 29. The occupant distribution is very similar to the RUCC classification performed for the distribution of fatalities.

Table 29. Distribution of occupants by Rural/Urban Classification and vehicle weight class

RUCC	Class 1	Class 2A	Class 2B	Class 3+
Large Metro	38%	35%	32%	28%
S/M Metro	37%	37%	37%	36%
Nonmetro	24%	28%	31%	35%

The distribution of occupants in crashes by the manner of collision and vehicle weight class is shown in Table 30. The distributions are quite similar for all weight classes, particularly when comparing Class 2A and Class 2B crashes. The largest difference is in front-to-rear crashes, where the proportion decreases with increasing weight class. The proportion of sideswipes increase with vehicle size.

Table 30. Distribution of occupants by manner of collision and vehicle weight class

Manner of Collision	Class 1	Class 2A	Class 2B	Class 3+
Single	10%	12%	13%	14%

Manner of Collision	Class 1	Class 2A	Class 2B	Class 3+
Front-to-rear	43%	39%	36%	30%
Front-to-front	3%	3%	3%	2%
Angle	22%	22%	20%	20%
Sideswipe-Same	10%	10%	12%	15%
Sideswipe-Opposite	1%	2%	3%	5%
Rear-to-side	1%	1%	2%	1%
Rear-to-rear	1%	1%	1%	1%
Other/ Unknown	9%	10%	10%	12%

The damage location by vehicle weight class for occupants in crashes is shown in Table 31. The distributions are fairly consistent for damage to the sides, top, and undercarriage across weight class. However, the proportion with damage to the rear of the vehicle decreases with increasing weight class, as does the damage to the front of the vehicle (but to a lesser extent).

Table 31. Distribution of occupants by damage location and vehicle weight class

Damage Location	Class 1	Class 2A	Class 2B	Class 3+
Frontal	43%	44%	41%	38%
Left	11%	11%	12%	14%
Right	10%	11%	12%	12%
Rear	32%	29%	25%	21%
Top	2%	2%	3%	2%
Undercarriage	0%	0%	0%	1%
Unknown	2%	2%	6%	12%

Occupants in crashes by the light condition and vehicle weight class are shown in Table 32. About three-quarters of occupants in all vehicle weight classes are in crashes that occurred in the daylight. Class 2A vehicles have the highest proportion of crashes in the dark.

Table 32. Distribution of occupants by light condition and vehicle weight class

Light Condition	Class 1	Class 2A	Class 2B	Class 3+
Light	74%	72%	76%	75%
Dark	20%	21%	18%	19%
Dawn	1%	2%	2%	2%
Dusk	2%	2%	2%	2%
Other/Unknown	2%	2%	2%	2%

Table 33 shows the distributions by weather conditions, which are consistent across all weight classes.

Table 33. Distribution of occupants by weather conditions and vehicle weight class

Weather Condition	Class 1	Class 2A	Class 2B	Class 3+
Clear/cloudy	86%	85%	86%	87%
Rain	8%	8%	7%	7%
Snow/sleet/hail	2%	3%	3%	3%
Fog/smoke	0.4%	0.4%	0.5%	0.5%
Other/unknown	3%	3%	3%	3%

Occupant Factors

Table 34 shows the distribution of occupants by their age and vehicle weight class. Compared to the lighter weight classes, Class 2B and Class 3+ have fewer people under age 18 and over 65 riding in them. The distribution by gender is shown in Table 35, where the differences in gender distribution vary substantially. About three-quarters of occupants in Class 2B and Class 3+ vehicles are male, while the distribution is more evenly split for Class 1 and Class 2A vehicles.

Table 34. Distribution of occupants in crashes by occupant age group and vehicle weight class

Occupant Age Group	Class 1	Class 2A	Class 2B	Class 3+
0-10	6%	9%	5%	4%
11-17	6%	7%	4%	4%

Occupant Age Group	Class 1	Class 2A	Class 2B	Class 3+
18-30	25%	19%	22%	19%
31-65	45%	49%	55%	59%
>65	12%	9%	6%	7%
Other/unknown	6%	7%	8%	7%

Table 35. Distribution of occupants in crashes by occupant gender and vehicle weight class

Occupant Gender	Class 1	Class 2A	Class 2B	Class 3+
Male	40%	50%	74%	77%
Female	53%	43%	17%	15%
Unknown	7%	7%	9%	8%

Information about reported use of occupant restraint systems is found in Table 36 and Table 37. The reported use of lap-shoulder belts is consistent across vehicle weight class, while Class 2B and 3+ vehicles have a lower reported rate of child restraint system use, but a higher rate of no belt use. For air bag deployment, the proportion of occupants in crashes with air bag deployments decreases with increasing weight class. Because nearly all vehicles had at least frontal air bags, the analysis is not limited to vehicles that were equipped with air bags.

Table 36. Distribution of occupants by seat belt type and vehicle weight class

Occupant Restraint Use	Class 1	Class 2A	Class 2B	Class 3+
CRS	4%	6%	2%	2%
Lap Shoulder	87%	84%	85%	86%
None	1%	1%	2%	2%
Other/unknown	8%	9%	10%	10%

Table 37. Distribution of occupants by air bag deployment status and vehicle weight class

Air Bag Deployment	Class 1	Class 2A	Class 2B	Class 3+
Yes	10%	7%	4%	3%
No	73%	74%	75%	78%
Unknown	17%	19%	21%	18%

The distribution of occupants by seating position is shown in Table 38. Results are fairly consistent for each seating position and weight class. Class 2B vehicles have the highest proportion of other/unknown seating position, which can include cargo areas. Occupants in Class 1 vehicles have more people in the driver position (indicating fewer passengers) and the fewest people in rear seating positions. Class 2A vehicles have the most occupants in the rear outboard positions.

Table 38. Distribution of occupants by occupant seating position and vehicle weight class

Occupant Position	Class 1	Class 2A	Class 2B	Class 3+
Driver	66%	60%	62%	63%
Front Center	0.1%	0.2%	0.4%	0.4%
Front Right	13%	14%	13%	15%
Other/unknown	12%	12%	16%	12%
Rear Center	1%	2%	2%	1%
Rear Left	3%	5%	3%	3%
Rear Right	4%	6%	4%	4%

The ejection status of occupants in crashes is shown in Table 39, with consistent distributions for each weight class. Unlike fatal crashes, additional details on ejection level and pathway are not included consistently across State crash records.

Table 39. Distribution of occupants by ejection status and vehicle weight class

Occupant Ejection Status	Class 1	Class 2A	Class 2B	Class 3+
No	88%	87%	85%	86%
Yes	0.2%	0.2%	0.2%	0.2%

Occupant Ejection Status	Class 1	Class 2A	Class 2B	Class 3+
Unknown	12%	13%	14%	13%

The distribution of occupants by driver age and vehicle weight class is shown in Table 40. The distribution of drivers under age 21 is similar across vehicle classes, while the proportion of drivers 21 to 30 and 65 and older decreases with increasing weight class, and the proportion of drivers 31 to 65 increases with vehicle weight class.

Table 40. Distribution of occupants by driver age and vehicle weight class

Driver Age	Class 1	Class 2A	Class 2B	Class 3+
<16	8%	9%	9%	8%
16-17	3%	3%	1%	1%
18-20	6%	4%	4%	3%
21-30	20%	16%	18%	15%
31-65	51%	58%	61%	65%
>65	12%	9%	6%	7%

Table 41 shows the distribution of occupants by injury level and vehicle weight class. The proportions of K, A, B, and unknown injuries are similar across weight classes, while the proportion of no injury (O) occupants increases with weight class and possible injury (C) decreases with weight class.

Table 41. Distribution of occupants by injury level and vehicle weight class

Occupant Injury Level	Class 1	Class 2A	Class 2B	Class 3+
O No injury	77%	78%	81%	83%
C Possible Injury	10%	8%	6%	5%
B Non-incapacitating injury	4%	4%	3%	3%
A Incapacitating injury	1%	1%	1%	1%
K Killed	0.1%	0.1%	0.2%	0.2%
Unknown	8%	9%	9%	8%

The distribution of occupants by driver gender and vehicle weight class shown in Table 42 is similar to the overall distribution of occupants by weight class. Class 2B vehicles have a higher proportion of male drivers and a lower proportion of female drivers.

Table 42. Distribution of occupants by driver gender and vehicle weight class

Driver Gender	Class 1	Class 2A	Class 2B	Class 3+
Male	41%	52%	79%	84%
Female	53%	42%	13%	10%
Unknown	6%	6%	8%	7%

The distribution of alcohol use by the driver and vehicle weight class, shown in Table 43, is consistent with vehicle weight class.

Table 43. Distribution of occupants by driver alcohol use and vehicle weight class

Driver Alcohol Use	Class 1	Class 2A	Class 2B	Class 3+
No	88%	87%	84%	84%
Yes	1%	1%	1%	1%
Not reported	11%	12%	14%	14%

The distributions of the number of occupants by vehicle weight class is shown in Table 44. Class 2A vehicles have the lowest proportion of solo drivers. Class 2B vehicles have the highest proportion of vehicles with 9 or more occupants—10 times the rate of other vehicle classes.

Table 44. Distribution of occupants in crashes by number of occupants and vehicle weight class

Number of Occupants	Class 1	Class 2A	Class 2B	Class 3+
1	60%	52%	60%	60%
2	21%	21%	18%	20%
3	10%	11%	8%	9%
4	5%	7%	5%	5%
5	2%	4%	2%	2%
6	0.6%	2%	1%	1%

Number of Occupants	Class 1	Class 2A	Class 2B	Class 3+
7	0.2%	1%	1%	0.4%
8	0.1%	0.3%	1%	0.1%
9+	0.1%	0.3%	3%	0.3%

Discussion

This analysis was performed to identify potential differences in crash, injury, and fatality trends in Class 2B vehicles compared to other vehicle classes. The analysis used two datasets, a combined census of police-reported crashes from nine States, and a national census of fatal crashes, restricted to only the fatal cases. However, neither dataset represents the traveling population. The State data is only a selection of all U.S. crashes, and while FARS is a census dataset, it is only a census of crashes yielding at least one fatality. A common approach for estimating characteristics of the traveling population is to restrict cases to only those struck in the rear. However, the restriction of the dataset to eliminate vehicle types other than pickups, SUVs, and vans does not allow use of this method as resulting sample sizes are too small to allow for meaningful statistical analysis.

Instead, the pattern of crashes in these datasets represents a combination of risk and exposure. To the extent that patterns for Class 2B vehicles differ from those of other classes (especially Class 1), those differences may reflect either differences in exposure (driving patterns) or risk. From these datasets, it is not possible to determine which is true. Thus, in the discussion below, comments on which patterns are likely to be related to risk versus exposure are based on prior understanding of crash mechanisms.

One of the most notable differences in Class 2B (and Class 3+) vehicles is the substantially higher proportion of male drivers and occupants. About three quarters of occupants of Class 2B and Class 3+ vehicles involved in crashes are male, compared to about 40 percent of Class 1 and 50 percent of Class 2A vehicles. For the most part, this difference is likely to be the result of exposure—simply that Class 2B vehicles are more often driven by males. However, male drivers tend to be somewhat higher-risk drivers than female drivers (Regev et al., 2018; Swedler et al., 2012), so it is possible that some of the differences seen in trends between Class 2A and Class 2B vehicles may be a result of behavior differences between men and women.

The analysis included crash conditions such as weather and lighting, as well as differences in types of crashes, to understand whether requirements for crash avoidance technologies that differ for Class 2B vehicles might affect the distribution of types of crashes they are involved in. There were only a few instances where there were notable differences. When analyzing the combined State dataset, Class 2B vehicles were involved in more sideswipe crashes than other vehicle classes, which could be related to their larger width and possibly larger blind spot. In the FARS analysis, there was a greater number of fatalities involving control loss than other classes. Requirements for electronic stability control may be useful for preventing these crashes in Class 2B vehicles. For weather conditions, Class 2B vehicles had a greater proportion of fatalities in severe weather (snow/sleet/hail) than Class 1 vehicles. It is not clear whether this is the result of drivers choosing to drive a larger vehicle in bad weather or from poorer performance in such conditions. Class 2B vehicles also had a higher number of fatal crashes in dark/not lit conditions than other vehicles. This may be due to driving patterns (e.g., more driving on rural unlit roads) or because of risk associated with those roads.

Despite differing regulatory requirements, nearly all vehicles from MY 2000+ are equipped with frontal-impact driver and front passenger air bags. However, Class 2B vehicles have the lowest rates of standard and optional side air bags. When reviewing the percentage of fatalities and occupants where the air bag deployed in the crash, Class 2B vehicles had lower rates of air bag deployment than Class 1 or Class 2A vehicles. Because nearly all vehicles are equipped with air bags, the lower deployment rate in Class 2B vehicles likely reflects the lower crash severity of these vehicles because of their higher weight.

Overall, crash, injury, and fatality patterns for occupants of Class 2B vehicles were not substantially different from other vehicle classes when restricting analysis to pickups, vans, and SUVs in each class. Besides the differences noted above, Class 2B occupants had the highest proportion of non-seating positions, which includes seating in cargo areas of pickup trucks. This likely contributes to the highest rate of fatalities involving ejections. The high ejection rate may also partly result from the lowest rate of belt use by occupants in fatal crashes among the four weight classes examined; this may be associated with the lower belt use rates observed in male drivers (91% versus 85%) (United Health Foundation, 2020). However, the higher proportions of unbelted fatalities in Class 2B vehicles may also partly result from fewer belted fatalities because of lower crash severity associated with large size. The other factor relevant to Class 2B vehicles is their higher-than-expected proportion of crashes and fatal crashes involving 9 or more occupants. One of two highlighted cases involved a limousine, while the other involved a pickup where many occupants were seated in the cargo area.

Class 2B vehicles have lower proportions of child occupants under 10 in both the combined State dataset and FARS than Class 1 or Class 2A vehicles, as well as corresponding lower rates of child restraint use. This may be due to the fact that Class 2B vehicles have the highest proportion of pickup trucks and lower proportions of SUVs and vans. In addition, male drivers tend to transport child passengers less frequently than female drivers (Klinich et al., in press).

Market Survey Findings

Class 2B Vehicles Market Survey

The research team conducted a market survey regarding the vehicles from 8,500 lbs to 10,000 lbs GVWR. This vehicle category is known as Class 2B, and its vehicles are mainly produced by large automobile manufacturers such as Ford or General Motors. The Class 2B category includes pickups, full-size vans, and SUVs. Many Federal safety regulations, including air bag requirements and installation of LATCH hardware, do not apply to this vehicle class. However, some manufacturers choose to voluntarily install or provide the option to install safety systems that are not required in these vehicles.

Research Objectives

The research objectives for the Class 2B market survey were to:

1. Identify the make and models of vehicles classified under Class 2B;
2. Investigate occupant restraints that original vehicle manufacturers supplied (i.e., installation rates of seat belts and voluntary supply of air bags for driver and passengers); and
3. Document the proportions of commercial and private ownership of the vehicles under this category.

Makes and Models of Class 2B Vehicles

The research team identified manufacturers of Class 2B vehicles and vehicle models through scholarly literature (Davis & Truett, 2002), vehicle registration data, vehicle crash data, and online resources.[2] The Class 2B vehicle manufacturers and their makes and models are listed in Table 45. Information on trim and GVWR was identified through the registration data and internet searches. Production years were identified through various online sources. Some errors in the registration and crash data were identified, such as vehicles incorrectly classified as Class 2B, thus the summarized data has risk for error.

Analysis of Polk's vehicle registration data from 1995 to 2018 found that Class 2B vehicles are composed of 8 makes, 41 models, and 137 trims. However, quality checks reduced the number of models reported as Class 2B to 31. The models that were excluded have GVWR greater than 10,000 lbs, e.g., Chevrolet Silverado C3500 (GVWR 14,000 lbs), Ford F350 SRW Super Duty (GVWR 12,400 lbs), and GMC Sierra C3500 (GVWR 11,000 lbs12).

Table 45. Manufacturers of Class 2B vehicles and their makes and models

Make	Model	Trim	Production Years	GVWR
Chevrolet	Express G2500	3LT, LS, LT, Paratransit	1995-Present	8,600-9,900
Chevrolet	Express G3500*	LS, LT, Paratransit	1995-Present	9,700 – 11,400
Chevrolet	Express Van *Also known as the GMC Vandura and GMC Rally Wagon*	G10, G20, G30	1964-1995	9,600

[2] The J. D. Power web site at NADAguides.com, and other web sites such as autolist.com, cars.com, nissanusa.com, and mbvans.com.

Make	Model	Trim	Production Years	GVWR
Chevrolet	Hi-Cube Van	G30	*Missing data (possibly* 1970s through the 90s*)*	8,600
Chevrolet	K30	*Trim not specified in Polk data*	*Missing data (likely 1960-1996)*	8,600
Chevrolet	Silverado*	C2500, C2500 Heavy Duty, LT, LTZ, C2500 High CountryK2500, K2500 Heavy Duty, K2500 High Country	1999-Present	8,600-10,850
Chevrolet	Suburban	C2500, C2500 LS, C2500 LT, K20, K2500, K2500 LS, K2500 LT, R2500, V2500	2002-2013	8,600
Chevrolet	Avalanche	2500	2001-2013	8,600
Chevrolet	V3500	*Trim not specified in Polk data*	1988-1991	9,200
Dodge	Ram 2500	2500 St/SLT, Laramie, Longhorn, Powerwagon, SLT, ST, ST/SLT, ST/ SLT/Laramie	2000-2009	8,565-10,000
Dodge	Ram 3500	ST/SLT	2000-2009	9,350
Dodge	Ram Wagon	B3500	2000-2002	8,700
Ford	Econoline	E150, E150 Van, E150 Wagon, E250 Cutaway Van, E250 Parcel, Delivery Cutaway Van, E250 Super Duty, E250 Super Duty Van, E250 Van, E350, E350 Cutaway Van, E350 Parcel Delivery Cutaway Van, E350 Super Duty, E350 Super Duty Van, E350 Super Duty Wagon, E350 Van	1999-2014	8,520-9,500
Ford	Excursion	Eddie Bauer, Limited, XLT	2000-2005	8,600
Ford	F-250	Super Duty	1999-Present	10,000
Ford	Transit	T-150, T-250, T-350, T-350HD	2013-Present	8,670-9,950
GMC	Forward Control Chassis	P3500	*Missing data (possibly 1980s through 90s)*	10,000
GMC	New Sierra*	C2500, K2500	2001-Present	9,900-10,850
GMC	Savana	Cutaway G3500, G2500, G2500 LS, G2500 LT, G2500 Paratransit, G3500, G3500 LS, G3500 LT, G3500 Paratransit, RV G2500, RV G2500 3LT, RV G3500	1997-Present	8,600-9,900
GMC	Sierra	C2500, C2500 Crew Cab, C2500 Denali, C2500 Heavy Duty, C2500 SLE, C2500 SLT, K2500, K2500 AT4, K2500 Crew Cab, K2500 Denali, K2500 Heavy Duty, K2500 SLE, K2500 SLT	1988-2004	9,500-9,900
GMC	Suburban *Later referred to as the Yukon XL*	C2500, K2500	1937-1999	8,600
GMC	Value Van	P3500	*Missing data*	10,000
GMC	Yukon XL	C2500, C2500 SLE, C2500 SLT, K2500, K2500 SLE, K2500 SLT	2000-Present	8,600
Hummer	H2	Base, Adventure, Luxury, Sut	2003-2009	8,600

Make	Model	Trim	Production Years	GVWR
Mercedes-Benz *Also branded as Dodge and Freightliner*	Sprinter*	2500, 3500	2003-Present	8,550-12,120
Nissan	NV	1500 S/1500 SV, 2500 S/2500 SV/2500 SL, 3500/S/SV/SL	2012-Present	8,550-9,400
Nissan	Titan XD	S, S/SV, SL/Platinum Reserve, SL/Platinum Reserve/SV, SL/Pro-4x/Platinum Reserve, SL/Pro-4x/Platinum Reserve/SV, SV, SV/Pro-4x, Platinum Reserve/SL	2004-Present	8,800
Ram	2500	Big Horn, Laramie Limited, Longhorn, Powerwagon, SLT, ST, Tradesman	2010-Present	10,000
Ram	Promaster 1500	*Trim not specified in Polk data*	2014-Present	8,550
Ram	Promaster 2500	*Trim not specified in Polk data*	2014-Present	8,900
Ram	Promaster 3500	3500 High	2014-Present	9,350

* = GVWR falls out of Class 2B range dependent on trim selection.

Number of Class 2B Vehicles in Operation

Analysis of Polk's vehicle registration data (available only from 2001 to 2019) informed the number of Class 2B vehicles in operation. Figure 2 shows the number of registered Class 2B vehicles from 2001 to 2019. Overall, the number of Class 2B vehicles has been continuously growing. There were about 10.3 million Class 2B vehicles in operation in 2018 and about 10.8 million in 2019 (i.e., approximately 5% growth).

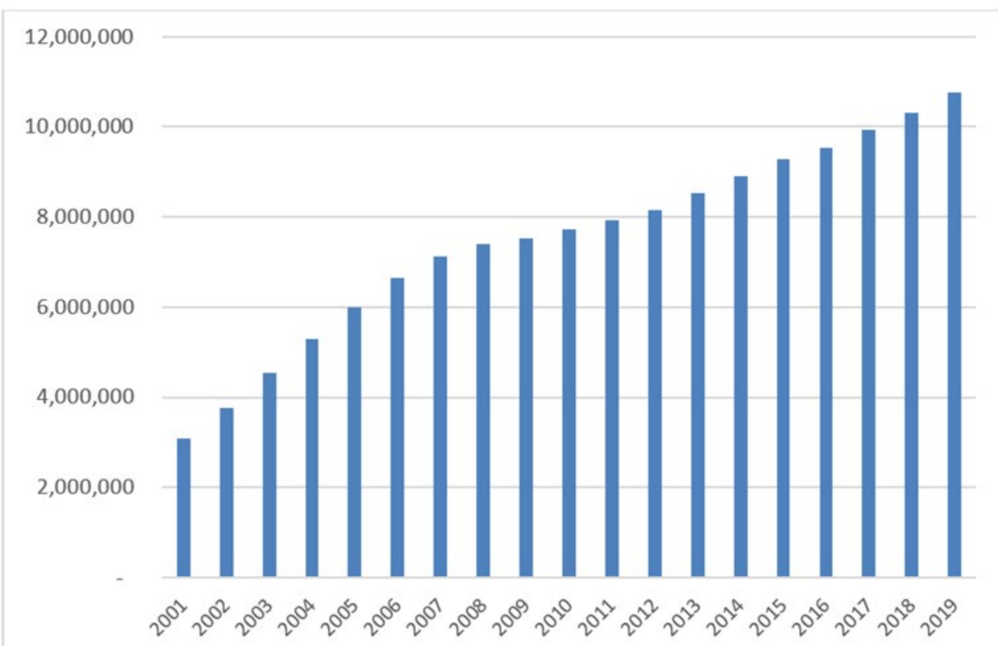

Figure 2. Number of registered Class 2B vehicles from 2001–2019

Examining the breakdown of the number of registered Class 2B vehicles by manufacturer make and model in the past 10 years reveals that the most common Class 2B vehicle is the Ford F-250, which totaled 2.8 million in 2019 (i.e., 26% of the total Class 2B vehicles in operation). The second most common vehicle is the Chevrolet Silverado, which totaled 2.2 million (i.e., 20% of the total Class 2B vehicles in operation). The next most common Class 2B vehicles included the Dodge RAM 2500 and Ford Econoline, which accounted for 1 million and 0.9 million, respectively (i.e., about 9% each).

Annual Sales of Class 2B Vehicles

The research team conducted a preliminary literature search that revealed some information regarding the sales volume and market size of older Class 2B vehicles. A study conducted in 2002 indicated that 521,000 Class 2B trucks were sold in 1999, which represented 6.4 percent of sales of all trucks under 10,000 lbs (Davis & Truett, 2002). The study also mentioned that 82 percent of the Class 2B trucks sold in 1999 were pickups, and one third of the trucks sold used diesel fuel.

Research on fuel emissions has estimated production information for Class 2B trucks. A Regulatory Impact Analysis conducted by the EPA and NHTSA (2016) estimated that in 2014 Class 2B and Class 3 production was 638,109 units, with nearly 80 percent being Class 2B. Further, this report estimated that in 2014, Ford made up over 50 percent of Class 2B, followed by Fiat/Chrysler (19.5%), GM (22.2%), Daimler (3.9%), and Nissan (2.7%).

The research team also explored Class 2B U.S. sales data and statistics published by auto sales tracking agencies or business[3] (See Table 46). Sales data were frequently not separated by vehicle class, and therefore the data are not a reflection of only Class 2B. Data that includes vehicles across classes has been indicated with an asterisk. These data show an upward trend in truck and van production across the last 10 years.

Table 46. Production volume rank for Class 2A and Class 3 vehicles from 2010–2019

Production Volume Rank	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Ford F250	Ford F250	Ford F250	Ford F250	Ford F250	Ford F250	Ford F250	Ford F250	Ford F250	Ford F250
2	Chevrolet Silverado	Chevrolet Silverado	Chevrolet Silverado	Chevrolet Silverado	Chevrolet Silverado	Chevrolet Silverado	Chevrolet Silverado	Chevrolet Silverado	Chevrolet Silverado	Chevrolet Silverado
3	Dodge Ram 2500	Dodge Ram 2500	Dodge Ram 2500	Dodge Ram 2500	Dodge Ram 2500	Dodge Ram 2500	Dodge Ram 2500	Dodge Ram 2500	Dodge Ram 2500	Dodge Ram 2500
4	Ford Econoline	Ford Econoline	Ford Econoline	Ford Econoline	Ford Econoline	Ford Econoline	Ford Econoline	Ford Econoline	Ford Econoline	Ford Econoline
5	Ford F350*	Ford F350*	GMC Sierra	GMC Sierra	GMC Sierra	GMC Sierra	GMC Sierra	GMC Sierra	GMC Sierra	GMC Sierra
6	GMC Sierra	GMC Sierra	Ford F350*	Ford F350*	Ford F350*	Ford F350*	Ford F350*	Ford F350*	Ram 2500	Ram 2500

[3] Web sites such as Gmauthority.com, carsalesbase.com, and goodcarbadcar.net.

7	Chevrolet Express G3500	Chevrolet Express G2500	Chevrolet Express G2500	Chevrolet Express G2500	Chevrolet Express G2500	Chevrolet Express G2500	Chevrolet Express G2500	Chevrolet Express G2500	Ford F350*	Chevrolet Express G2500
8	Chevrolet Express G2500	Chevrolet Express G3500	Chevrolet Express G3500	Chevrolet Express G3500	Chevrolet Express G3500	Chevrolet Express G3500	Chevrolet Express G3500	Ram 2500	Chevrolet Express G2500	Ford F350*
9	Ford Excursion	Ford Excursion	Ford Excursion	Ford Excursion	Ford Excursion	Ram 2500	Ram 2500	Chevrolet Express G3500	Chevrolet Express G3500	Chevrolet Express G3500
10	GMC Savana	GMC Savana	GMC Savana	GMC Savana	GMC Savana	Ford Excursion	Ford Excursion	Ford Transit	Ford Transit	Ford Transit
11	Chevrolet Suburban	Chevrolet Suburban	Chevrolet Suburban	Chevrolet Suburban	Ram 2500	GMC Savana	GMC Savana	Ford Excursion	Ford Excursion	GMC Savana
12	Hummer H2	Hummer H2	Hummer H2	Hummer H2	Chevrolet Suburban	Chevrolet Suburban	Ford Transit	GMC Savana	GMC Savana	Ford Excursion
13	Dodge Ram 3500*	Dodge Ram 3500*	Dodge Ram 3500*	Dodge Ram 3500*	Hummer H2	Hummer H2	Chevrolet Suburban	Chevrolet Suburban	Chevrolet Suburban	Nissan NV
14	Dodge Ram Wagon	Dodge Ram Wagon	Dodge Ram Wagon	Dodge Ram Wagon	Dodge Ram 3500*	Ford Transit	Hummer H2	Hummer H2	Hummer H2	Chevrolet Suburban
15	GMC New Sierra	GMC New Sierra	GMC New Sierra	GMC New Sierra	Mercedes -Benz Sprinter	Dodge Ram 3500*	Dodge Ram 3500*	Nissan NV	Mercedes-Benz Sprinter	Hummer H2
16	Chevrolet G30	Dodge Sprinter	Mercedes -Benz Sprinter	Ram 2500	GMC New Sierra	Mercedes -Benz Sprinter	Nissan NV	Mercedes -Benz Sprinter	Nissan NV	Mercedes-Benz Sprinter
17	Dodge Sprinter	Chevrolet G30	Dodge Sprinter	Mercedes -Benz Sprinter	Dodge Ram Wagon	Nissan NV	Mercedes -Benz Sprinter	Dodge Ram 3500*	Dodge Ram 3500*	Dodge Ram 3500*
18	GMC Yukon Xl	GMC Yukon Xl	GMC Yukon Xl	Nissan NV	Nissan NV	GMC New Sierra	GMC New Sierra	GMC New Sierra	GMC New Sierra	Nissan Titan XD
19	GMC Suburban	GMC Suburban	Chevrolet G30	Dodge Sprinter	GMC Yukon Xl	Dodge Ram Wagon	Dodge Ram Wagon	Dodge Ram Wagon	Nissan Titan XD	GMC New Sierra
20	Hummer H2 Sut	Hummer H2 Sut	Nissan NV	GMC Yukon Xl	Dodge Sprinter	GMC Yukon Xl	GMC Yukon Xl	Nissan Titan XD	Dodge Ram Wagon	Dodge Ram Wagon
21	Freightliner Sprinter	Mercedes -Benz Sprinter	Hummer H2 Sut	Chevrolet G30	Chevrolet G30	Dodge Sprinter	Dodge Sprinter	GMC Yukon Xl	GMC Yukon Xl	GMC Yukon Xl

22	Sprinter 3500 Sprinter	Nissan NV	GMC Suburban	Hummer H2 Sut	Freightliner Sprinter	Freightliner Sprinter	Freightliner Sprinter	Dodge Sprinter	Dodge Sprinter	Freightliner Sprinter
23	Chevrolet Van	Freightliner Sprinter	Freightliner Sprinter	GMC Suburban	Hummer H2 Sut	Chevrolet G30	Hummer H2 Sut	Freightliner Sprinter	Freightliner Sprinter	Dodge Sprinter
24	Chevrolet V3500	Sprinter 3500 Sprinter	Sprinter 3500 Sprinter	Freightliner Sprinter	GMC Suburban	Hummer H2 Sut	Chevrolet G30	Hummer H2 Sut	Hummer H2 Sut	Hummer H2 Sut
25	Mercedes-Benz Sprinter	Chevrolet Van	Chevrolet Van	Sprinter 3500 Sprinter	Ford Transit	GMC Suburban	GMC Suburban	Chevrolet G30	Chevrolet G30	Chevrolet G30
26	GMC Jimmy*	Chevrolet V3500	Chevrolet V3500	Chevrolet V3500	Sprinter 3500 Sprinter	Ram Promaster 3500	Ram Promaster 3500	GMC Suburban	GMC Suburban	GMC Suburban
27	GMC Vandura	GMC Jimmy*	GMC Jimmy*	Chevrolet Van	Ram Promaster 3500	Sprinter 3500 Sprinter	Sprinter 3500 Sprinter	Ram Promaster 3500	Ram Promaster 3500	Ram Promaster 3500
28	Chevrolet V30	Chevrolet V30	Chevrolet V30	Chevrolet V30	Chevrolet V3500	Chevrolet V3500	Chevrolet V3500	Sprinter 3500 Sprinter	Sprinter 3500 Sprinter	Nissan Titan
29	Chevrolet K30	GMC Vandura	GMC Vandura	GMC Jimmy*	Chevrolet Van	Chevrolet Van	Chevrolet Van	Chevrolet V3500	Chevrolet V3500	Sprinter 3500 Sprinter
30	GMC Rally Wagon	Chevrolet K30	Chevrolet K30	Chevrolet K30	Chevrolet V30	Chevrolet V30	Chevrolet V30	Chevrolet Van	Chevrolet V30	Chevrolet V3500
31	GMC Value Van	GMC Rally Wagon	GMC Rally Wagon	GMC Vandura	GMC Jimmy*	GMC Jimmy*	GMC Jimmy*	Chevrolet V30	Chevrolet Van	Chevrolet V30
32	GMC Forward Control Chassis	GMC Value Van	GMC Value Van	GMC Rally Wagon	Chevrolet K30	Chevrolet K30	Chevrolet K30	GMC Jimmy*	GMC Jimmy*	GMC Jimmy*
33	Chevrolet Express Van	GMC Forward Control Chassis	GMC Forward Control Chassis	GMC Value Van	GMC Vandura	GMC Vandura	Nissan Titan XD	Chevrolet K30	Chevrolet K30	Chevrolet Van
34	Sprinter 2500 Sprinter	Chevrolet Express Van	Chevrolet Express Van	Chevrolet Express Van	GMC Rally Wagon	GMC Rally Wagon	GMC Vandura	GMC Vandura	GMC Vandura	Chevrolet K30
35	Chevrolet Hi-Cube Van	Sprinter 2500 Sprinter	Sprinter 2500 Sprinter	GMC Forward Control Chassis	GMC Value Van	GMC Value Van	GMC Rally Wagon	GMC Rally Wagon	GMC Rally Wagon	GMC Vandura
36	Nissan NV	Chevrolet Hi-Cube Van	Chevrolet Hi-Cube Van	Sprinter 2500 Sprinter	Chevrolet Express Van	Chevrolet Express Van	GMC Value Van	GMC Value Van	GMC Value Van	GMC Rally Wagon

37	Ford Transit	Ford Transit	Ram 2500	Chevrolet Hi-Cube Van	Sprinter 2500 Sprinter	Sprinter 2500 Sprinter	Chevrolet Express Van	Sprinter 2500 Sprinter	Sprinter 2500 Sprinter	GMC Value Van
38	Nissan Titan	Nissan Titan	Ford Transit	Ram Promaster 3500	GMC Forward Control Chassis	GMC Forward Control Chassis	Sprinter 2500 Sprinter	Chevrolet Express Van	Chevrolet Express Van	Sprinter 2500 Sprinter
39	Nissan Titan XD	Nissan Titan XD	Nissan Titan	Ford Transit	Chevrolet Hi-Cube Van	Chevrolet Hi-Cube Van	GMC Forward Control Chassis	GMC Forward Control Chassis	GMC Forward Control Chassis	Chevrolet Express Van
40	Ram 2500	Ram 2500	Nissan Titan XD	Nissan Titan	Nissan Titan	Nissan Titan	Chevrolet Hi-Cube Van	Chevrolet Hi-Cube Van	Chevrolet Hi-Cube Van	GMC Forward Control Chassis
41	Ram Promaster 3500	Ram Promaster 3500	Ram Promaster 3500	Nissan Titan XD	Nissan Titan XD	Nissan Titan XD	Nissan Titan	Nissan Titan	Nissan Titan	Chevrolet Hi-Cube Van
Total	7,732,047	7,937,812	8,161,816	8,528,246	8,904,805	9,275,995	9,536,004	9,925,791	10,299,710	10,776,061

* Vehicle crosses classes.

As identified in scholarly literature and the current review, Ford is the primary manufacturer of Class 2B vehicles. Per annual sales data shown in Figure 3, the F-series has seen a rise in the past 10 years after a significant fall around 2008, which can likely be attributed to the recession. Sales data for only the Ford F-250 could not be identified.

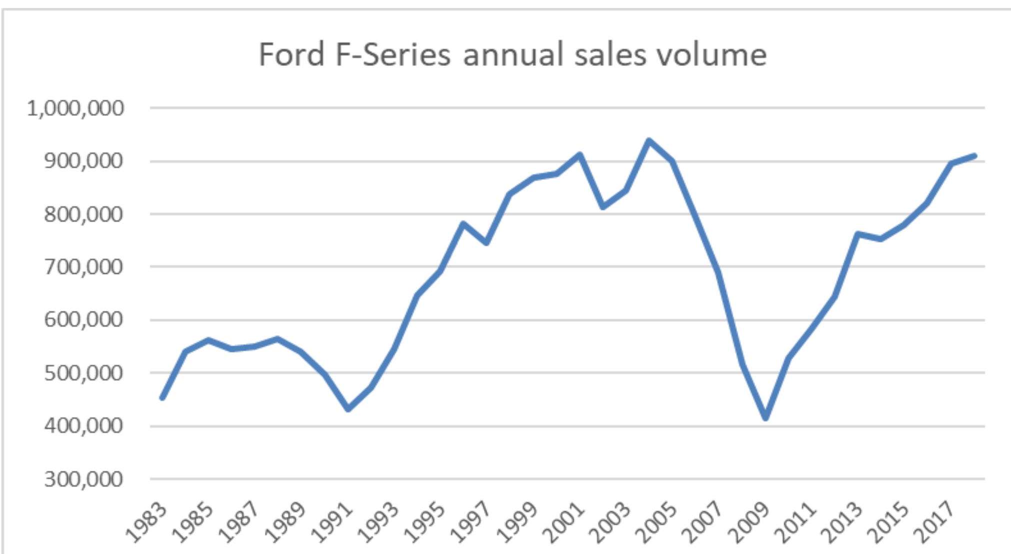

Figure 3. Ford F-series annual sales volume from 1983–2018

Data from Polk's vehicle registration information also provide some insight into the annual sales of Class 2B vehicles. Figure 4 shows the estimated number of new Class 2B sales by registration year. From the Polk's vehicle registration data, if the MY of a vehicle is the same or greater than the registration year, then it is considered a new vehicle. In early- to mid-2000s, there was a higher number of new Class 2B vehicles compared to the 2010s. The data also shows that the sales of Class 2B vehicles sharply declined during the 2007–2009 economic recession. In 2018 there were 414,463 new registrations of Class 2B vehicles. The number increased to 482,669 new registration of Class 2B vehicles in 2019. Again, the most common new registrations of Class 2B vehicle is Ford F-250, which accounted for 203,500 registrations in 2019 (i.e., 42%). It was followed by the Chevrolet Silverado, which accounted for about 90,000 new registrations in 2019 (about 19%).

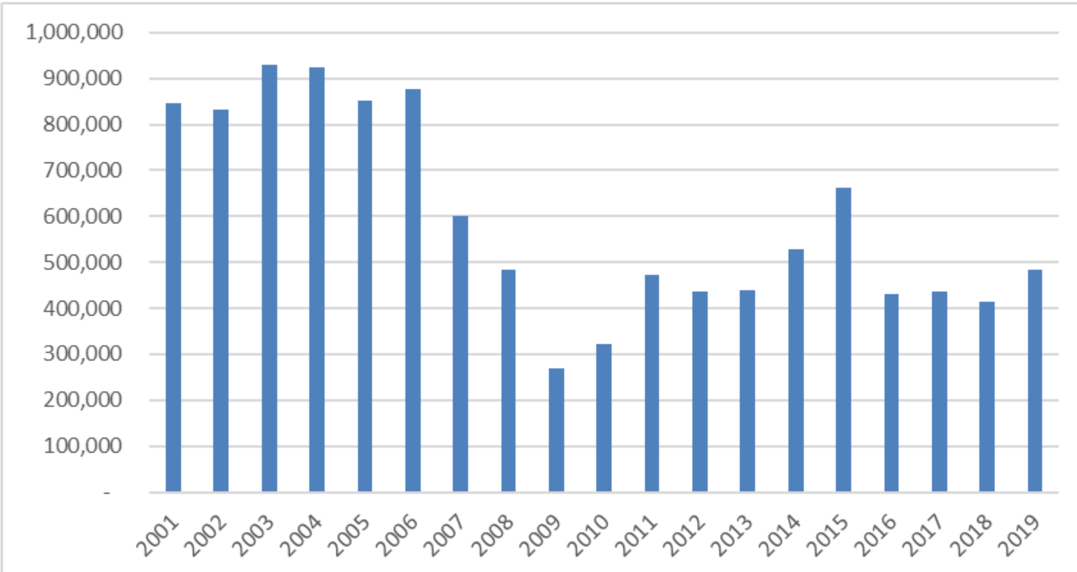

Figure 4. Count of new Class 2B vehicles from Polk's registration data

OEM-Supplied Occupant Restraints in Class 2B Vehicles

Data from Class 2B vehicle safety features were identified by scraping data from Autoblog.com. Data were gathered on installation of frontal air bags, side-impact air bags, side curtain air bags, knee air bags, seat belt pretensioners, and head restraints. Data were cleaned and quality checked by the research team, but unidentified errors from the website may exist. The research team was not able to identify websites that summarized seat belt installation rates and locations.

Figure 5 summarizes the quantity of vehicle models from 1999 to 2020 that were included in the Autoblog data scraping research. Vehicles included in this summary were manufactured by Ford, Chevrolet, GMC, Dodge, Hummer, Nissan, Mercedes, and Ram. Vehicles were counted as unique data points if the trim was different. For example, the Ford Transit-150 Cargo was counted separately from the Ford Transit-150 Passenger.

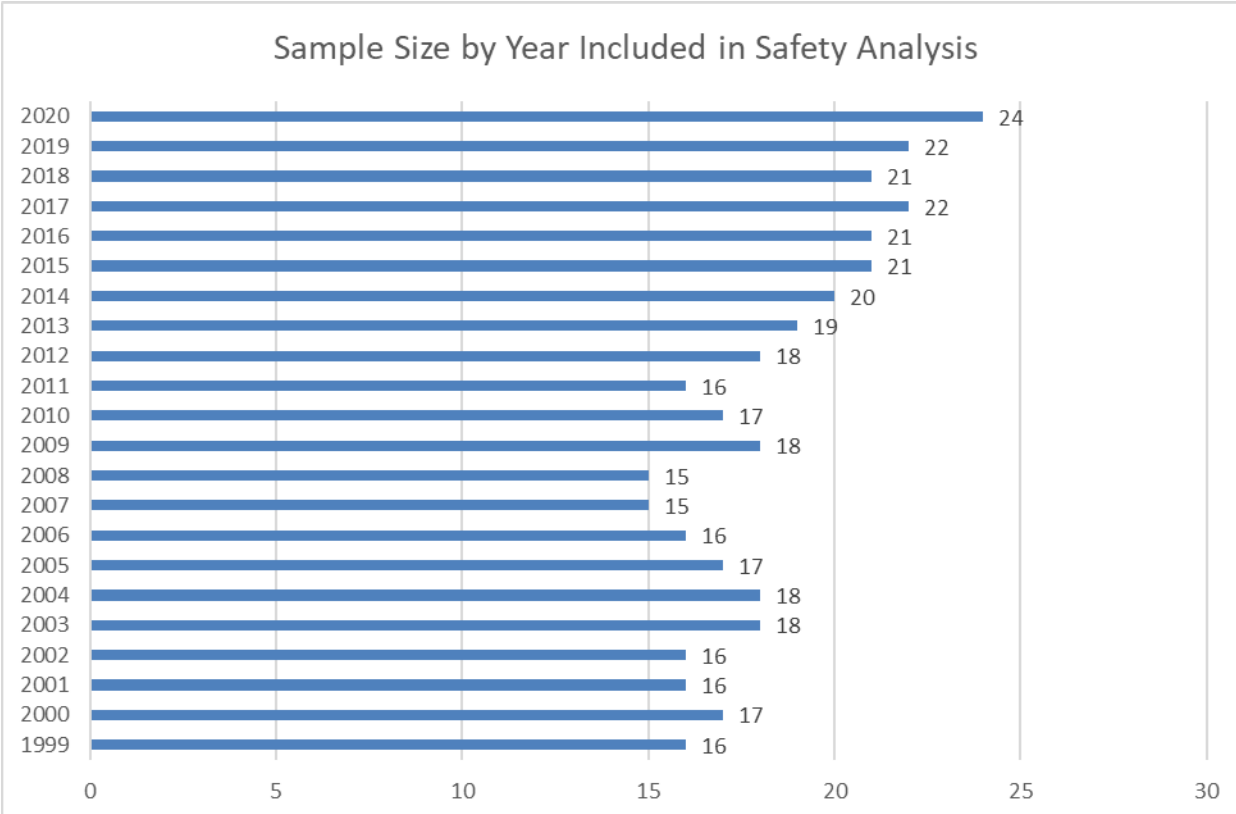

Figure 5. Sample size of vehicles by year included in the Class 2B safety analysis

Figure 6 shows the front-impact air bag installation rates for Class 2B vehicles from 1999 to present. In 2001 all identified Class 2B vehicles contained front-impact air bags.

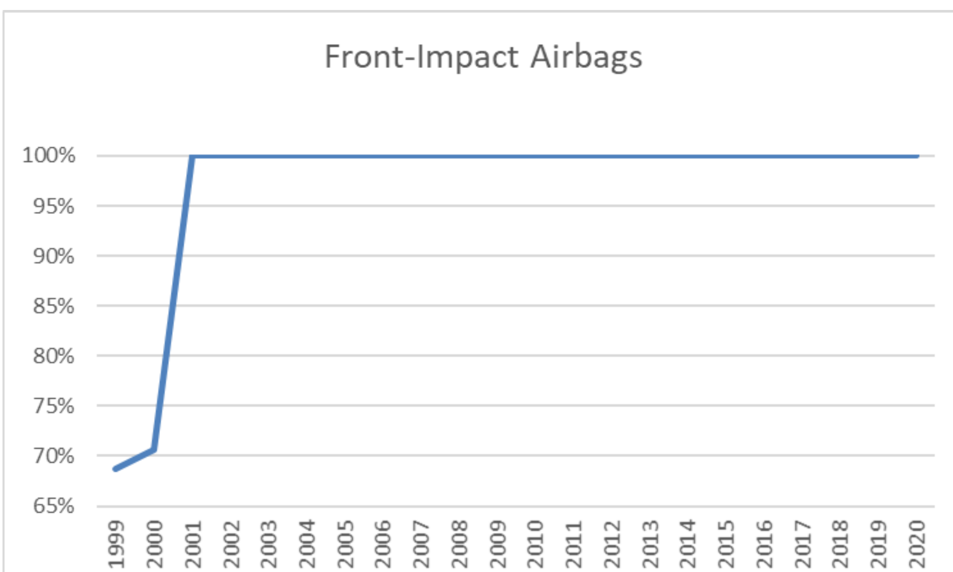

Figure 6. Class 2B front-impact air bag installation from 1999–2020

Figure 7 shows installation of torso air bags (that protect an occupant's torso during a side impact crash) in Class 2B vehicles from 1999 to present. Torso air bags were largely not installed in Class 2B vehicles from 1999 through 2009. From 2015 to 2016 there was a drastic increase in torso air bags, with installation rates jumping from 48 percent to 90 percent.

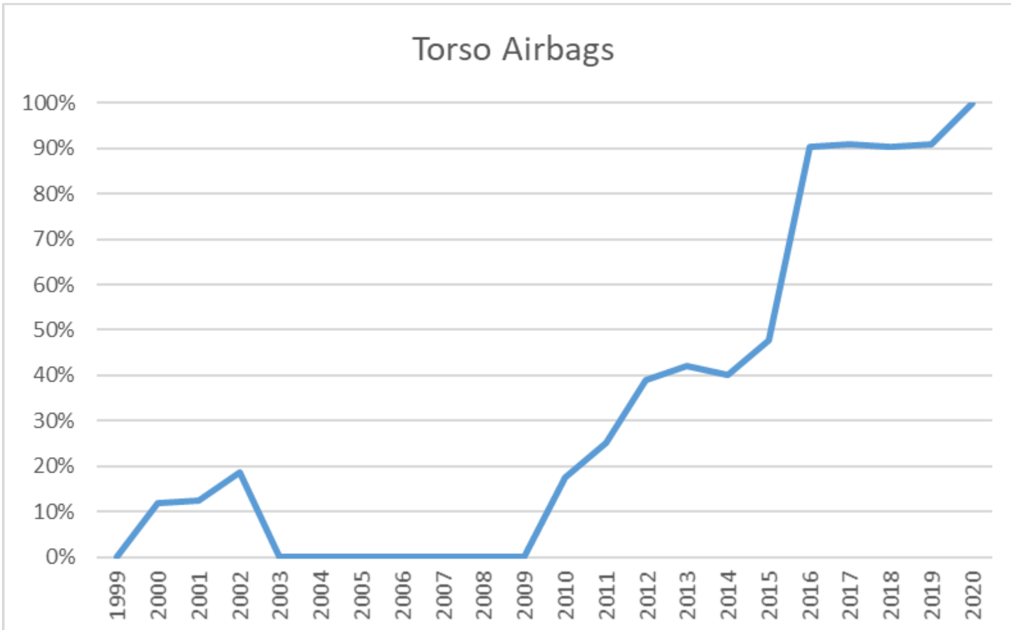

Figure 7. Class 2B side-impact air bag installation from 1999–2020

Figure 8 displays side curtain air bag use from 1999 to 2020. Beginning in 2008 there was a gradual rise in side-curtain air bag installations leading to 100 percent of the identified Class 2B vehicles containing side curtain air bags in 2020.

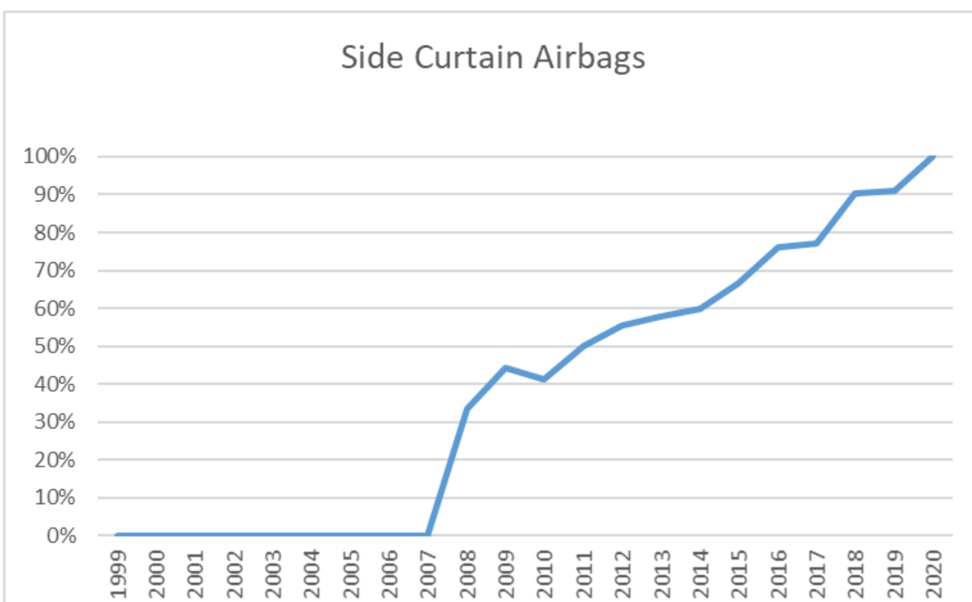

Figure 8. Class 2B overhead air bag installation from 1999–2020

Figure 9 reflects data of knee-air bag installation in Class 2B vehicles from 1999 to 2020. Installation rates of knee-air bags have remained low. The largest proportion of knee-air bags installed was 6 percent, seen in 2012. Although research did not identify specific reasons for the low installation rate, data from Insurance Institute for Highway Safety (IIHS) revealed there may be little benefit on injury risk (Monfort & Mueller, 2019).

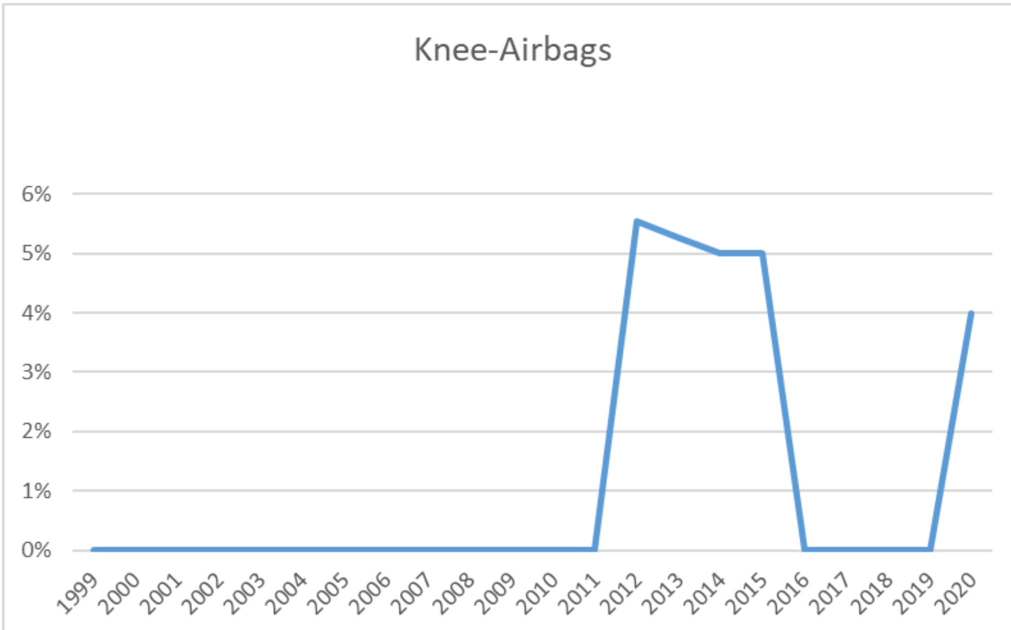

Figure 9. Class 2B knee-air bag installation from 1990–2020

Figure 10 reflects Class 2B vehicles' use of seat belt pretensioners from 1999 to 2020. Before 2009 there was a gradual rise in pretensioner installation. Installation rates after 2009 have remained level (70–80%).

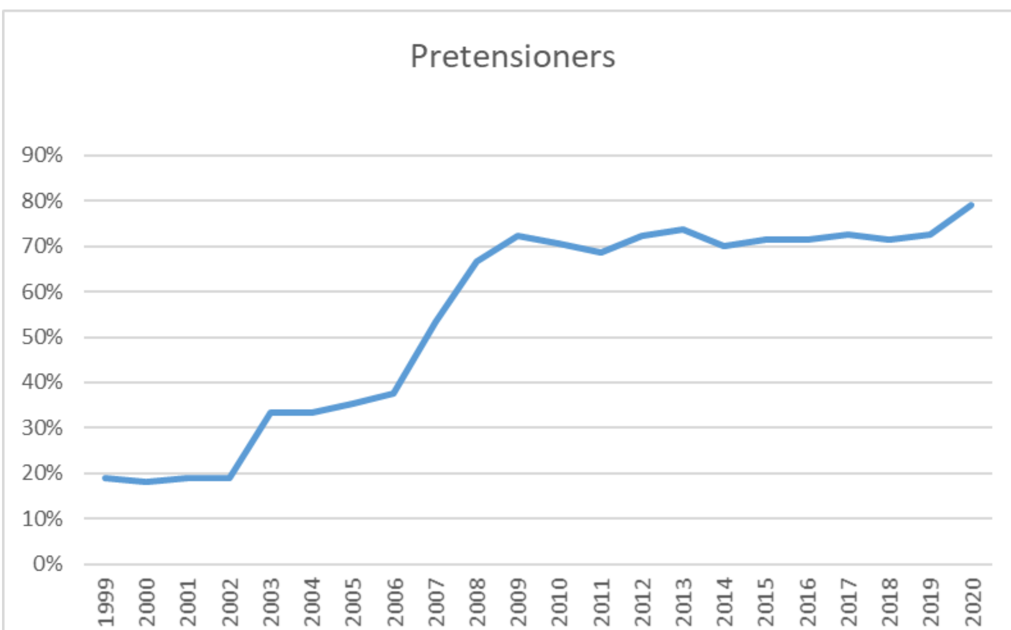

Figure 10. Class 2B pretensioner installation from 1999–2020

Figure 11 reflects data of head restraints in Class 2B vehicles from 1999 to 2020. Installation rates of head restraints have remained low. The largest proportion of head restraints installed was 15 percent, seen in 2014.

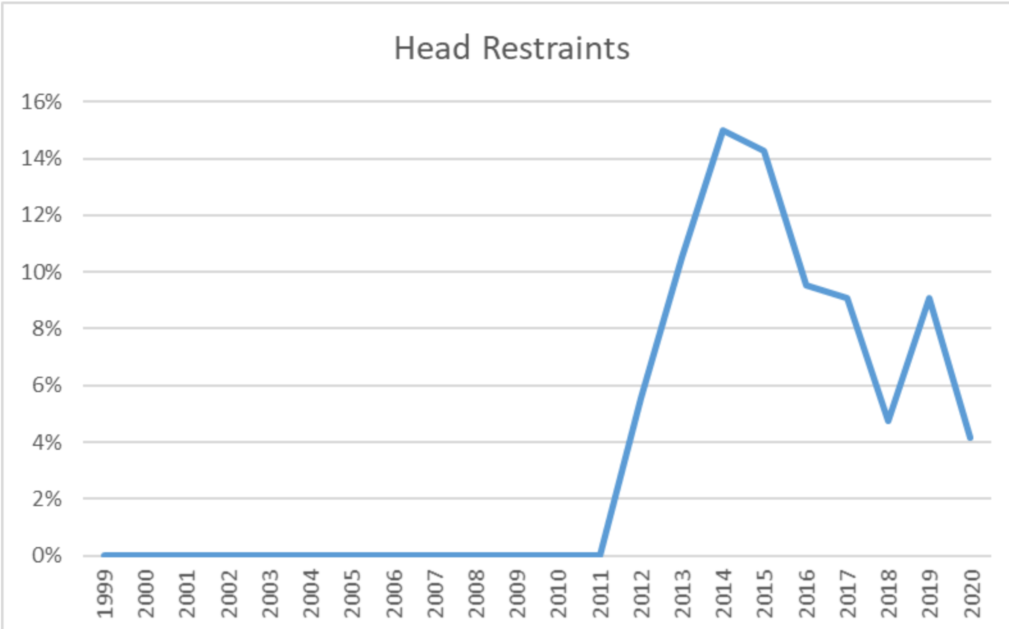

Figure 11. Class 2B head restraint installation from 1990–2020

Information on installation of LATCH safety restraints was gathered from online resources and the LATCH Manual (Donaldson et al., 2019). The LATCH manual explains that the cabs of pickup trucks frequently have little space to place tethers, resulting in challenges with placement. Table 47 summaries the restraint and LATCH features installed in Class 2B vehicles.

Table 47. Restraint and LATCH features in Class 2B vehicles

Make and Model	Year	Row 2 Center	Row 2 Outboard	Row 3 Center	Row 3 Outboard	Additional Details
Chevrolet Avalanche*	2003-2013	LATCH (1)	LATCH (1) Tether anchor (1)	N/A	N/A	
Chevrolet Express Cargo*	2001-2019	N/A	N/A	N/A	N/A	• Tether anchor on the back of the front passenger seat • No rear seating
Chevrolet Silverado 2500HD	2014-2019	Tether anchor (1)	LATCH (2)	N/A	N/A	
Chevrolet Express Passenger*	2001-2002	Tether anchor (1)	Tether anchor (2)	Tether anchor (1)	Tether anchor (2)	• No tether anchors in a 4-passenger bench seat option
Chevrolet Express Passenger*	2003-2007	Tether anchor (1)	LATCH (2)	Tether anchor (1)	None	
Chevrolet Express Passenger*	2008-2019	Tether anchor (1)	LATCH (2)	Tether anchor (1)	LATCH (2)	

Make and Model	Year	Row 2 Center	Row 2 Outboard	Row 3 Center	Row 3 Outboard	Additional Details
Chevrolet Suburban*	2015-2019	LATCH (1; bench seat only, not bucket seat)	LATCH (2)	Tether anchor (1)	Tether anchor (2)	
Dodge Ram extended cab	2001-2002	Tether anchor (1)	Tether anchor (2)	N/A	N/A	
Dodge Ram Quad cab	2003-2009	Tether anchor (1)	LATCH (2)	N/A	N/A	
Dodge Ram mega cab	2006-2009	LATCH (1)	LATCH (2)	N/A	N/A	
Ram Wagon	1989-2000	Tether point (1)	Tether point (1-2)	N/A	N/A	
Ford Econoline5-pass wagon	2003-2015	LATCH (1)	LATCH (1) Tether anchor (1)	N/A	N/A	• No LATCH system in the delivery van body
Ford F-250	2017-2019	Tether anchor (1)	LATCH (2)	N/A	N/A	
GMC Sierra	2019	Tether anchor (1)	LATCH (2)	N/A	N/A	

* The manual did not specify the exact vehicle model, so the findings may include multiple models with different classifications (e.g., Chevrolet Avalanche 1500 and 2500).

Ownership/Vehicle Registration of Class 2B Vehicles

In 2017 Birky and colleagues published a report to assess the possibility of shifting to electrification of Class 2B and Class 3 Commercial Vehicles (Birky et al., 2017). The researchers report that Class 2B and Class 3 vehicles are used for commercial and personal uses; however, limited data exists on the breakdown of vehicle ownership. Also noted was that the last Vehicle Inventory and Use Survey (VIUS; 2002) is likely not reflective of the current market.

Interview Outreach and Findings

A variety of stakeholders were contacted to participate in a written survey and follow-up interview. Identified stakeholders belonged to various industries such as truck manufacturing plants, work truck body manufacturers, large-scale manufacturers, and subject matter experts. Only one subject matter expert agreed to participate in the survey. The subject matter expert shared suggestions on how to categorize Class 2 data but had limited experience on Class 2B manufacturing.

Limousines Market Survey

This survey focused on the vehicle category that includes limousines greater than 10,000 lbs GVWR or have a 130-inch or greater wheelbase. A limousine is technically defined by its use as a luxury vehicle that is driven by a chauffeur, not the vehicle’s physical characteristics. Physically, limousines can vary from the size of a sedan (typical of taxis and rideshares) to a long party bus. For the purpose of this research, NHTSA is solely interested in larger, heavier, and/or stretched limousines; therefore, this report excludes some traditional limos by definition such as taxis and rideshares that are sedans.

Research Objectives

The objective was to conduct a market survey of limousines, which includes stretch and non-stretch limousines. Specific objectives included the following:

1. Identify the method of manufacture (e.g., are the vehicles altered before first sale? Are they modified after first sale?).[4]
2. Estimate production, sales, or registrations where data is available.
3. Identify vehicle classifications of the vehicles BEFORE and AFTER modification or alteration and method of certification.
4. Estimate number of seats as well as seat belt and air bag installation rates.
5. Understand what efforts modifiers use to ensure that the modified vehicles are compliant and whether modification guidelines are provided by the original manufacturer.

To successfully undertake the objectives, the research team drew information from a variety of sources. These sources included analysis of existing vehicle registration data from Polk, review of related literature, and conducting stakeholder outreach (interviews with industry experts).

It is a common practice that vehicles are altered/modified to become a limousine. A limited number of passenger car and SUV models are used as the base vehicle for limousines (e.g., Escalade, Excursion, Hummer). The research team searched for information to understand the extent of the alterations/modifications, whether a vehicle is altered before first sale or modified after first sale, and the vehicle classification before and after the alteration/modification. The research team documented the manufacturing procedure, compliance of altered/modified vehicles to applicable regulations, and whether alteration/modification guidelines are provided by the original manufacturer.

Stakeholder Outreach

To get good limousine market size information, the research team reached out to 18 limousine manufacturers and other stakeholders in the industry. The team sent emails and made phone calls to extend interview invitations. However, no limousine manufacturer was willing to participate in an interview except one subject matter expert who works in the business of limousine consultancy.

During the interview with the industry expert, the following questions were asked, and responses were documented:

a. Do they modify new or used vehicles? How old are the used vehicles?
b. Why are/aren't air bags installed?
c. Are there any cost or feasibility concerns associated with installing air bags?
d. If air bags are not installed, would they prefer air bags to be installed?
e. Do they make stretch limousines? What modification guidelines are used?
f. Do they do pass-through certification? Who certifies the end product?
g. How many passengers can be held?
h. If, post-altered vehicles are self-certified as safe, what guidelines (standards, specifications) are followed for self-certification?
i. What are the State certifications available for the States where the manufacturers are located?

[4] "Altered vehicle" means a completed vehicle previously certified to the FMVSS that has been altered before the first purchase of the vehicle other than for resale in such a manner as may affect the conformity of the vehicle with an FMVSS or the validity of the vehicle's stated weight rating or vehicle type classification. "Modified vehicle" means a vehicle that was modified after the first purchase of the vehicle other than for resale.

Make and Model of Limousines

It is difficult to determine all the makes and models of limousines because manufacturers use a variety of base models when converting them into a limousine. Based on extensive literature searches, the research team was able to compile a list of limousine makes and models. Although the list is thorough, there may be makes and models not captured in the list. For ease of presentation, the list of makes and models of limousines are grouped into two categories depending on their passenger carrying capacity (i.e., sedan- and SUV-based limousines that accommodate up to 12 passengers, and van- and bus-based limousines that accommodate more than 12 passengers [some accommodate up to 52 passengers]).

The following are the make and model of the identified sedan- and SUV-based limousines:

- Audi A6
- Audi Q7
- BMW 550i
- BMW 750Li
- BMW X5
- Cadillac Escalade
- Cadillac Fleetwood
- Cadillac Professional
- Cadillac Ward
- Cadillac XTS
- Chrysler 300
- Chrysler LeBaron
- Ford Expedition XLT
- GMC Yukon Denali
- Hummer H2
- Lincoln MKT
- Lincoln Navigator
- Lincoln Town Car
- Mercedes-Benz E350
- Mercedes-Benz GL350
- Mercedes-Benz S400
- Porsche Cayenne S
- Range Rover HSE
- Rolls Royce Phantom
- Rolls-Royce Park Ward
- Rolls-Royce Touring Limo

The following is a list of the makes and models of the van- and bus-based limousines:

- Ford E-450
- Ford F-550
- Ford F-750
- Freightliner Ecoach40
- Freightliner XCR
- Freightliner Workhorse
- Gillig Phantom
- GMC C5500
- International 3000
- International 3200
- MCI 102D3
- Mercedes-Benz Sprinter
- Neoplan Cityliner
- Van Hool T2145
- Van Hool T940

Limousine Manufacturers

The Limousine, Charter, and Tour magazine (n.a.) lists 45 limousine manufacturers. The complete list of the limousine manufacturers is provided in Appendix A. It is unknown whether all limousine manufacturers listed are currently in business. Also, it is unknown whether all manufacturers listed build stretch limousines.

Method of Manufacturing of Stretch Limousines

Although the stretching process of limousines sounds straight forward, it requires significant technical capabilities and precision engineering. Subject matter experts have discussed the process of limousine stretching, and a summary is presented below (Suffolk County, 2016; Garbow, 2018).

Limousine conversion companies acquire a stock vehicle from a dealer or OEM. The interior of the vehicle is stripped out. In addition, the brake lines, fuel lines, electrical harnesses, and drive shaft are removed. The stripped vehicle is then put on a rolling trolley and is locked in a hoisted position. After ensuring the front and rear vehicle parts are aligned, the vehicle is cut in half right behind the B-pillar. Once the vehicle is split, the two ends of the vehicle are pushed apart to the desired length. The new middle section, composed of support beams, is manufactured and welded on both ends of the vehicle to bring the two halves together. The length of the new middle section can vary from a few inches to 120 inches or greater. The new section of the vehicle must be welded properly and prevented from corrosion and other elements that may make the welds be weak points in the vehicle. Additional B-pillars are erected as desired, and new roof and floor structures are mounted. Side-intrusion bars and cross beams are put in place and welded. Rear doors and exterior panels are attached, and the entire body of the vehicle is painted and polished. The interior of the vehicle is typically configured to accommodate 6 to 12 occupants. The brake lines, fuel lines, and electrical harness are extended and upgraded as needed. In some cases, the engine, driveshaft, and suspension systems must be updated to deliver enough power to properly accelerate the vehicle and to drive on a positive road slope.

One critical element of stretching limousines is keeping the weight of the vehicle as low as possible. The added middle section and extension of vehicle systems add weight to the vehicle. Stretching a Lincoln MKT Premiere Limousine by 120 inches requires an addition of 4,000 ft. of wiring and over 800 lbs of steel (Car and Driver, 2012). To decrease the vehicle weight, limousine manufacturers often remove the front passenger seat and tend to use lightweight materials whenever possible. To permanently remove the front passenger seat, some manufacturers weld the anchor holes that hold the seat so that it cannot be placed back again.

Some popular makes of sedans and SUVs that are converted to stretch limousines include Lincoln, Cadillac, Hummer, Mercedes-Benz, Infiniti, and Chrysler.

The proportion of stretch limousines that are manufactured from new and used vehicles is unknown. Stretch limousines that are manufactured under certification programs (i.e., Ford's Qualified Vehicle Modifier [QVM] and General Motor's Cadillac Master Coachbuilders [CMC]) are built by using new vehicles. However, an industry expert suggested that "there is no current data available on this, but anecdotally, since the demise of the Lincoln Town Car, where retrofitters would stretch out new vehicles, it is my understanding that most vehicles are used or recirculated at this point."

The stretching process of limousines can be time consuming and labor intensive. For example, a 120-inch stretch QVM-built Lincoln MKT Town Car limousine manufactured in 2007 required about 366 hours of work including 4 hours of quality control (Suffolk County, 2016).

Limousine Conversion Certification Programs

Several original vehicle manufacturers created limousine conversion certification programs to manage pertinent issues related to stretch-limousine production. Some issues include the general safety of stretched limousines and the quality of the conversion process. Failure to follow Federal standards and guidelines during the limousine modification process often leads to building limousines that will not stop or steer safely and effectively. The certification programs ensure that participating limousine conversion companies adhere to FMVSS regulations and other guidelines issued by original vehicle manufacturers in the limousine conversion process. Such certification programs have provided higher levels of safety, reliability, and professionalism in the limousine industry.

In the process of stretch limousine construction, there is a trade-off between maximizing occupant capacity and minimizing vehicle weight. Stretch limousine weight and its distribution is an important component of the structural integrity and durability of the chassis and other vehicle component systems (e.g., brakes, tires, axles, and suspension).

There are two stretch limousine testing and certification programs, namely:

1. Ford's Qualified Vehicle Modifier Program, and
2. General Motor's Cadillac Master Coachbuilders Program.

Participants of the QVM and CMC certification programs are required to adhere to specific engineering and quality control guidelines, which are designed with the vehicle's capabilities in mind. It is estimated that the limousine conversion companies that participate in the QVM and CMC certification programs currently manufacture about 70 percent of the world's limousines each year (Royale Limousine, n.a.).

Ford's qualified vehicle modifier program

Ford's QVM program is a limousine modification program that was started in 1990 by Ford Motor Company (Lincoln Motor Company) with the objective of providing technical support and guidelines for stretching the Lincoln MKT Town Car and Lincoln Navigator L limousines. It was developed following the 1987 Lido Beach, New York, stretch limousine crash that killed members of a wedding party after the limousine was ripped apart in a collision with another vehicle. Ford's QVM was started by a group of engineers that designed a Lincoln Town Car chassis with an 85-inch stretch that met all Federal standard requirements. This was followed by subsequent testing to demonstrate that the Town Car could be safely and successful stretched up to 120 inches. Based on these successfully demonstrated tests, Ford developed the QVM program and started distributing stretch limousine manufacturing guidelines that meet the FMVSS. As per the QVM guidelines, only Lincoln MKT Town Cars are approved for conversion into a stretch limousine, with a maximum stretch length of 120 inches. QVM-built, 120-inch stretch limousines are configured to carry 10 or fewer occupants, including the driver.

Ford does not necessarily approve each Lincoln Town Car stretch; rather Ford's QVM program evaluated and approved the stretch process, materials used, assembly process, and engineering control and management. Ford conducts pre-arranged annual facility inspections for reviewing the engineering capability, design and build process controls, and quality control procedures of the participating companies.

Ford conducts an annual meeting with QVM participants. The objective of the annual meeting is empowering continuous development, as well as reviewing future product changes, new guidelines, and accommodating any requests from participating members. Although the QVM program has been in existence since the early 1990s, its participating manufacturers has decreased over time. For example, in 2006 there were 17 participating manufacturers; however, the number of participants decreased to only 8 in 2016 (QVM, n.a.). The reason for the decrease in the QVM program participants is due to economic slowdowns, reduction in the market size of stretch limousines, availability of other base models for stretch limousines, and decision of manufacturers to upfit non-stretched van- or bus-based limousines.

General Motor's Cadillac Master Coachbuilders program

General Motor's CMC program was started in 1991 by General Motors/Cadillac Professional Vehicles. The program offers technical guidelines for stretching an XTS sedan by up to 70 inches. Under this program, Cadillac provides specially engineered and designed incomplete vehicle chassis, known as the V4U XTS stretch limousine chassis, to its certified CMC program participants for final stretch limousine manufacturing and distribution.

The heavy-duty limousine chassis that Cadillac provides has a reinforced body structure, additional parts for supporting higher gross vehicle weight, and an extended wiring harness. In addition, the vehicle's front and rear suspension systems are reinforced, and heavy-duty brakes and steering systems are provided. The CMC program allows stretching the middle section of the original chassis structure from 18 to 70 inches. In addition, Cadillac also provides W30 XTS-L sedan chassis that can be stretched 5 to 8 inches.

GM continuously provides guidelines to support its CMC program participants. Any improvements to the CMC specifications are disseminated to the participants. To verify CMC program participants' compliance with quality and safety, Cadillac Professional Vehicles team members conduct onsite participant reviews every 12 to 18 months.

According to information provided from a limousine expert the research team interviewed, the CMC program was discontinued in October 2019. The reason for the discontinuation of the program was decrease of participants in the program.

Safety Equipment in Stretch Limousines

Air bags

Stretch limousines usually do not have air bags in the passenger compartment, although they do provide driver compartment air bags (Suffolk County, 2016). Passenger compartment air bags are beneficial because they reduce the injury risk associated with impact forces during crash events.

Industry experts suggested that the reason behind lack of air bags in the passenger compartment of stretch limousines is because of the technical difficulties that would prevent aftermarket additions and integrating the new air bag system with the original system of the vehicle (Suffolk County, 2016). In addition, the seating configuration in stretch limousines is not regulated (i.e., the seating arrangement can significantly differ among stretch limousines). This makes it even harder to come up with a standard air bag system. Most stretch limousines have perimeter seats, and a crash may have different impacts depending on seating position (e.g., a front impact could be a front impact to the driver but could be a side-impact for passengers facing sideways).

Seat belts

In most cases of stretch and non-stretch limousines, three-point seat belts are provided in the seats inside the driver compartment, while two-point seat belts are provided in the seats inside the passenger compartment. However, passengers are less likely to wear the seat belts while traveling inside stretch limousines according to an industry expert the research team interviewed. Both in limousines and other vehicle types, passengers not wearing seat belts are most likely to be injured in the event of a crash.

While rare, some stretch limousine companies have vehicles that are equipped with LATCH systems for child seat installation. Non-stretch limousines less than 10,000 lbs manufactured after 2002 are required to have LATCH systems in place or child seats as per FMVSS No. 225 (49 C.F.R. § 571.225).

Front and rear impact safety of limousines

Industry experts suggested that stretch and non-stretch limousines are equipped with front and rear crumple zones (Suffolk County, 2016).

Side impact safety of limousines

Anti-intrusion beams are installed inside of the doors and side panels of stretch limousines to protect passengers during side-impact collisions. The material that manufacturers use for anti-intrusion beams ranges from a panel of flat steel to tubular steel.

Vehicle Classification Before and After Limousine Modification

The classification of non-stretched limousines (made by upfitting the interior of select vehicles) is expected to be unchanged before and after the upfit. On the other hand, the classification of stretched limousines can be significantly different from the original classification assigned by the OEM. However, the research team was not able to get any information on this topic from stretch limousine manufacturers, because all stakeholders that could address this question declined an interview request or were not available for an interview.

Annual Sales of Limousines

Annual sales of limousines, broken down by make and model as well as stretch and non-stretch features, is very difficult information to find. There is no abundancy of publicly available information to address this topic. However, some information can be obtained from publications of limousine associations and agencies.

It was estimated that limousine manufacturers sold 4,340 stretch limousines and buses, 4,608 sedans, and about 1,500 SUVs or large vans to the industry in 2014 (Gaille, 2017). According to a November 2018 article published in *The Drive* (a website dedicated for car technology, global auto news, and in-depth vehicles reviews) 6,500 stretch limousines were sold in the United States in 1985, and after decline in manufacturing during the economic crisis in the 90's manufacturing grew back to 5,700 units produced in 2000 (Garbow, 2018). The articles reviewed did not provide details of the limousines produced, such as the GVWR and passenger carrying capacity.

One stretch limousine and coach manufacturer produced 450 units in 2013 (Luxury Coach & Transportation, 2013). The units were composed of modified limousines based on MKT stretch limousines: Sprinter vans; Navigators, Escalades, Chrysler 300 sedans, and GMC vans. The same manufacturer produced about 400 units in 2017, where Ecoach45 Freightliners, sprinter shuttles, and MKT Evolution stretch limousines were considered as the leading limousine/coach-based models (Luxury Coach & Transportation, 2018).

One industry expert suggested that starting in the last few years, limousine manufacturers are becoming less interested in stretch limousines due to manufacturing complexity. Similarly, consumer interest in stretch limousines is declining due to concerns regarding their safety. In response, limousine service providers are not including stretch limousines in their fleet and instead are incorporating larger vans and bus-based limousines. For example, in 2007 stretch limousines made about 14 percent of the limousine fleet in the top 10 limousine operators in the United States. However, in 2017 the number dropped to just over 2 percent (Garbow, 2018). According to a subject matter expert the research team interviewed, sprinter vans are becoming more common for shuttle and corporate van configurations over stretch limousines. The effect of the shift from stretch limousine to van- and bus-based limousines can also be seen from the decline in the number of participants in Ford's QVM certification program.

The Polk's vehicle registration data can also provide estimates of limousines as manufactured by OEMs. Note that in the Polk's vehicle registration dataset, a limousine is a vehicle body type (not vehicle use) and excludes limousines built by manufacturers on a chassis purchased from OEMs or having aftermarket modifications performed. The vehicle makes and models identified as limousines in Polk data include Cadillac models Fleetwood, Ward, Professional, and XTS; Chrysler model LeBaron; Ford model Expedition; Lincoln models MKT, Navigator, and Town Car; and Rolls-Royce models Park Ward and Touring Car. In 2019 there were about 19,000 registered limousines manufactured by OEMs according to Polk. Overall, the count of registered limousines appears to decline after the 2008 economic crisis. Lincoln is by far the most common limousine, followed by Cadillac. One limitation of the Polk's vehicle registration data is that it does not track the modification that vehicles may undergo after they leave the OEM manufacturing plant. In other words, Polk does not capture limousine modifications by conversion companies and aftermarket modifications.

Other than these estimates, the research team was not able to obtain annual sales of limousines, broken down by make and model as well as stretch and non-stretch features, from limousine manufacturers and associations of limousine operators. The research team contacted 18 stakeholders in the limousine manufacturing industry, but all interview invitations were declined—except one who is in the business of limousine consultancy.

Ownership of Limousines

There is no information on the ownership of limousines in the literature. Therefore, the research team was informed by the opinion of industry experts. The interviewed limousine expert suggested that private ownership of stretch limousines is very uncommon. The expert further highlighted that almost 100 percent of stretch limousines are owned by businesses. The ownership of non-stretch limousines is difficult to quantify because a non-stretch limousine is simply a luxury vehicle with a chauffeur. There are private people who own limousines and employ chauffeurs to drive them.

Passenger Carrying Capacity of Limousines

Given the luxury nature of limousines, their passenger carrying capacity can be less than their corresponding non-luxury vehicles for spaciousness reasons. Non-stretch limousines (sedan- or SUV-based) usually accommodate 4 to 8 seating positions. In such type of vehicles, the seating directions are almost always forward-facing. Because of the additional middle section, stretch limousines can accommodate 6 to 12 seating positions. The seating positions can vary significantly, depending on the interior configuration of stretch limousines and vehicle length. An industry expert suggested that the proportion of seating positions is evenly split among forward-, side-, and rear-facing positions (i.e., 33% forward-facing; 33% side-facing; 33% rear-facing). Many stretch limousine manufacturers limit passenger carrying capacity to 10 to avoid being classified as a bus. In such cases, the front passenger seat is removed, and the passenger compartment is made to accommodate 9 passengers (i.e., a total of 10 occupants including the driver).

The recent trend in the limousine industry is the use of larger van- and bus-based limousines. Van- and bus-based limousines offer much higher passenger carrying capacity, as well as passenger comfort and safety. One prominent limousine manufacturing company is producing bus-based limousines (such as Freightliner Ecoach40) that can accommodate 52 passengers, all forward-facing seating positions (Luxury Coach & Transportation, 2018).

Motor Homes and Entertainer Buses

The motor home and entertainer bus market survey focused on gathering market information on analysis of existing datasets, reviewing literature, and conducting targeted stakeholder interviews. The industry uses various nomenclatures to refer to motor homes. This includes recreation vehicles (RVs), motor coaches, luxury coaches, entertainer coaches, and others.

Research Objectives

The objectives of the market survey of motor homes and entertainer buses were the following:

1. Identifying the make and models of vehicles under this category.
2. Identifying the number of vehicles, their passenger carrying capacity, the vehicle class the original manufacturer specified, and the vehicle class the final manufacturer specified.
3. Documenting the proportions of vehicles that are built on an over-the-road bus chassis as compared to body-on-frame.
4. Estimating the annual sales or registrations of vehicles under this category.
5. Estimating the proportions of commercial and private ownerships of such vehicles.
6. Estimating the relative propensity of side-facing versus forward-facing seats and the type of seat belt installation at these seats.

Motor Homes and Entertainer Buses – NHTSA's Interest in This Project

The NHTSA Call Order for this project indicated an interest in both larger motor homes and entertainer buses (even though entertainer buses are not included in 49 C.F.R. § 571.3) that fulfill the following criteria.

- GVWR over 26,000 lbs.
- Have at least four of the facilities described in the Part 571.3 definition of a motor home, which include
    - Cooking
    - Refrigeration or ice box
    - Self-contained toilet
    - Heating and/or air conditioning
    - Potable water supply system including a faucet and a sink; and a separate 110-125–volt electrical power supply and/or propane

If the vehicle did not meet the criteria defined above, the data were discarded as NHTSA is not interested in this vehicle.

Differences Between Motor Homes and Entertainer Buses

In some cases, motor homes and entertainer buses are used interchangeably in the literature. However, industry experts prefer to distinguish entertainer buses from motor homes. To have a clear understanding of the difference between motor homes and entertainer buses, the research team consulted industry experts. One industry expert defined an entertainer bus as a luxury vehicle used to transport customers who travel in groups and on a frequent basis (e.g., members of a musical band, comedians, performers, theatrical groups, and campaigners and entertainers that continuously travel from one city to another to perform). Usually, entertainer buses have more seating areas to accommodate more people, and as a result they have less space for other amenities. On the other hand, motor homes have more living space. Another industry expert indicated that entertainer buses have small kitchens (most without ovens), a small bathroom, and bunk sleepers (can have 12 or more bunk beds). Motor homes usually have larger kitchens, bathrooms, and bedrooms. Another expert added that motor homes are built to last 150,000 to 250,000 miles, while entertainer buses are designed just like commercial buses (some entertainer buses may be converted commercial buses) and can last up to 1,000,000 miles or more.

Makes and Models of Motor Homes and Entertainer Buses

Make and model of motor homes

The information on the makes and models of motor homes was gathered from literature searches and web pages of OEMs. There are overwhelming varieties of motor home makes, models, and floor plans of motor homes. Table 48 shows motor home manufacturers and the model types they produce (only models with GVWR greater than 26,000 lbs are included).

Table 48. Motor home manufacturers and their models

Manufacturer	Models
American Coach	Allegiance, Dream, Eagle, Heritage, Revolution, American Tradition
Coachman	Cross Country, Pathfinder, Sportscoach

Manufacturer	Models
Cool Amphibious Manufacturers International LLC	Terra Wind
Country Coach	Allure, Inspire, Intrigue, Tribute
Damon	Astoria, Tuscany, Essence
Entegra Coach	Anthem, Cornerstone, Insignia, Aspire, Reatta, Reatta XT
Fleetwood RV	Discovery, Expedition, Pace Arrow LXE, Revolution, Excursion, Bounder, Providence
Forest River RVs	Berkshire, Berkshire XL, Berkshire XLT, Charleston, Legacy, Legacy SR340
Foretravel Motorcoach	ih-45, ic-37, Realm FS6
Gulf Stream RVs	Caribbean, Constellation, Tour Master
Hemphill Brothers Coaches	H3-45
Holiday Rambler RVs	Endeavor XE, Navigator, Neptune, Scepter, Ambassador, Endeavor, Imperial, Navigator XE, Trip
Itasca RVs	Ellipse, Horizon, Latitude, Meridian, Meridian V Class, Solei
Jayco	Embark, Insignia
Liberty Coach	Liberty Lady, Elegant Lady
Monaco Coach Corporation	Camelot, Cayman, Dynasty, Diplomat, Executive, Knight, Marquis, Signature, Vesta
Newell Coach	Newell
Newmar	Canyon Star, Dutch Star, Essex, King Aire, Kountry Star, London Aire, Mountain Aire, New Aire, Ventana, Ventana LE
Nexus	Bentley, Bentley Diamond, Evoque
Thor Motor Coach	Aria, Astoria, Outlaw, Palazzo, Tuscany, Tuscany XTE, Venetian
Tiffin Motorhomes	Allegro Bus, Allegro Red, Phaeton, Zephyr
Winnebago	Destination, Ellipse, Ellipse Ultra, Forza, Grand Tour, Horizon, Journey, Journey Express, Meridian, Solei, Vectra

To limit the scope of the data collection effort for subsequent tasks, the search focused on identifying the motor homes manufactured in the last 5 years (2016–2020). The following data were collected for each motor home manufactured:

- Make (manufacturer)
- Model
- Year manufactured
- GVWR
- Floor plan

For the period from 2016 to 2020, the research team identified 14 motor home manufacturers. As shown in Table 49, a total of 972 different motor home models and/or floor plans exist between the 14 motor home manufacturers (only models with GVWR greater than 26,000 lbs are included). Each of the 972 vehicles has a unique make, model, year, GVWR, or floor plan. An accompanying spreadsheet to this report contains the full list of the data. Table 49 presents a summary of the 14 manufacturers and the number of different motor home types they produce. Newmar Corp. has the largest selection of motor homes (312 varieties of models and floor plans), followed by Entegra Coach (112 varieties of models and floor plans).

Table 49. Fourteen manufacturers produced a total of 972 motor home types from 2016–2020

Manufacturer	Number of vehicles with different model, and/or floor plans
American Coach	65
Coachman RVs	19
Entegra Coach	112
Fleetwood RV	77
Forest River, Inc.	65
Holiday Rambler	66
Itasca	8
Jayco	6
Monaco Coach	26
Newmar Corp.	312
Nexus RVs	6
Thor Motor Coach	82
Tiffin	82
Winnebago	46
TOTAL	**972**

Make and model of entertainer buses

Identifying the makes and models of entertainer buses is very difficult, because entertainer buses are highly customized to customer needs and hence data could not be collected. Entertainer buses are built to order for customer specification, and no two vehicles are alike. The websites of the entertainer bus companies often list only the inventory of entertainer buses they produce and do not identify the true make and model of the vehicles. However, the research team was able to identify the following manufacturers of entertainer buses:

1) Marathon Coach
2) Emerald Luxury Coaches
3) Featherlite Coaches

4) Liberty Coach
5) Millennium Luxury Coaches
6) Super Coach
7) Russell Coach
8) Hoffman Coach
9) Vulcan Coach
10) Hemphill Brothers Coach Company
11) Nitetrain Coach Company

Number of Motor Homes and Entertainer Buses in Operation

Number of motor homes from Polk's vehicle registration data

Polk's vehicle registration data provides an insight into the number of motor homes in operation. Among the many variables the database provides, GVWR and Vehicle Type are important variables for identifying motor homes. The GVWR requirement of motor homes is that it should be greater than 26,000 lbs. Under the Vehicle Type variables, motor homes are identified as "motor home chassis." Therefore, to determine the count of motor homes in operation, the vehicle registration data was filtered so that only GVWR greater than 26,000 lbs and "motor home chassis" were considered.

It is assumed that the quantity of registered motor home chassis is a good estimator of the number of motor homes in operation. The research team considers that a motor home chassis built by an OEM is later completed by a motor home manufacturing company. Figure 12 shows the count of registered motor home chassis in the past 19 years (2001 to 2019). Overall, the data indicates that the total number of motor homes with GVWR greater than 26,000 lbs has been steadily increasing, with the exception of the slight decline in 2011. In 2018 and 2019 the count of registered motor homes was 175,508 and 172,455, respectively. Note that the data does not include aftermarket conversion of motor homes (e.g., conversion of a school bus into a motor home).

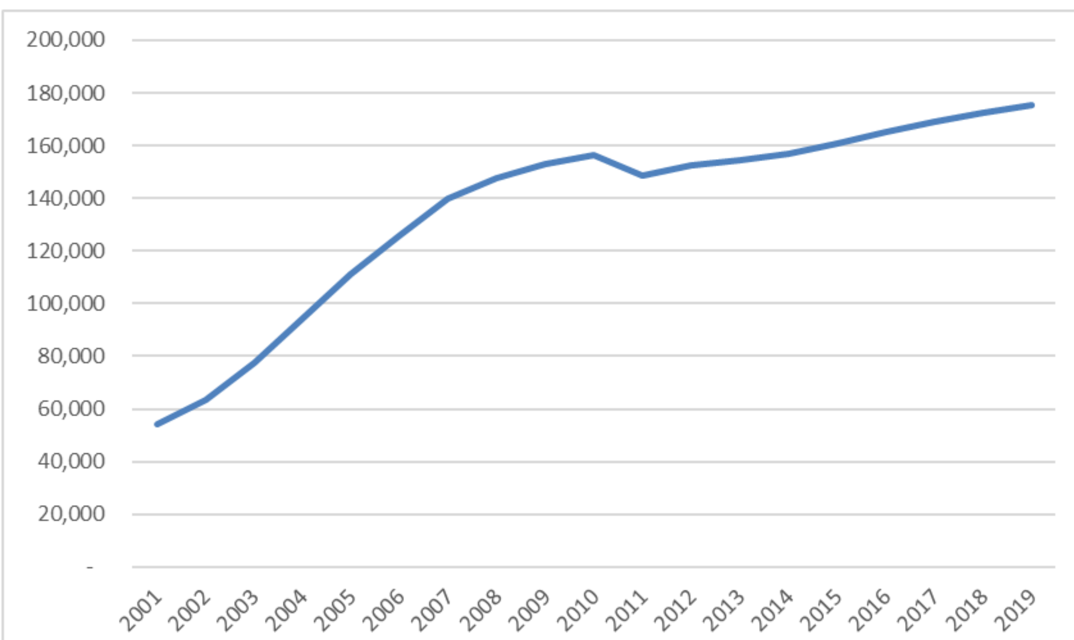

Figure 12. Count of motor home chassis by registration year

In total, the chassis of the motor homes in operation are manufactured by nine companies – Bluebird, Country Coach, Daimler Trucks North America, Foretravel, Gillig, Navistar International, Oshkosh, Spartan, and Western Recreational Vehicle Inc. The number of motor homes with chassis manufactured by Daimler Trucks North America are by far the most common. This is followed by motor homes built on chassis manufactured by Navistar International and Spartan. Freightliner Modular Rail and Raised Rail by Daimler Trucks North America are the most common *new* motor home chassis manufacturers.

Figure 13 shows the number of newly registered motor home chassis by registration year. If the MY of the motor home chassis is the same or greater than the registration year, then the motor home chassis is considered a new production. For example, when examining the vehicle registration data for 2017, all motor home chassis with the MY 2017 and above are considered new units. As shown in Figure 13, the number of new motor home chassis units was the highest in 2004 (a total of 14,615) and was followed by a sharp decline until 2009 (reaching the lowest count of 1,952). From 2010 to 2019, the count of new motor home chassis rebounded slightly. In 2018 and 2019 there were 5,281 and 4,554 new motor home chassis registrations, respectively.

Figure 13. Count of new motor home chassis by registration year

Number of entertainer buses in operation

It is difficult to determine the number of entertainer buses in current operation. The reason is that the entertainer bus market is not regulated, and some entertainer buses are built by converting used commercial buses—which makes it difficult to quantify the number of entertainer buses in operation. However, a recent article published by Luxury Coach & Transportation magazine (2019) mentioned that there are about 900 entertainer buses on the road. The number was confirmed by a subject matter expert the research team consulted via email correspondence.

Annual Sales of Motor Homes and Entertainer Buses

Annual sales of motor homes

The Recreational Vehicle Industry Association (RVIA) publishes annual shipments of motor homes (i.e., Type A motor homes that have GVWR greater than 26,000 lbs). A shipment is referred to as a wholesale transportation of new motor homes (not used before) from the manufacturer to commercial entities for retail sale (e.g., dealers). Annual volume of motor home shipments from RVIA can be considered as a good indicator of annual sales of motor homes. The data comes from RVIA members, which covers about

98 percent of the recreation vehicle manufacturers. The data on recreation vehicle shipments that RVIA compiles is gathered based on an annual survey of recreation vehicle manufacturers.

Figure 14 shows the annual shipments of new motor homes as reported by RVIA in the last 10 years (Recreation Vehicle Industry Association, 2019). There was a consistent increase in the annual shipment of motor homes from 2010 until 2017. However, this was followed by decline in shipment in the last 2 years (i.e., 2018 and 2019). The number of motor home shipments in 2019 was 16,420. In 2019 motor home shipments experienced a drop of 24.4 percent compared to 2018 shipments and a drop of 29.7 percent compared to 2017 shipments.

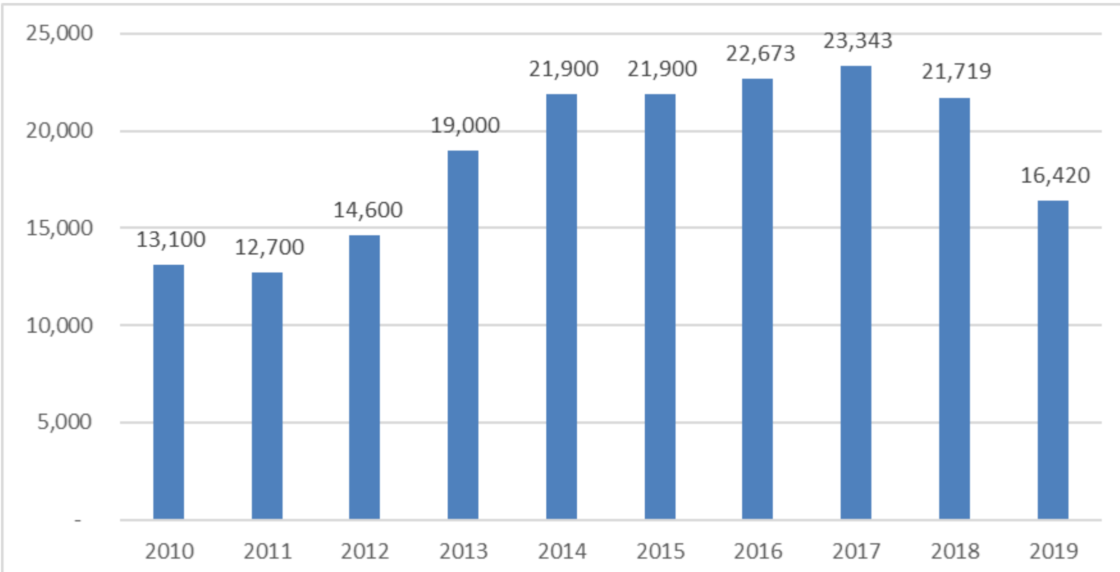

Figure 14. Annual motor home shipments from 2010–2019 as reported by RVIA

Figure 15 shows the monetary value of new motor home shipments in the last 10 years. Although the number of motor home shipments and their values are correlated, the value of motor home shipments in 2018 was significantly higher than other years. The value of motor home shipments in 2019 was estimated to be $3,460 million, which was a drop of 25.1 percent compared to the 2018 value.

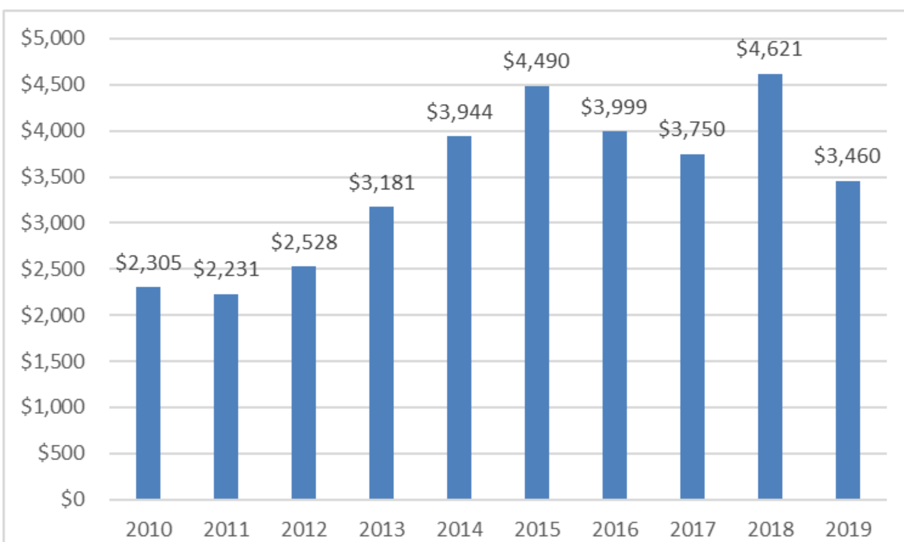

Figure 15. Motor home shipment value (in million dollars) from 2010–2019 as reported by RVIA

It is important to note that the data on shipments of motor homes includes motor homes that were shipped to Canada. In 2019 the proportion of motor home shipments destined to Canadian provinces was estimated to be 4.55 percent.

Annual sales of entertainer buses

The research team was not able to find any information on the annual sales of entertainer buses.

Passenger Carrying Capacity

To understand the passenger carrying capacity of motor homes, the floor plan of each vehicle was reviewed. It was determined that the number of seats would be used to determine passenger carrying capacity, which excludes beds that are commonly found in these vehicles. These vehicles have several types of seating. For example, there are traditional driver and front passenger seats, couch seating, swivel chairs, dining chairs, and booth seating. Due to the different seating types, a seat needed to be defined. The standard designated seating positions (49 C.F.R. § 571.10) were used to determine the passenger carrying capacity of motor homes.

Floor plans of vehicles manufactured in 2019 were reviewed, with the assumption that the passenger carrying capacity changes insignificantly year to year. In addition, the research team reached out to select motor home manufacturers to collect additional information on seating positions and their directions.

The passenger carrying capacity of motor homes varies by size and internal configuration. Overall, motor homes have passenger seating positions ranging from 4 to 10.

Seat Orientation and Seat Belt Type

The direction of the seating positions also varies by size and internal configuration of motor homes. In general, the driver and front passenger seats are considered forward-facing seats although they can be turned around to face a different direction. Sofa seats are normally placed along the side of the motor home (side-facing). If the sofa is L-shaped, there is a possibility that part of the sofa will be facing forward. Some larger motor homes have two sofas, which in most cases are placed parallel to each other and face the side of the motor home. In most cases, booth dinette seats would be forward and rearward-facing.

Table 50 shows the number of seating positions and facing directions in select motor home seats, namely Forest River and Winnebago, by make and model. Representatives of these motor home manufacturers indicated that all designated seating positions have at least two-point seat belts (the driver and the front passenger seats have three-point seat belts). The seats without seat belts represent seats that are not supposed to be occupied when the motor home is moving (e.g., folding chairs and movable chairs).

Table 50. Number and facing direction of select motor home seats

Motor home	Make	Model/floor plan	Number of seats with seat belts	Number of seats without seat belts	Seating directions of seats with seat belts	Seating directions of seats without seat belts
Forest River	Berkshire	34B	7	2	4 forward, 3 side	Rear
	Berkshire	39A	8	2	4 forward, 4 side	Rear
	Berkshire XL	37A	8	2	4 forward, 4 side	Rear
	Berkshire XL	40C	7	2	4 forward, 3 side	Rear
	Berkshire XL	40D	9	2	4 forward, 5 side	Rear
	Berkshire XL	40E	7	2	4 forward, 3 side	Rear
	Berkshire XLT	43C	9	2	4 forward, 5 side	Rear
	Berkshire XLT	45A	7	2	4 forward, 3 side	Rear
	Berkshire XLT	45B	9	2	4 forward, 5 side	Rear

Motor home	Make	Model/floor plan	Number of seats with seat belts	Number of seats without seat belts	Seating directions of seats with seat belts	Seating directions of seats without seat belts
Forest River (cont.)	Berkshire XLT	45CA	9	2	4 forward, 5 side	Rear
	Sportscoach SRS	339DS	6	2	3 forward, 1 rear, 2 side	1 forward, 1 rear
	Sportscoach SRS	365RB	7	2	3 forward, 1 rear, 3 side	1 forward, 1 rear
	Sportscoach SRS	366BH	8	0	4 forward, 2 rear, 2 side	N/A
	Sportscoach RD	402TS	8	0	4 forward, 2 rear, 2 side	N/A
	Sportscoach RD	403QS	10	0	4 forward, 2 rear, 4 side	N/A
Winnebago	Ellipse	42HD	4	2	2 side, 2 Forward	Side, Swivel
	Ellipse	42QD	4	2	2 side, 2 Forward	Side, Swivel
	Ellipse Ultra	42HL	4	5	2 side, 2 Forward	side, 4 folding
	Ellipse Ultra	42QL	4	2	2 side, 2 Forward	Side, Swivel
	Ellipse Ultra	45RL	4	5	2 side, 2 Forward	side, 4 folding
	Forza	36G	7	3	2 Side, 4 Forward, 1 Rear	Side, Swivel, Rear
	Forza	38F	9	0	3 Side, 4 Forward, 2 Rear	Side, Swivel, Rear
	Forza	38W	9	0	3 Side, 4 Forward, 2 Rear	Side, Swivel, Rear
	Forza	38R	8	1	3 Side, 4 Forward, 1 Rear	Rear
	Grand Tour	42QL	4	6	2 side, 2 Forward	Side, Swivel, 4 folding
	Grand Tour	45RL	4	5	2 side, 2 Forward	Side, 4 folding
	Grand Tour	42HL	4	5	2 side, 2 Forward	Side, 4 folding
	Horizon	40A	4	6	2 side, 2 Forward	Side, Swivel, 4 folding
	Horizon	42Q	4	6	2 side, 2 Forward	Side, Swivel, 4 folding
	Journey	36M	6	5	4 side, 2 Forward	Side, 4 folding
	Journey	40J	4	2	2 side, 2 Forward	Side, Swivel
	Journey	42E	4	6	2 side, 2 Forward	Side, Swivel, 4 folding
	Journey	38P	8	1	3 Side, 4 Forward, 1 Rear	Back
	Journey	40R	4	5	2 side, 2 Forward	Side, 4 folding
	Meridian	36M	6	5	4 side, 2 Forward	Side, 4 folding
	Meridian	38P	4	5	2 side, 2 Forward	Side, 4 folding
	Meridian	40R	4	5	2 side, 2 Forward	Side, 4 folding
	Meridian	42E	4	6	2 side, 2 Forward	Side, 4 folding
	Solei	36G	7	2	2 Side, 4 Forward, 1 Rear	Side, Rear
	Solei	38R	8	1	3 Side, 4 Forward, 1 Rear	Rear
	Tour	42QD	4	2	2 side, 2 Forward	Side, Swivel
	Tour	45RD				
	Tour	42HD	4	2	2 side, 2 Forward	Side, Swivel

Chassis Types of Motor Homes and Entertainer Buses

The purpose of the third research objective was to understand how these vehicles are constructed. Specifically, the objective was to determine the proportions of vehicles that are built on an over-the-road chassis compared to a body-on-frame chassis.

1) **Over-the-Road:** An over-the-road (OTR) chassis is commonly referred to as a unibody chassis. In an OTR chassis, the frame of the vehicle and the chassis are integrated as a single structure. These chassis are more crashworthy and promote better fuel economy compared to body-on-frame chassis (Undercoffler, 2017). However, OTR chassis do not handle twisting forces resulting from hauling or off-road uses compared to body-on-frame chassis (Marathon Coach, Inc., n.a./a).
2) **Body-on-Frame:** A body-on-frame (BOF) chassis is a ladder-type frame that serves as the base of the vehicle and is not attached to the vehicle's frame. This type of chassis resists twisting better than an OTR chassis and has a greater hauling and towing capacity. This type of chassis also tends to be heavier than OTR chassis and has a higher center of gravity. Vehicles built with these chassis lack crumple zones that absorb energy during a crash (Undercoffler, 2017; Freightliner Custom Chassis, n.a.).

The specifications of each motor home from brochures and owner's manuals were reviewed to identify the chassis type for each motor home. For the motor homes' make, model, and floor plan referenced above, each of the 977 vehicles were constructed using a BOF chassis. An overwhelming majority of the chassis were manufactured by Freightliner (this was also confirmed from the Polk's vehicle registration data). A small number of vehicles were built using BOF chassis manufactured by Spartan Motors and Ford.

Entertainer buses manufactured by Marathon Coach Inc., Emerald Luxury Coaches, Featherlite Coaches, Liberty Coach, and Millennium Luxury Coaches were built on an OTR chassis. The annual production volume of such entertainer buses is very limited. For example, the Marathon Coach Inc. has manufactured only about 1,300 Prevost luxury motor homes and entertainer buses since 1983 using OTR chassis (Marathon Coach, Inc., n.a.).

These findings are consistent with the opinion of one industry expert who suggested that motor homes are built on BOF chassis and entertainer buses are built on OTR chassis.

Commercial Versus Private Ownerships of Motor Homes and Entertainer Buses

The research team was not able to find data that estimated the proportions of commercial and private ownership of motor homes and entertainer buses.

Anecdotal information collected from motor home manufacturers indicates that most motor homes are privately owned, while a few are owned by business entities like LLCs. One representative estimated that about 70 percent to 75 percent of motor home sales are registered to people. Another representative indicated that nearly 100 percent of motor homes are registered to people.

Regarding ownership proportions of entertainer buses, one industry expert suggested that most entertainer buses are owned by businesses that actively serve in the entertainment industry and others. Some could be owned by wealthy people (e.g., mostly celebrities). An article published by Luxury Coach & Transportation magazine said that entertainer coach companies lease their entertainer buses (also known as entertainer coaches) to traveling campaigners and entertainers (musicians, comedians, performers, and theatrical groups) to transport speakers, performers, and their technical crews.

Medium Bus Market Survey

A market survey of medium buses was conducted for medium buses that met the following criteria:

- GVWR between 10,000 lbs and 26,000 lbs;
- 10 passengers or more with one driver;
- Buses used for transit, intercity transportation, and shuttle services that are not included in the limousine category; and
- Buses commonly referred to as cutaway buses.

The definition used for cutaway buses for this research encompasses bus manufacturers purchasing a chassis from four major engine manufacturers then building cutaway buses on the chassis. These cutaway buses are purchased by Federal, corporate, and private entities. This includes State-owned transit, fleets for shuttles such as airport and hotel shuttles, assisted living shuttles, churches, schools and universities, day care facilities, and corporate transportation companies. School buses were not included in this study, along with other buses that did not meet the criteria listed above.

The primary objective of this survey was to look at the end product produced by bus manufacturers. This study provides available information regarding the economic impact of NHTSA requiring additional regulations for this category of vehicles.

Passenger restraints (seat belts) are required for vehicles less than 10,000 lbs GVWR and greater than 26,000 lbs GVWR, but not between 10,000 and 26,000. Only driver seat belts, and any outboard passenger seat, are required for these medium buses. Low floor buses (a bus that has no steps between the ground and the floor of the bus at one or more entrances) are in the same GVWR as other medium buses and therefore are not required to provide passenger seat belts.

Research Objectives

The research team conducted a market survey of medium buses with the following objectives.

1. Estimation of the number of new vehicles in this category and their passenger carrying capacity
2. Identification of 2-point and 3-point seat belt installation rates in new vehicles of this category
3. Identification of the number of vehicles made by cutaway bus manufacturers
4. Determination of how new technology in bus safety could potentially impact safety regulations and reinforcement of safety regulations

The research team gathered market information on medium buses based on the analysis of existing datasets, review of related literature, researching each manufacturer's website, and by conducting targeted stakeholder outreach.

Stakeholder Outreach

To supplement information found from literature reviews and general internet searches, stakeholders with expertise in the industry were identified and contacted. Fourteen stakeholders were identified, and four interviews were conducted with medium bus stakeholder and industry experts. Prior to each interview, a set of questions was sent to the stakeholder asking specific vehicle and market size information. This was followed by a phone interview to discuss additional vehicle information and safety issues. Interviewees included industry experts affiliated with bus manufacturers, Mid-Size Bus Manufacturers Association (MSMBA), National Truck Equipment Association (NTEA), seating manufacturers, associations, and bus distributors/dealerships. Each interviewee provided their market perspective regarding industry standards and sales/production information.

Some of the questions that the research team asked the stakeholders included the following.

a. What types of buses are in this weight class and what is their market share?
b. What are the sizes of the buses- length and weight?
c. What is the passenger capacity of the buses?
d. What are the production numbers?
e. What are the seat belt installation rates?
f. Are there multi-staged vehicles? If vehicles are multi-staged, what is the procedure and how many manufacturers are there? How many vehicles do they produce annually? Where and how do after market modifications occur?
g. What types of belts are installed? Who installs them? When aren't seat belts installed? What are the feasibility concerns regarding installing or not installing seat belts?
h. What are your thoughts on installing passenger seat belts? Why are/aren't they installed? Are there any cost or feasibility concerns associated with installing passenger seat belts?
i. What are the seat facing directions and locations?
j. Is there any modification made to seats?
k. How are buses sold and what is the sale price?
l. What is the market share by bus type?
m. What are the impacts of installing seat belts on vehicle weight, cost, and passenger capacity?

Makes and Models of Medium Buses

Medium bus makes, models, passenger seating capacity, and vehicle specifications including floor height, vehicle length, vehicle weight, and its use were collected based on available information from literature and manufacturer websites. Available information on sales of medium buses and market share by make and model was documented. Information on pricing of medium buses was difficult to obtain as most manufacturers do not post price information.

The research team was able to identify medium bus manufacturers and models. Different makes and models meeting the medium bus size criteria are listed in Table 51. In addition to make and model, the table lists the passenger carrying capacity, chassis type or supplier, bus length, weight, number of floorplans available, and if the vehicle is a low floor. The research team was unable to find GVWR and other information of some makes and models of medium buses. Blank cells in Table 51 represent missing information.

Table 51. Medium buses make, model, and specifications

Manufacturer	Model	Number of passengers	Chassis type	Length (ft.)	Weight (lbs)	No. of floor plans
Champion	LF Transport*	18-23; 6 WC	Ford	21, 23, 25	12,300-14,200	4
	Challenger	16-25 / 6 WC; 17-29	Chevy 4500 / Ford	23, 25, 27	12,500-14,500	5
	Defender (only 4 models meet weight)	29-40; 6-12 WC / 21-25; 5-8 WC	Freightliner / Ford F-550	29, 33, 35, 38 / 25, 27,29	26,000 / 18,000, 19,500	
	LF Avenger*	16-29; 2-3 WC	Ford	29	19,500	5

Manufacturer	Model	Number of passengers	Chassis type	Length (ft.)	Weight (lbs)	No. of floor plans
Goshen Coach	Pacer II	8-14	Ford E-350 or Chevrolet G3500	19.5-24	11,500-14,500	4
	Impulse	8-28	Ford: E-350 & E-450 or Chevy G3500 & G4500	21-27	11,500-14,500	4
	G-Force	16-23	Available on Ford F-450 or F-550 chassis	24-33	16,500-19,500	4
World Trans	22E/G	19	Ford E-350/450; or Chevy G3500/4500	266	11,500-12,500 or 14,500; 12,300-14,200	1
	24 E/G	21	Ford E-350/450; or Chevy G3500/4500	288	11,500/ 12,500/ 14,200	1
	26E/G	25	Ford E-350/450; or Chevy G3500/4500	314	14,500	1
	22N	13; max of 5 rows	Ford E-350/450; or Chevy G3500/4500	22	11,500/ 12,500/ 14,500	1
Arboc	Independence*	15- 5 wheelchair	Ford Transit or Ram Promaster (Ram weight not in category)	23.5	11,000 lbs	4
	Mobility*	21- 6 wheelchair	Ford or GM	24, 26, 28	14,200 & 14,500	5
	Freedom*	22-8 wheelchair	Ford or GM	24, 26, 28	14,200 & 14,500	5
Coach and Equipment	Phoenix ML		Ford E350			
	Phoenix DRW		Ford E450			
Diamond Coach	VIP 2800	29 max, 8 wheelchairs	Ford and Chevy	28		4
	Transit nugget	9-14 max, 2 wheelchairs	XLT HR DRW TRANSIT		10,360	
	VIP 3500	36 max, 8 wheelchairs	Ford 450 and 550	28, 32, 35		5
	VIP 2500	25 max, 7 wheelchairs	Ford and Chevy27'7"	25		7
	VIP 2200	21 max, 7 wheelchairs		23		9
	VIP 2000	17 max, 5 wheelchairs		22		5
Starcraft	Allstar	12-25 max, 2 wheelchairs	E350, F450	20, 22, 24, 25	11,500, 12,500, 14,000, 14,500	5
	Allstar XLF550	25-33	F550	28, 30, 32	19,500	6
	Allstar XLF650	33, 39, 45	F650	32, 36, 40	25,999	6
	MVP	24-28	E450	27	14,500	2
	Starlite	14-16	E350, E450	20, 22	11,500; 12,500	3
	Starlite transit	14-16	3500			5
	Starquest	14-19	E340; E450; G3500	21, 22, 23	11,500, 12,300, 12,500	5
	XLT F650	30-44	Cummins ISB 240HP	32, 36, 40	25,999	6

Manufacturer	Model	Number of passengers	Chassis type	Length (ft.)	Weight (lbs)	No. of floor plans
Turtletop	VT3	17	Ford 3500 HD	23	10,360	6
	Van Terra	15	Ford E-350 SRW; Ford E-350 DRW	21	10,500, 11,500, 12,500	9
	Odyssey	25	Ford F-450 or Chevy G-4500	23 - 27	14,500, 14,200	12
	Odyssey XL	34, 41	Ford F-550; Freightliner S2C	30 - 39	19,500-26,000	13
	Terra transit	27	Chevy G-4500 / G-4500 / G-4500; Ford E-450 / E-450 / E-450 / F-550 / F-550	23, 24, 26, 26, 28, 29, 31, 33	14,200, 14,500, 19,500	14
Grech Motors	Sprinter	up to 13	3500 170" Ext. high roof	22.5	11,030	8
	E450 (GM24 and GM28)	14-16; 23			14,500	8
	F550	28-32			19,500	6
ElDorado Coach	Aerolite- 3	13-15	Ford or Chevy	19 - 22	11,500-12,500	8
	Aerotech	17-29	Ford or Chevy	22 - 27	11,500-14,500	10
	AeroElite	25-33	Ford or Chevy	26 - 33	19,500-23,500	12
	Advantage	19-29	Ford of Chevy	22 - 27	11,500-14,500	10

* = Low Floor model.
WC = wheelchair.

Number of Medium Buses in Operation

R. L. Polk's vehicle registration data provides some information on the number of medium buses in operation. Among the many variables provided by the data, GVWR and Vehicle Type are important variables for identifying medium buses. The GVWR requirement of medium buses is that they should weigh more than 10,000 lbs but less than 26,000 lbs. Under the Vehicle Type variable, buses in general are identified as Bus Non School. To subset medium buses from the bus category, the research team used the variable GVWR. Therefore, to determine the number of medium buses in operation, Polk's vehicle registration data was filtered to include only cases with GVWR from 10,0000 lbs to 26,000 lbs and Bus Non School as the vehicle type.

It is assumed that the count of registered medium buses is a good estimator of the number of medium buses currently in operation. Figure 16 shows the count of registered medium buses from 2015 to 2019 (in the Polk's data, the variable Bus Non School was applicable to entries made after 2015). Overall, the number of registered medium buses remained constant. In 2018 there were 11,282 registered medium buses. The number of registered medium buses in 2019 was 11,029, which is slightly lower compared to 2018. Note that the data does not include aftermarket conversion of vehicles to medium buses.

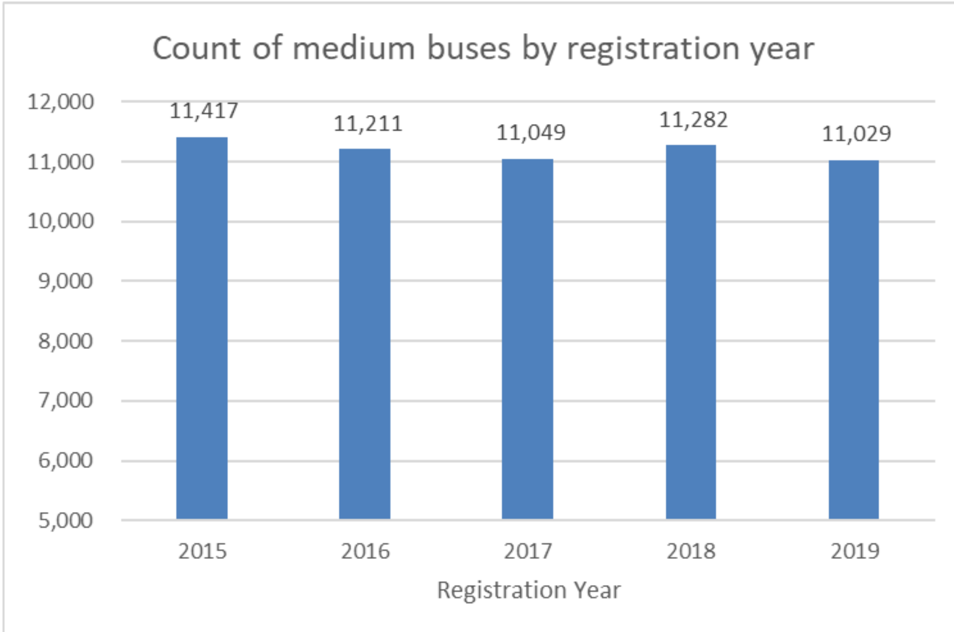

Figure 16. Count of medium buses by registration year

Table 52 shows the volume rank of registered medium buses by make. The data shows that Freightliner/MB Line is the most popular medium bus (making about 19 percent of all medium buses) followed by International/3200 (making about 16% of all medium buses).

Table 52. Breakdown of the volume rank of registered medium buses by make

Rank	2015	2016	2017	2018	2019
1	Freightliner	Freightliner	Freightliner	Freightliner	Freightliner
2	IC Corporation	IC Corporation	IC Corporation	IC Corporation	IC Corporation
3	International	International	International	International	International
4	Spartan Motors	Spartan Motors	Spartan Motors	Spartan Motors	Spartan Motors
5	El Dorado	El Dorado	El Dorado	El Dorado	El Dorado
6	Oshkosh Motor Truck Co.	Oshkosh Motor Truck Co.	Oshkosh Motor Truck Co.	Oshkosh Motor Truck Co.	Oshkosh Motor Truck Co.
7	Chance Coach Transit Bus	Chance Coach Transit Bus	Chance Coach Transit Bus	Chance Coach Transit Bus	Chance Coach Transit Bus
8	Ontario Bus	Ontario Bus	Ontario Bus	Ontario Bus	Ontario Bus
9	Orion Bus	Orion Bus	Orion Bus	Orion Bus	Orion Bus
10	Thomas	Thomas	Thomas	Thomas	Thomas
11	GMC	GMC	GMC	GMC	GMC
12	Hendrickson	Hendrickson	Hendrickson	Hendrickson	Hendrickson
Grand Total	**11,417**	**11,211**	**11,049**	**11,282**	**11,029**

Annual Sales and Production of Medium Buses

Interviews provided sales and production information solely for the manufacturers represented by the stakeholders. The Polk's vehicle registration database provided information of new registration by chassis for medium buses. One challenge identified during analysis was that the same chassis that a medium bus is built on can also be used to build dump trucks or other vehicle types. The database identified the number of registrations per year from 2015 to 2019. This does not seem to include all medium buses, as Polk's vehicle registration data does not capture all medium buses manufactured (e.g., those converted after-market). The average lifecycle of the buses is 7 years. The number of registrations per year stays consistent.

A literature search and investigations of manufacturer websites found data on annual public versus private production and sales of buses by size, passenger capacity, and their market share for 2008 and 2014 (Bureau of Transportation Statistics, n.a.). Annual production from 2002 to 2016 was also found. However, most data found was not current, except through the stakeholder interviews.

Specific manufacturer annual sales information was not found publicly. Information used for this report was found either in the registration database or from interviews with stakeholders.

A stakeholder engaged in distribution of medium buses reported that Eldorado, Champion, Coach and Equipment, Turtletop, and Starcraft are all major market share companies. Starcraft has the strongest market share of approximately 25 percent to 30 percent of all sales, 80 percent of which are shuttlebuses. Coach and Equipment is second with about 1,000 to 1,200 sales per year. Turtletop is third with 500 to 600 per year. Executive Coach contributes the smallest amount, producing 200 to 400 per year.

The price of new medium buses ranges from $55,000 to $80,000 depending on their size and passenger carrying capacity. Additional features can increase the price by as much as $20,000 (e.g., wheelchair accessibility).

Medium bus sales were reported equally for industrial (e.g., FTA-funded public transit) and retail use, with an approximate 50 percent split. Retail use may include operators from colleges, retirement care facilities, or airport and hotel shuttles.

Medium buses typically have two types of customers. The first group includes customers that use medium buses for commercial purposes (i.e., to generate revenue). The second group includes customers that need buses to provide services not attached to revenue (e.g., church buses and retirement home buses).

Arboc is a higher end manufacturer and usually produces 600 vehicles of the yearly 12,000 to 16,000 industry production. Those 600 vehicles represent about 75 percent of the low floor segment of medium bus market.

A distributor of medium buses was interviewed and reported that they stock between 100 to 150 buses at any time. The dealership specs the buses for quick sales to customers that do not need specific branding and specifications. The interviewee suggested that these buses are equipped with 2-point seat belts.

A report and a supplement addendum from the National Transportation Safety Board (2018a, 2018b) provided the following information regarding production:

- Medium bus production with a GVWR of 10,500 lbs to 14,500 lbs saw a growth of 137 percent from 2008 to 2014 for a 13-passenger–capacity bus. Medium buses with a 17-passenger capacity grew 60 percent between 2008 to 2014. The 21-passenger bus production decreased 12 percent.
- In the same timeframe, the 14,501-16,000 GVWR 25-passenger bus production grew 33 percent, and the 15,001-26,000 GVWR 29-passenger buses grew 47 percent.
- Public vs private sales were close to 50/50 in the early 2000s but since 2009, the public sales have increased by 56 percent whereas the private sales have remained close to the same number of units (now at 29%).

Another data source that provided information on the annual sales of medium buses was the Polk's vehicle registration database. In the registration data, GVWR and Vehicle Type were used to distinguish medium buses from other bus types. New registration of medium buses was identified by comparing the

MY of vehicles with the registration year. If the MY of the vehicle is the same or greater than the registration year, then the vehicle was considered as a new registration. The notion is that annual registration of new medium buses can be used to determine the annual sales of medium buses. Figure 17 shows the number of new medium bus registrations from 2015 to 2019. As previously noted, one challenge with this data is that the chassis used to identify medium buses can also be used for dump trucks.

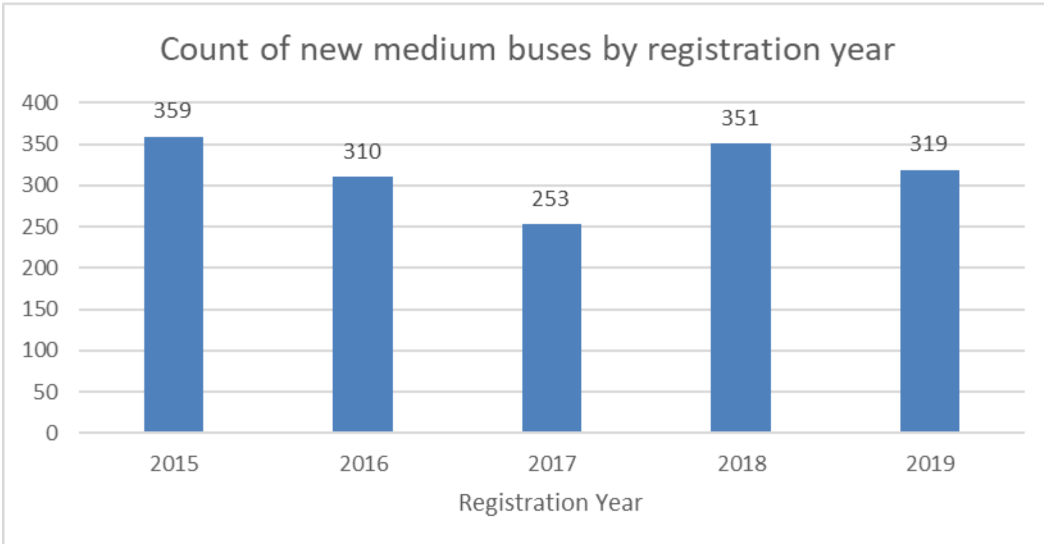

Figure 17. Count of new registrations of medium buses from 2015–2019

The annual sales and production estimates discussed may not be definitive. Issues with the data include the unavailability of new information and pricing. Manufacturers of buses do not have rich information regarding the bus specifications and pricing that car dealers have on their websites. Very few sources provided production numbers, and the data are ambiguous because not all information represented is completely based upon the criteria used to define medium buses in this survey. Registration data are based upon chassis, and the same chassis can be used for multiple vehicles in different classes.

Passenger Carrying Capacity

The passenger carrying capacity of medium buses varies significantly by make, model, and floor plan. The minimum passenger carrying capacity of medium buses is 10. Larger medium buses can carry up to 45 passengers. If the medium buses are wheelchair accessible, their passenger carrying capacity is significantly reduced. Some medium buses that are wheelchair accessible are equipped with folding chairs (which may or may not include integrated 2-point retractable seat belts in the chairs) at the place designated for wheelchairs or places with limited space. The breakdown of passenger carrying capacity of medium buses by make, model, and floor plans was shown in Table 51.

Seat Belt Installation Rates

Where seat belts are not required, seat belts are installed if requested by the purchaser of the buses. Two types of seat belts are offered, namely 2-point and 3-point. The 2-point seat belts are lap belts and do not require any special seating, nor do they add weight and loading requirements. The 3-point seat belts are lap and shoulder belts and the stakeholders interviewed mentioned that they require heavier-weight seats (on the average they require additional seating material that weighs 10 pounds above the traditional 2-point belt seats). The stakeholders further mentioned that the additional material required for 3-point seat belt installation not only creates an additional cost to the purchaser (approximately $140 per seat) but also creates a higher load weight for the vehicle, which could potentially move the vehicle into another weight class. The larger seats reduce leg room, resulting in a lesser hip-to-knee ratio, and reduced seating capacity. According to the stakeholders consulted, an average 14,500 lbs GVWR chassis will lose 2 seats due to changes to accommodate installation of 3-point seat belts. The industry would also need to mitigate this issue to ensure these ratios stay acceptable.

A manufacturer stakeholder reported that they usually install seat belts in 50 percent to 65 percent of the vehicles they manufacture. The request for seat belts comes from the end users / customers. Approximately 25 percent of their seat belt installations are for 3-point seat belts. The lower installation rate of 3-point seat belts can be attributed to the higher cost of the vehicle itself and also the loss of passenger capacity.

A seating manufacturer reported that they produce 99 percent of the market share of seats for cutaway buses with a passenger carrying capacity of 14 to 47. The 2-point seat belts are made by the seating manufacturer to fit their seats. However, the 3-point seat belts are purchased from a supplier and then installed on the seats by the seat manufacturer. Seating accommodates child safety seats for medium buses.

Seat belt installation is specific based upon seat direction. Forward-facing seats can have either 2- or 3-point seat belts depending on customer choice. Side-facing seats usually have 2-point seat belts. Type of seat also determines the type of seat belts to be installed. For example, all 2-point seat belts use an auto retractor that is made specifically for the seat, while 3-point seat belts have different retractors depending on whether the seats are rigid, recline, or fold away. The attachment mechanisms for the belts are dictated by the type of seat and type of vehicle. Seats in medium buses can be mounted on legs, floor tracks, or side walls.

Head restraints are not required by FMVSS No. 202 for buses with a GVWR greater than 10,000 lbs. These buses are not held to the FMVSS No. 202 standard. If seats are purchased without head restraints, they can be bolted on later and are considered by the industry to be the same as factory headrest additions to the seats according to a medium bus distributor stakeholder.

Motorcycle Helmet Market Survey

The focus of this survey was to conduct a survey of motorcycle helmets available in the U.S. market. Helmets are used to prevent head injuries when motorcyclists are involved in crashes. Serious head injury is a common cause of fatal motorcycle crashes; therefore, understanding the annual sales and type of helmets available is important. As of 2017 motorcycle registration and usage has increased, but the fatality rate per miles traveled has not significantly decreased (National Center for Statistics and Analysis, 2019a). Therefore, NHTSA is interested in the market size of motorcycle helmets by make and model.

Motorcycle helmet type and the risk of head injury and neck injury during motorcycle crashes have been extensively researched (Brewer et al., 2013; Erhardt et al., 2016; NCSA, 2019b; Subramanian, 2007). The research focused on four types of motorcycle helmets: full face, open face, modular, and half face. Full face helmets, also referred to as "complete" helmets, cover the entire head, face, and jaw, providing the highest level of protection. Open face helmets cover the entire head and ears but not the rest of the face or jaw, thus are sometimes called "3/4" helmets. Modular helmets, or "flip up" types, are a mix of full face and open face helmets because the chin bar and visor of the helmet can flip up to open the front face. Half helmets cover the entire head but not the ears, face, and jaw. There are other special helmet types for sport and recreation purposes (e.g., off-road helmets, dual-sport helmets, and racing helmets), which were not covered in the survey. Likewise, only certified motorcycle helmets were considered, excluding any novelty or non-compliant types.

There are three common certification standards available on helmets sold in the United States. The law requires any helmet sold in the United States be certified to and compliant with FMVSS No. 218;

however, sales in Europe are governed by the Economic Commission for Europe (ECE) 22.05 standard. An independent organization, the Snell Memorial Foundation, also has performed safety certifications against its own standards since 1959. The standards are updated every 5 years, including in 2015 and 2020. Some U.S. consumers seek helmets that are not only certified to the FMVSS, but also meet additional certifications such as ECE or Snell. NHSTA randomly purchases certified helmets available on the market for formal compliance testing, which includes a performance portion with impact, penetration, and retention testing, supported by dropping the helmets onto an anvil, plus a number of other non-performance tests such as labeling.

Research Objectives

The research team conducted the market survey of motorcycle helmets using the following objectives.

1. Identifying the make, model, and certification attached to the motorcycle helmet (e.g., DOT, Snell) available for sale.
2. Estimating the cost and annual sales volume of motorcycle helmets by type (full face, open face, half, and modular).
3. Estimating the average weight of the motorcycle helmets by types.

Research Methodology

Most of the data on helmet manufacturers were collected from public websites. Many manufacturers, such as HJC Helmets (www.hjchelmets.us/), post the currently available models, often sorted by type as shown in Figure 18. For example, the C70 helmet by HJC (www.hjchelmets.us/product/c70/) is listed as a full-face type.

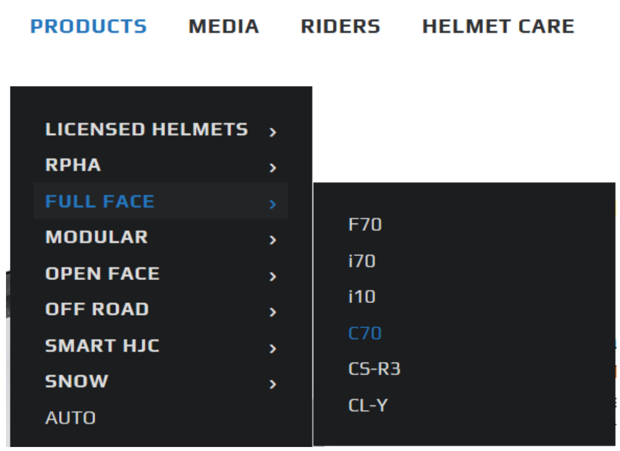

Figure 18. Sorting of motorcycle helmets types

As seen in Figure 19, this website shows not only the helmet make and model, but also a price range for manufacturer suggested retail price (MSRP), which became the basis for this data collection. Additionally, the site shows certifications obtained for each model (Figure 20).

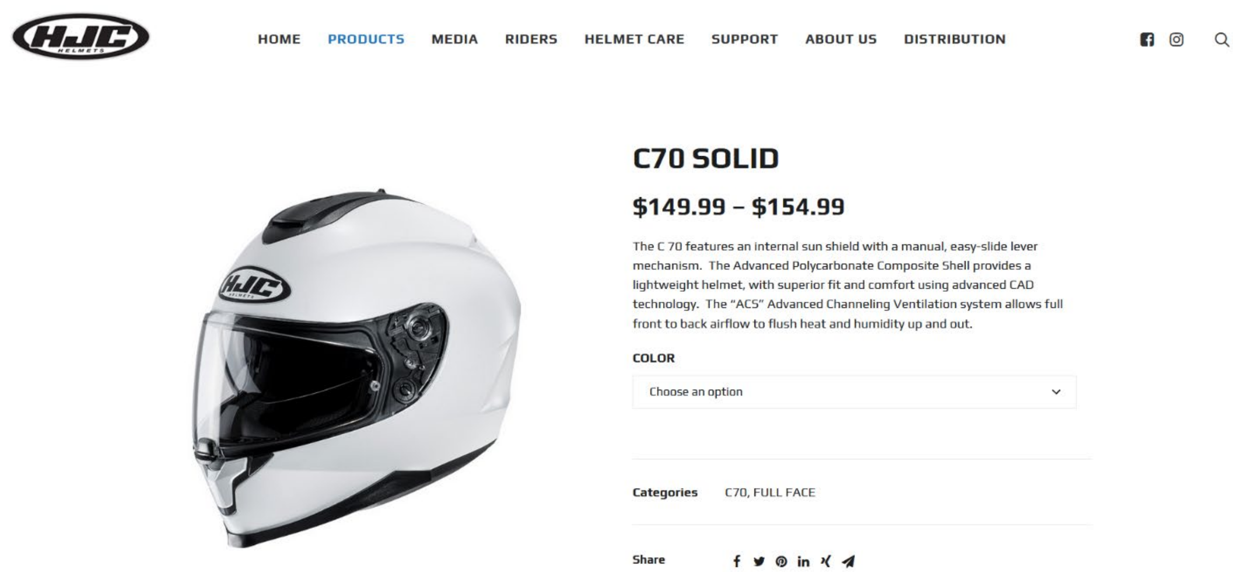

Figure 19. Brief description and MSRP of a select helmet

Figure 20. Certification labels for motorcycle helmets

Although around 100 motorcycle helmet models were obtained from the manufacturer website, this method was limited to the newest, top-of-the-line models and provided almost no data on the weight of the helmet. To fill those gaps, popular helmet retailer websites were scraped using custom tools to build the inventory of available models and to complete the weight survey. Additionally, specific journal articles and blogs provided details on the certification, as well as some of their own analysis, which also include weights of the helmets.

Finally, to supplement data obtained from literature review and website scraping, interviews with 16 helmet manufacturers and 1 distributor were requested. The responses to these requests were minimal, possibly due to the impact of COVID-19 on workplaces. In all, only 1 manufacturer and 1 distributor were interviewed. This disappointing result significantly impacted the second research objective, because specific helmet sales data were not readily available outside the manufacturing companies. Therefore, this portion of the objective largely remains unobtained.

Make, Model, and Certification of Motorcycle Helmets

Various manufacturers produce different types of motorcycle helmets. To ensure compliance with minimum safety requirements, most manufacturers test their products to the standards set out by FMVSS No. 218, the Economic Commission for Europe, and the Snell Memorial Foundation. Table 53 shows known reputable motorcycle helmet manufacturers, the helmet types they produce, and their standard certifications. The complete inventory list is available under a separate spreadsheet.

Table 53. Motorcycle helmet manufacturers, helmet types, and standard certifications

Manufacturer	Helmet type	Standard certifications
6D Helmets	Full Face	DOT, ECE
AFX	Full Face, Modular, Open Face, and Half	DOT, ECE
AGV	Full Face, Modular, and Open Face	DOT, ECE
Akuma	Full Face	DOT, ECE
Arai	Full Face	DOT, ECE, Snell
Bell	Full Face, Modular, Open Face, and Half	DOT, ECE, Snell
Bilt	Full Face, Modular	DOT, ECE
Biltwell	Full Face, Open Face	DOT, ECE
Fly Racing Street	Full Face, Modular, Open Face, and Half	DOT, ECE, Snell
GMAX	Full Face, Modular, Open Face, and Half	DOT, ECE
HCI	Full Face, Modular, Open Face, and Half	DOT
HJC	Full Face, Modular, Open Face, and Half	DOT, ECE, Snell
Icon	Full Face	DOT, ECE
Klim	Full face, and Modular	DOT, ECE
LS2	Full Face, Modular, Open Face, and Half	DOT, ECE, Snell
Nexx	Full Face, Modular, and Open Face	DOT, ECE
Nolan	Full Face, Modular, and Open Face	DOT, ECE
Ruby Helmets	Full Face, and Open Face	DOT
Schuberth	Full Face, Modular, and Open Face	DOT, ECE
Scorpion	Full Face, Modular, Open Face, and Half	DOT, ECE, Snell
Sedici	Full Face, Modular, and Open Face	DOT, ECE, Snell
Sena	Full Face, Open Face and Half	DOT, ECE

Using the data obtained through scraping of websites of motorcycle helmet manufacturers and retail sales, Figure 21 to Figure 25 show the top 10 makers of motorcycle helmets for each type on the market today, along with the relative size of their availability inventory.

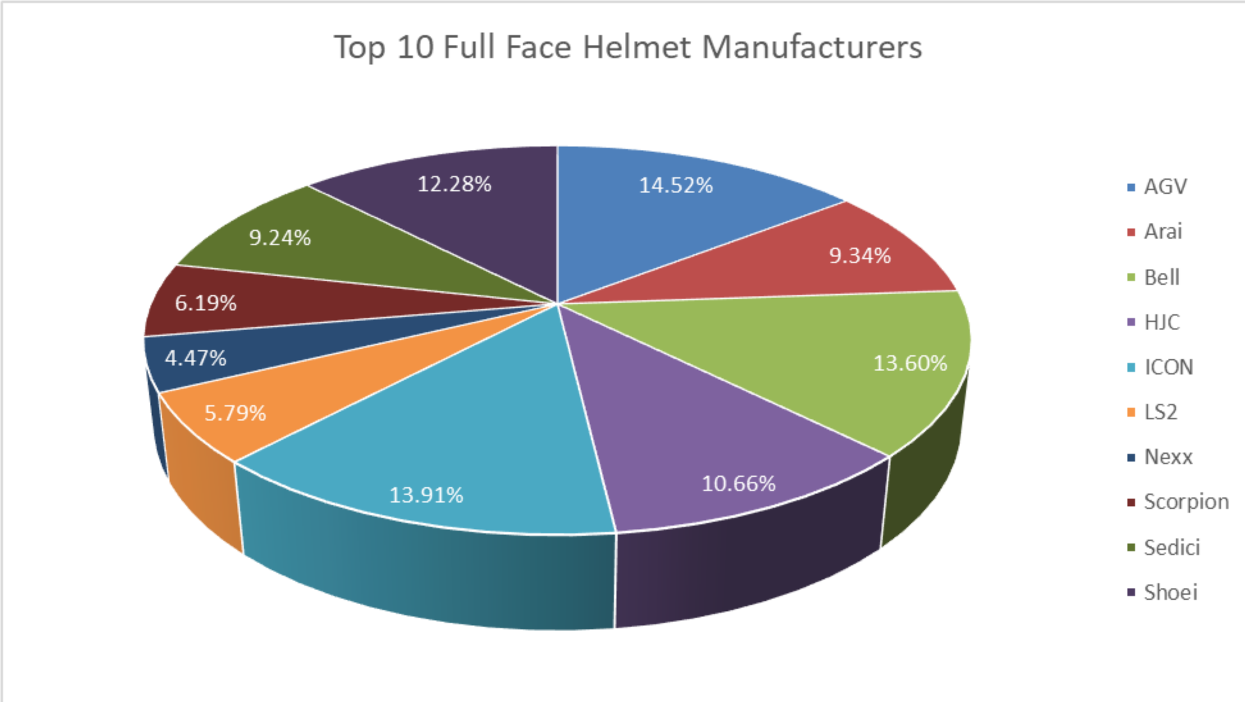

Figure 21. Top 10 full face helmet manufacturers

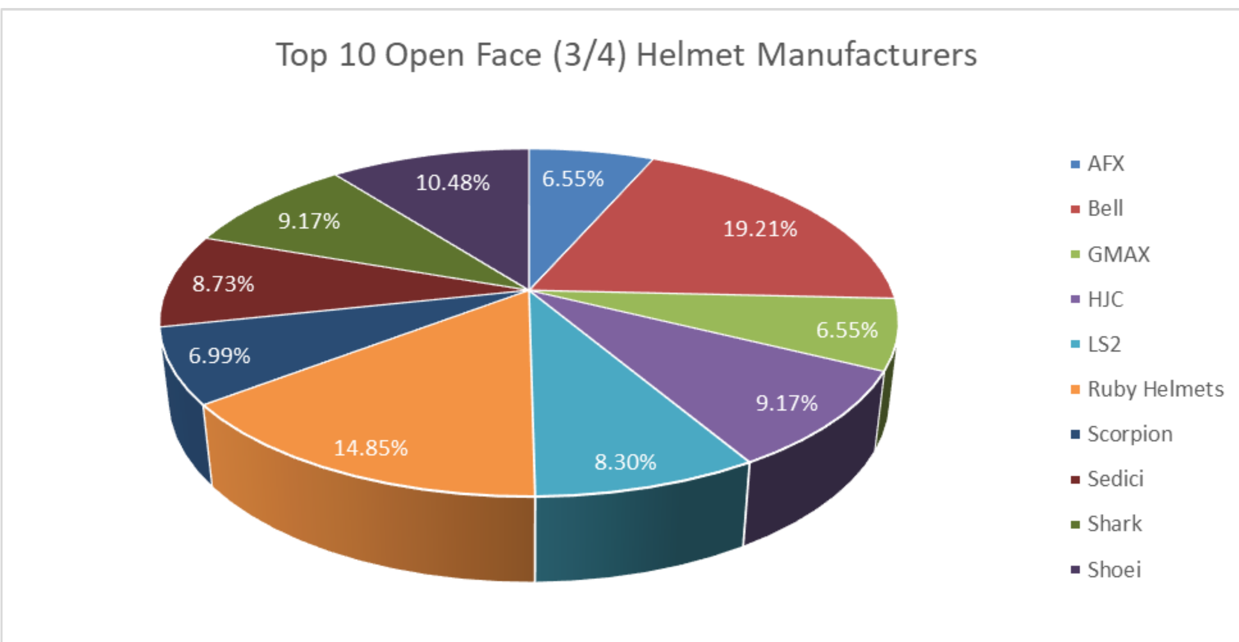

Figure 22. Top 10 open face (3/4) helmet manufacturers

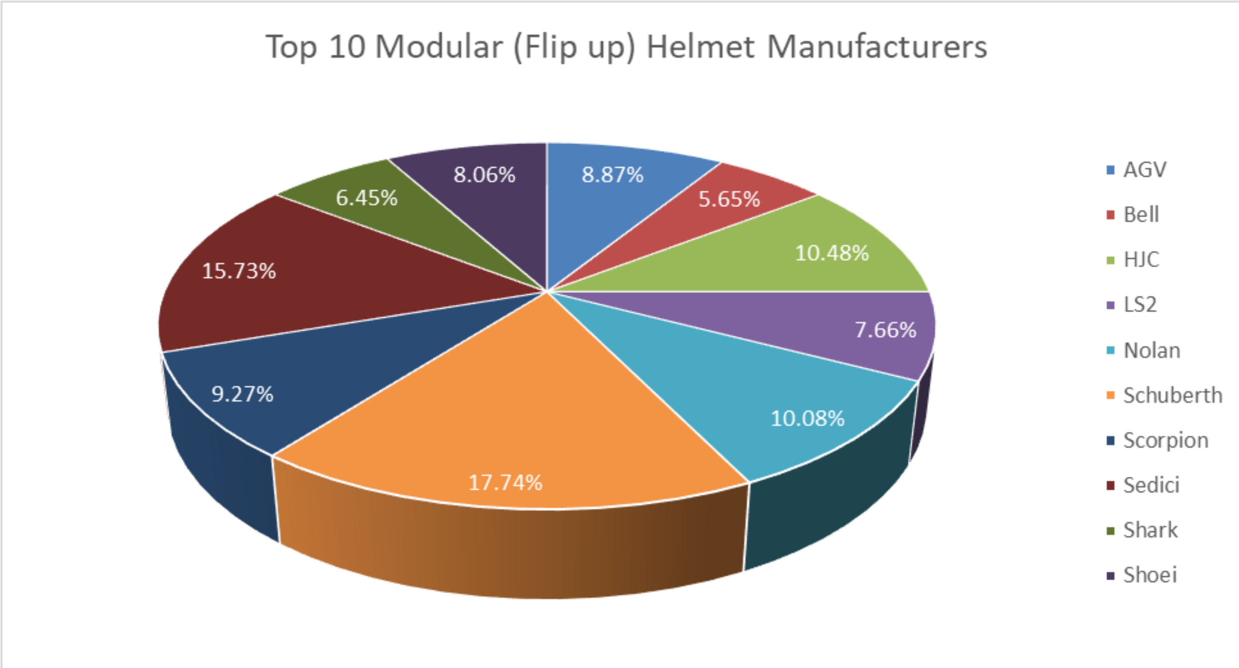

Figure 23. Top 10 modular (flip up) helmet manufacturers

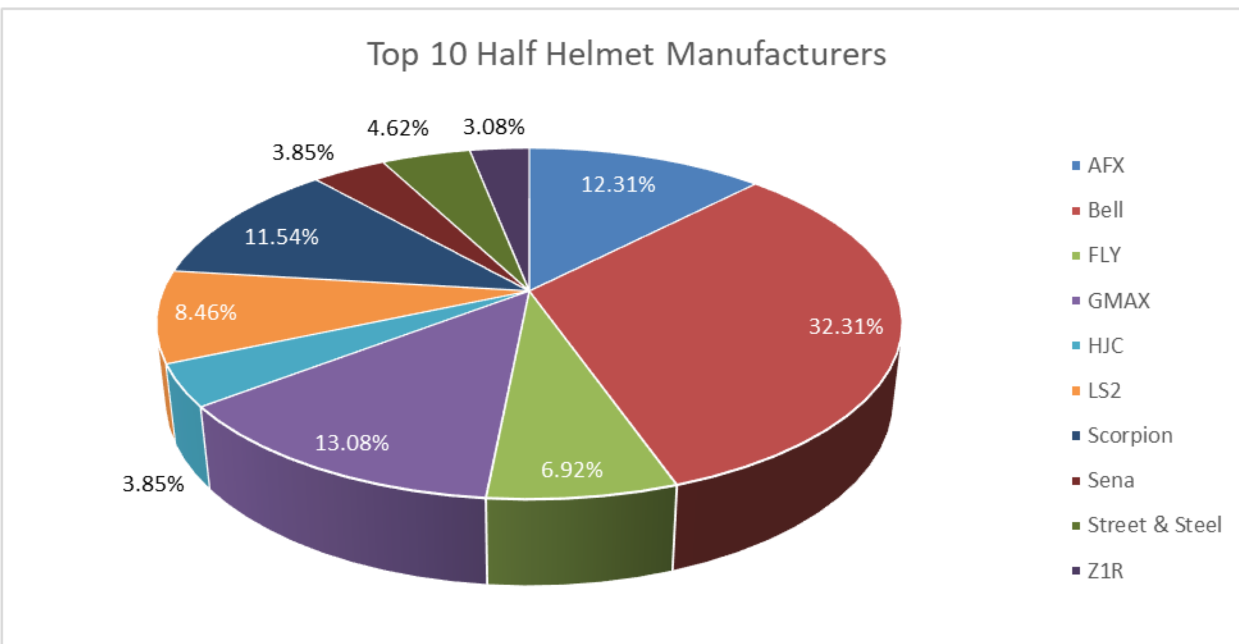

Figure 24. Top 10 half helmet manufacturers

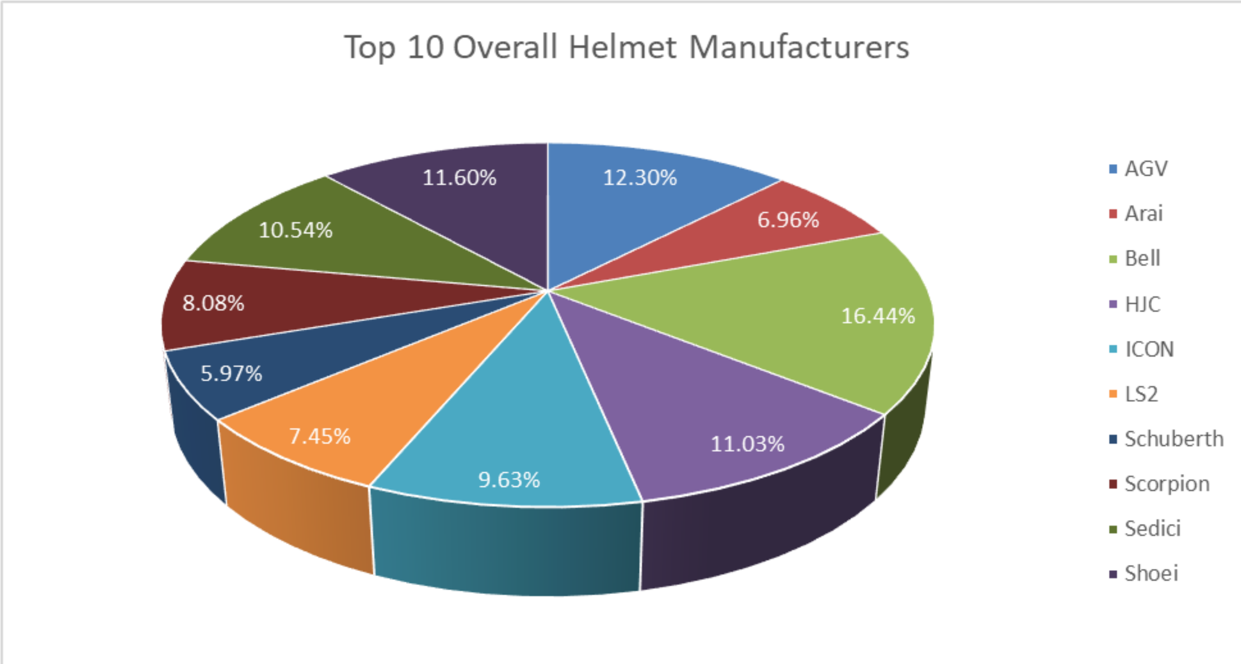

Figure 25. Top 10 overall helmet manufacturers

From these charts, one can see that 90 percent of top overall helmet manufacturers are also the top manufacturers for full face types, and 80 percent of them are also top modular type producers. In contrast, those top 10 overall manufacturers are less likely to be large producers of open face (60%) and half helmets (40%). Data from the interviews confirmed that the industry considers the full-face type as the safest while the half helmets are deemed least safe. As such, the sales of the full face and modular types are reported to be trending up, while the half helmet type sales are down. Another possibility could be that some European and Asian-based manufacturers choose not to produce half-helmets for the U.S. market since half helmets would not comply with the standards they more generally use. The researcher team uncovered no cases where a half helmet was certified to the ECE or Snell certifications.

Whereas the market survey included inventory data from manufacturers that sell motorcycle helmets in the U.S. market, not every available helmet from those manufacturers is certified for sale in the United States. The data shows that 97 percent of the helmet manufacturers included in this market survey identified DOT as the primary certification for their helmets. Further, at least 92 percent for each helmet type were listed with DOT as the primary certification. While this is not a major surprise given the list of producers, this does seem to confirm that the United States is a significant target market for each of these manufacturers.

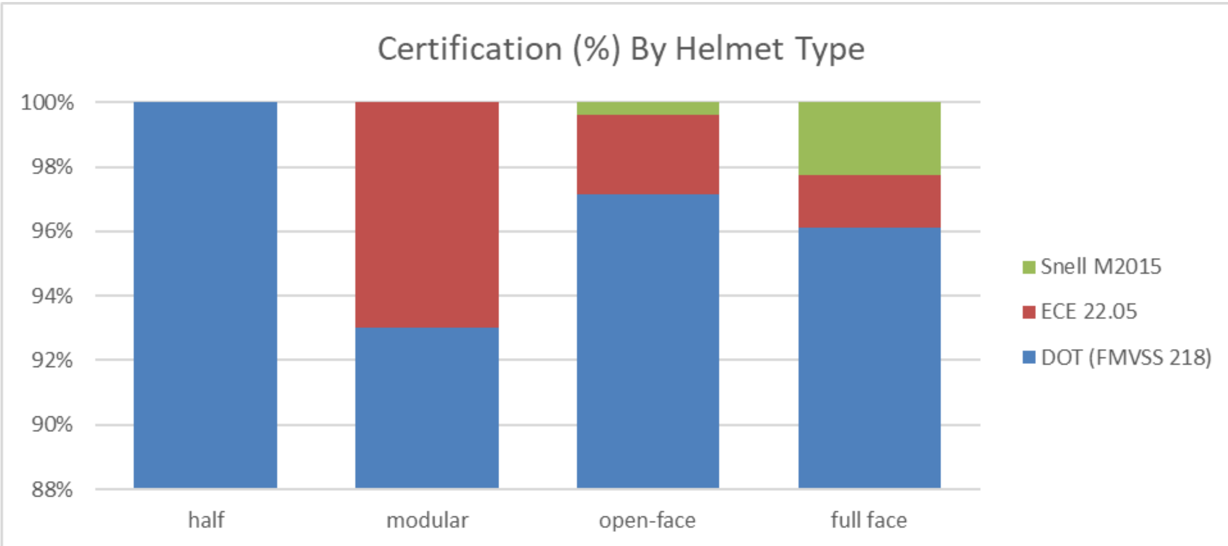

Figure 26. Certification percentage by helmet type

Costs and Annual Sales of Motorcycle Helmets

The motorcycle helmet sales data identified by the authors and obtained from manufacturers was scarce. The primary source for this information, as described under the Research Methodology section, was the outreach and interviews conducted. Because only two responses were received, and among those only one returned any sales data, it is difficult to project the annual sales for each type of helmet. Generally speaking, the full face and modular helmets tend to outsell the partial face types, according to the conducted interviews, despite generally being more expensive.

The breakdown of the minimum, maximum, and average costs by type is shown in Figure 27 Figure 28, and Figure 29, respectively (shown separately to allow for proper scaling). The full-face and modular types are generally more expensive due to the additional material required for the full-face coverings and some additional advanced features often added for comfort and convenience. This is particularly true for modular, or flip-up, helmets that are designed to allow for easy removal of chin guards to allow for talking on the phone or drinking. Note that this data was gathered throughout winter of 2019 to spring of 2020, and thus reflects the pricing only at that time. Wherever available, the MSRP was used, yet some prices may actually reflect retailer discounts. In this inventory and cost/weight analyses, “off-road” and “dual-sport” helmets were not included. In addition, no effort has been done to specifically separate “track racing” from the common street helmets.

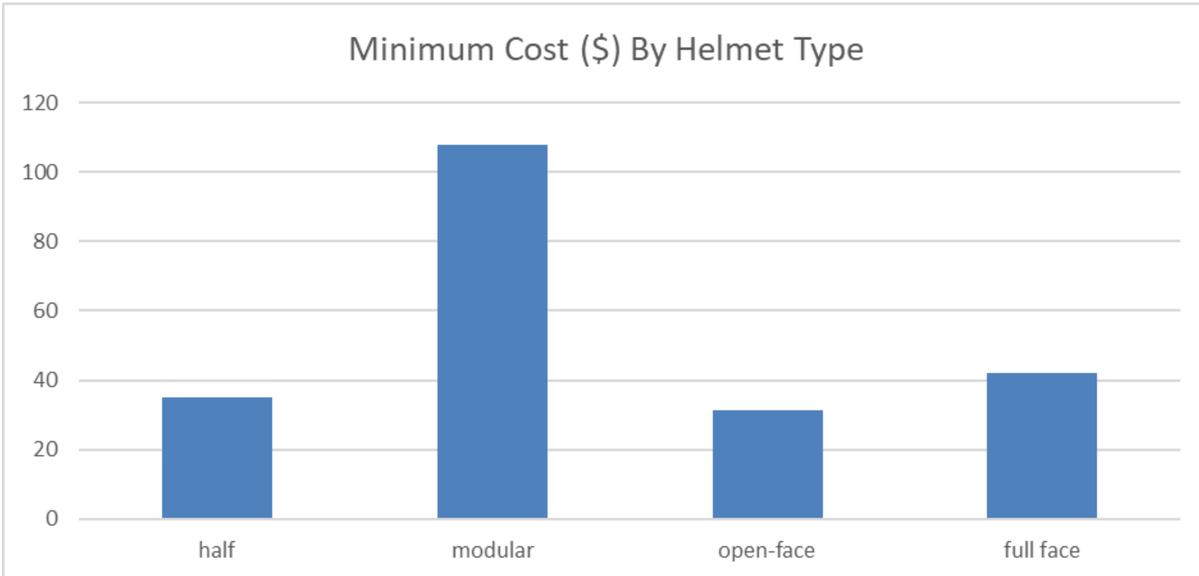

Figure 27. Minimum cost of motorcycle helmets by type ($)

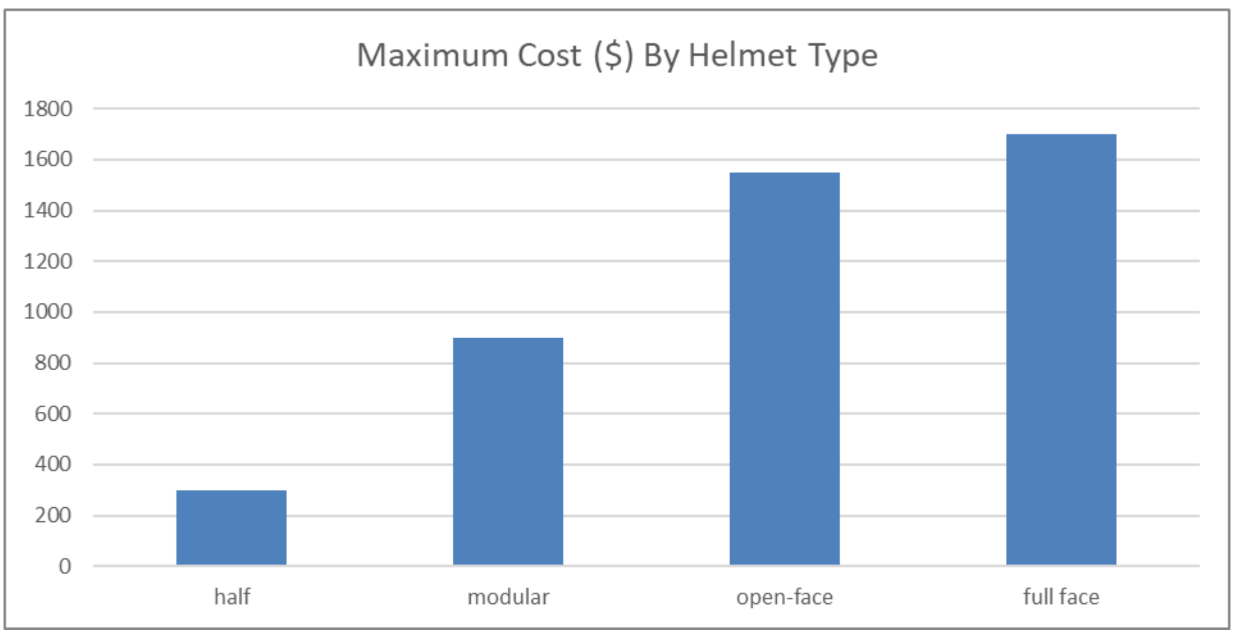

Figure 28. Maximum cost of motorcycle helmets by type ($)

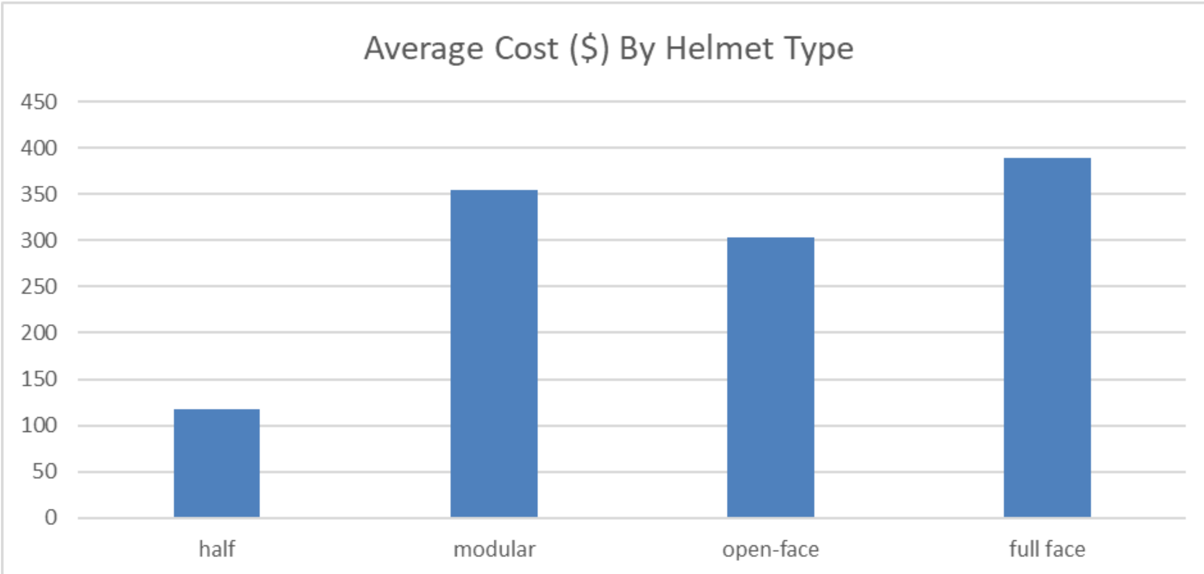

Figure 29. Average cost of motorcycle helmets by type ($)

Additionally, the costs were further broken down by certification in attempt to determine if the cost of the testing is evident in the price. It was found that the Snell certifications do appear to cost more on average, despite a few high-end models choosing not to pursue the Snell label. The minimum, maximum, and average costs of motorcycle helmets by certification are shown in Figure 30, Figure 31, and Figure 32, respectively.

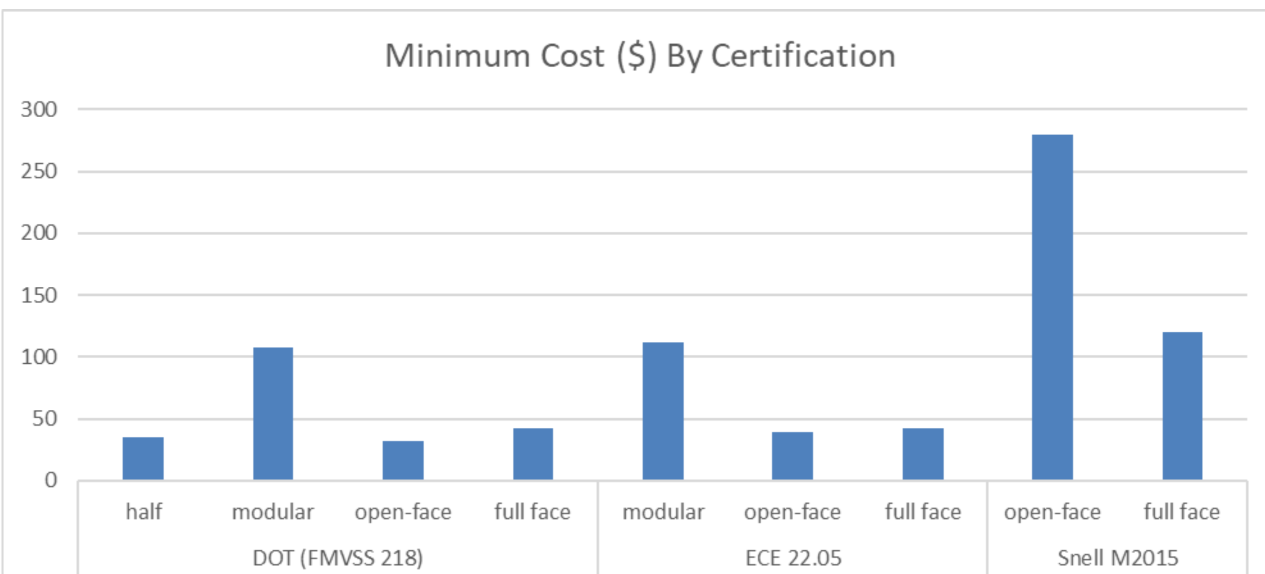

Figure 30. Minimum cost of motorcycle helmets by certification ($)

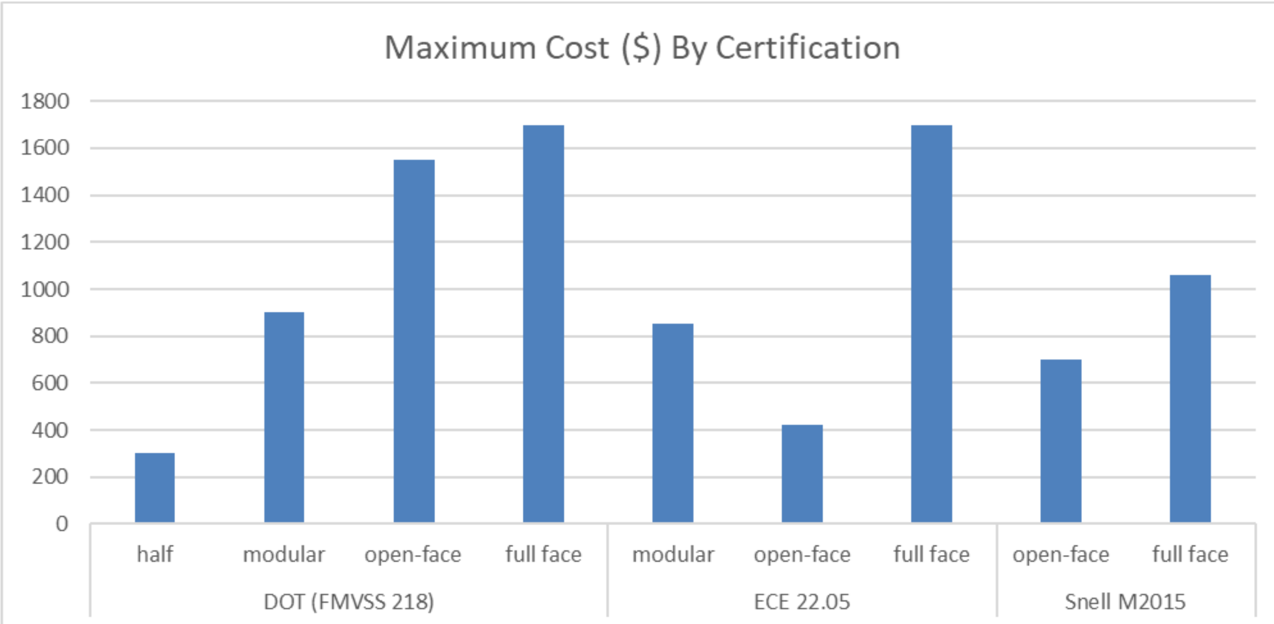

Figure 31. Maximum cost of motorcycle helmets by certification ($)

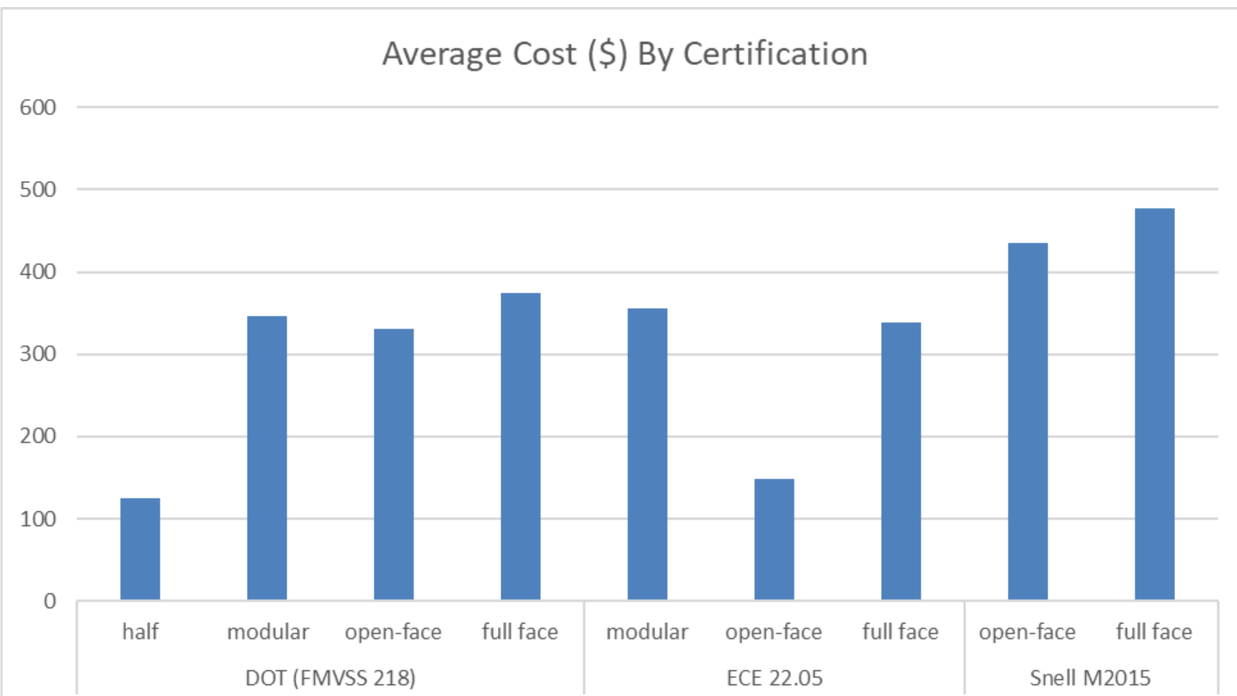

Figure 32. Average cost of motorcycle helmets by certification ($)

Average Weight by Helmets Type

Helmet weight is an important feature of motorcycle helmets because consumers often associate it as being related to comfort. The minimum, maximum, and average weight of each type is shown in Figure 33.

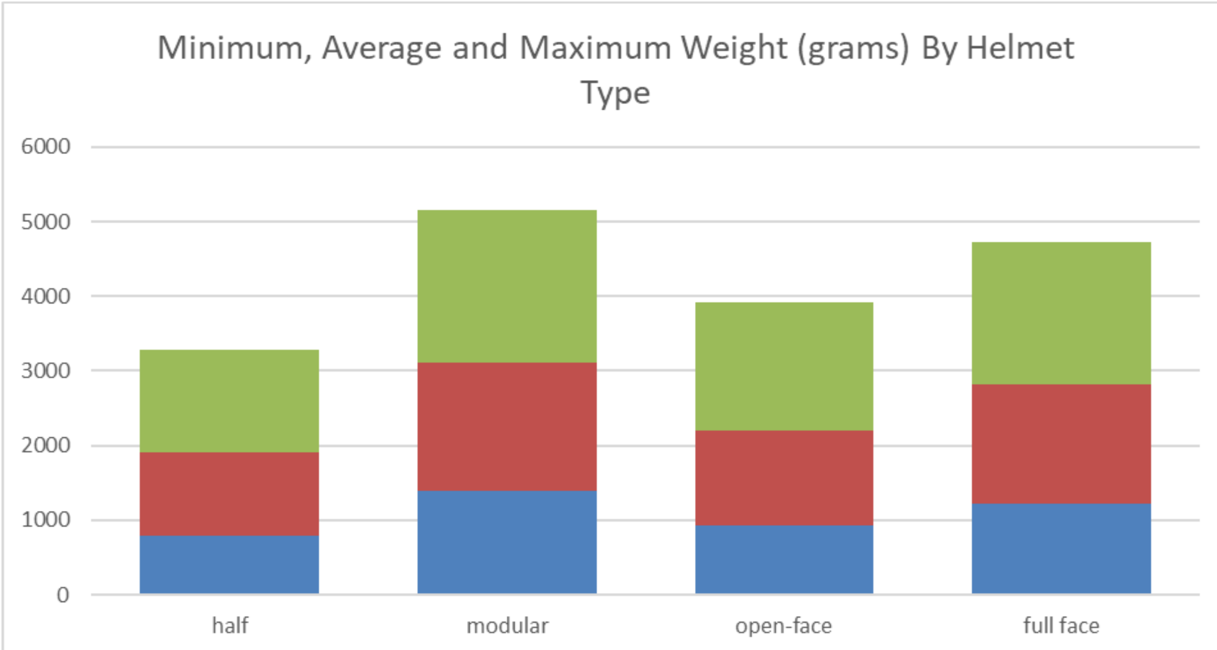

Figure 33. Minimum, maximum, and average of motorcycle helmets weights by type

The research team explored whether there is a correlation between the certifications and the overall helmet weight. In this case, there seems to be little evidence of such correlation, as shown in Figure 34.

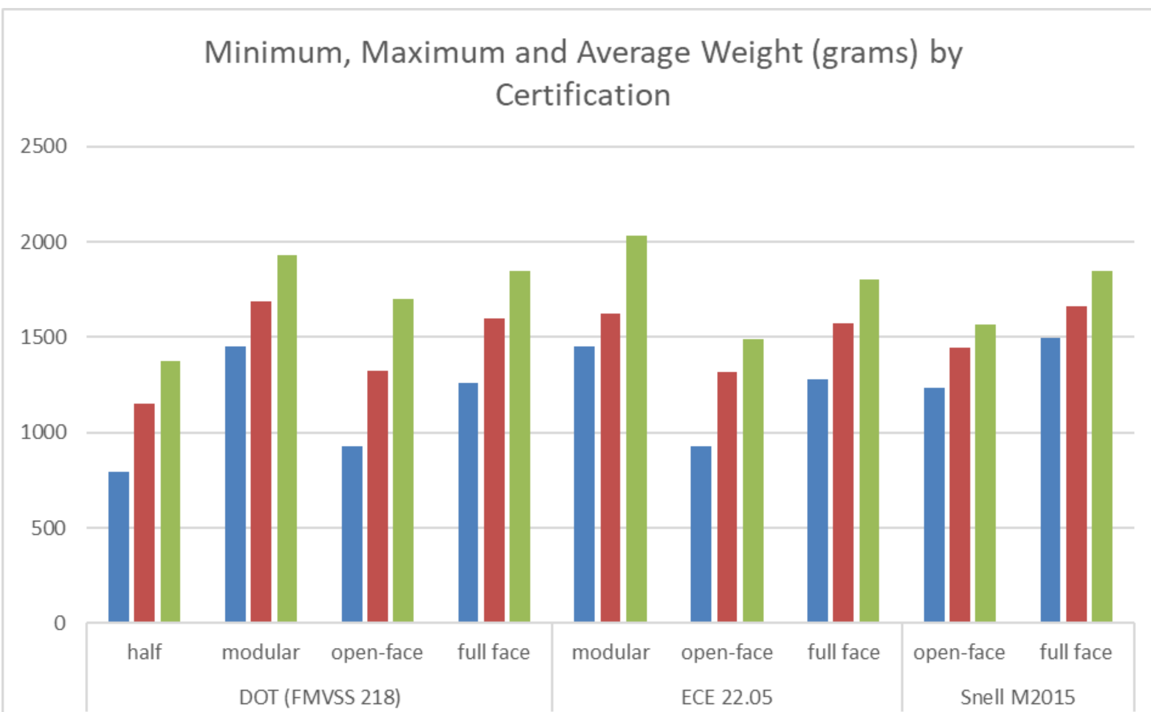

Figure 34. Minimum, maximum, and average of motorcycle helmets weights by certification and type

Additional Findings

The interview process revealed some general concern over the thoroughness of NHTSA compliance testing, which is echoed by some available online commentary. As a result, the research team did some additional analyses outside the strict project objectives using the NHTSA test result database (NHTSA, n.d.). The data obtained, which details failure rates from performance and non-performance tests, generally conflicts with these industry assessments. Therefore, the team suggests further study is warranted to determine how to improve on DOT test reporting.

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Appendix A: List of Limousine Manufacturers

Manufacturer	Business Type	Business location
Accubuilt Inc.	Limousine Manufacturer, Bus/Van Manufacturer	Lima, OH
American Limousine Sales	Dealer, Bus/Van Manufacturer, Limousine Manufacturer	Los Angeles, CA
Atlantic Turtle Top Inc.	Bus/Van Manufacturer, Dealer, Limousine Manufacturer	S. Grafton, MA
AUDI of America LLC	Limousine Manufacturer	Herndon, VA
BMW of North America LLC	Limousine Manufacturer	Woodcliff Lake, NJ
Cadillac Professional Vehicles	Limousine Manufacturer, Vehicle Manufacturer	Detroit, MI
Carat Security Group	Limousine Manufacturer	Fairfield, OH
Chrysler Fleet	Limousine Manufacturer	Auburn Hills, MI
DaBryan Coach Builders	Limousine Manufacturer	Lima, OH
Detroit Custom Coach	Bus/Van Manufacturer, Limousine Manufacturer, Supplier, Vehicle Manufacturer	Oak Park, MI
Empire Coachworks Intl.	Limousine Manufacturer	East Brunswick, NJ
Executive Coach Builders (ECB Limousines)	Limousine Manufacturer, Bus/Van Manufacturer, Vehicle Manufacturer	Springfield, MO
Federal Coach	Bus/Van Manufacturer, Limousine Manufacturer	Goshen, IN
Ford Motor Co. / QVM Limousines	Limousine Manufacturer	Dearborn, MI
Ford Motor Co./Limousine & Livery Vehicles	Limousine Manufacturer	Dearborn, MI
Galaxy Coach Enterprises	Limousine Manufacturer, Bus/Van Manufacturer	Santa Ana, CA
General Motors Corp. - Fleet & Commercial Operations	Limousine Manufacturer, Bus/Van Manufacturer	Detroit, MI
General Motors of Canada Limited	Limousine Manufacturer	Oshawa, ON
Hyundai Motor America	Vehicle Manufacturer, Limousine Manufacturer	Costa Mesa, CA
Imperial Coach Builders	Limousine Manufacturer, Bus/Van Manufacturer	Springfield, MO
LA Custom Coach	Limousine Manufacturer	Fontana, CA
Lakeview Custom Coach	Dealer, Vehicle Manufacturer, Limousine Manufacturer	Oaklyn, NJ
LCW Automotive Corp.	Limousine Manufacturer	San Antonio, TX
Lehmann Peterson	Limousine Manufacturer	Arlington Heights, IL
Limos By Moonlight	Limousine Manufacturer, Bus/Van Manufacturer	Orange, CA
Limousines World	Limousine Manufacturer	San Francisco, CA
Luggage Bellhop	Limousine Manufacturer	Lawndale, CA
Mauck2 LLC	Bus/Van Manufacturer, Limousine Manufacturer	Columbus, OH
Mercedes-Benz USA Fleet Operations	Limousine Manufacturer	Montvale, NJ
Picasso Coach Builders Corp.	Limousine Manufacturer	Rego Park, NY
Pinnacle Limousine Manufacturing	Limousine Manufacturer	Hacienda Heights, CA
PowWow Smart	Limousine Manufacturer	Ft. Lauderdale, FL
Presidential Coachbuilders	Limousine Manufacturer	Jurupa, CA
Quality Coachworks	Limousine Manufacturer, Bus/Van Manufacturer	Ontario, CA
Royal Coachworks Inc.	Dealer, Limousine Manufacturer	St. Louis, MO
Royale Limousine (a Cabot Coach Builders Co.)	Limousine Manufacturer, Bus/Van Manufacturer, Vehicle Manufacturer, Supplier	Haverhill, MA

Manufacturer	Business Type	Business location
Scaletta Armoring	Limousine Manufacturer	Bedford Park, IL
Signature Limo Builders	Limousine Manufacturer, Bus/Van Manufacturer	Henderson, NV
Tiffany Coachworks	Limousine Manufacturer, Bus/Van Manufacturer, Vehicle Manufacturer	Perris, CA
Toyota Motor Sales USA	Limousine Manufacturer	Torrance, CA
Ultimate Custom Coach	Limousine Manufacturer, Bus/Van Manufacturer	Riverside, CA
USA Limousine Sales Inc. (@ Krystal)	Dealer, Limousine Manufacturer, Bus/Van Manufacturer, Supplier	Brea, CA
Vehicle Production Group (VPG)	Vehicle Manufacturer, Limousine Manufacturer	Miami, FL
VMT Enterprises	Dealer, Bus/Van Manufacturer, Limousine Manufacturer	Hallandale Beach, FL
Wolverine Coachbuilders LLC	Limousine Manufacturer	Vassar, MI

Source: Luxury Coach & Transportation. (n.a.). [Title unknown]. Also known as LCT Magazine, a publication that ceased publication in early 2020. Non-working link at http://directory.lctmag.com/companytype/limousine-manufacturer

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