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Motor Carrier Type and Factors Associated with Fatal Bus Crashes

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16. Abstract

In 2000, the Federal Motor Carrier Safety Administration's (FMCSA) regulatory responsibilities were extended to buses with seating for nine or more occupants, including the driver, transported for compensation. FMCSA has also begun supporting data collection on buses involved in fatal crashes, to enhance information on the buses involved and the motor carriers that operate them. In response, the Transportation Safety Analysis Division at the University of Michigan Transportation Research Institute (UMTRI) initiated the Buses Involved in Fatal Accidents (BIFA) project to collect much more detailed information about buses involved in fatal crashes.

The present study focuses on factors associated with fatal bus crashes involving different bus operator types. Five different carrier types are identified: School, transit, intercity, charter/tour, and "other" bus operators. There are substantial differences between these carrier types that are reflected in many aspects of the crashes they are involved in, including when and where the crashes occur, who is injured in them, the configuration of the crash, the previous driving record of the bus drivers, and the frequency of driving errors related to the crash.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	Inches	25.4	millimeters	mm
ft	Feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kpa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
rnL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or “t”)	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	**1.8C + 32**	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

Table of Contents

Tables

Figures

Motor Carrier Type and Factors Associated with Fatal Bus Crashes

Introduction

An estimated 54,000 buses are involved in a traffic accident each year, including about 300 in fatal crashes, 12,000 in crashes involving injury, and 42,000 in crashes with only property damage.[1] While the number of buses in crashes is small in relation to other vehicle types (429,000 trucks, 3.9 million light trucks, and 6.7 million passenger cars annually), there has been an increased focus on the safety of bus operations recently. In 2000, the Federal Motor Carrier Safety Administration's (FMCSA) regulatory responsibilities were extended to buses with seating for nine or more occupants, including the driver, transported for compensation. FMCSA has also begun supporting data collection on buses involved in fatal crashes, to enhance information on the buses involved and the motor carriers that operate them.

In 2000, the Transportation Safety Analysis Division at the University of Michigan Transportation Research Institute (UMTRI) initiated a survey called the Buses Involved in Fatal Accidents (BIFA) project. This crash data collection, supported by FMCSA, supplements the standard data collected on all fatal crashes by the National Highway Traffic Safety Administration. But since BIFA focuses on buses alone, it can provide a much more detailed description of each bus involved in a fatal crash and the carrier that operated it.

The BIFA survey is necessary because the identification of buses and bus operators in nationally-representative crash data files has been relatively simple or lacking altogether. Up until recently, the main national file on fatal crashes, the Fatality Analysis Reporting System (FARS) file, has only distinguished "school," "cross-country/intercity," "transit," and "other" bus types. Moreover, common terminology for buses mixes physical characteristics with how they are operated. "School bus" connotes an identifiable bus type, but school buses often are converted to other uses. "Cross country" buses can be used for personal use, by scheduled intercity carriers, or as charter/tour buses. In fact, both the vehicles used as buses and the entities that operate them are very diverse, including, in addition to the usual types, hospitals and nursing homes, non-profit organizations and churches, shuttle services and private companies. The BIFA survey was

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[1] *Traffic Safety Facts, 2001.* National Highway Traffic Safety Administration, National Center for Statistics and Analysis, U.S. Department of Transportation, Washington DC 20590. December 2002.

designed to capture this diversity, and by increasing the resolution of bus identification, improve our understanding of the different safety issues in the bus industry.

This study focuses on factors associated with fatal bus crashes involving different bus operator types. Five different carrier types are identified: School, transit, intercity, charter/tour, and "other" bus operators. There are substantial differences between these carrier types that are reflected in many aspects of the crashes they are involved in, including when and where the crashes occur, who is injured in them, the configuration of the crash, the previous driving record of the bus drivers, and the frequency of driving errors related to the crash. These differences point up the fact that in discussing bus "safety" it is necessary to distinguish among the segments of the passenger transportation industry.

Data

The first year of the Buses Involved in Fatal Accidents (BIFA) survey is used here. Modeled on UMTRI's Trucks Involved in Fatal Accidents (TIFA) program, the BIFA survey collects detailed information on all buses involved in all fatal traffic crashes. For the purpose of the survey, a bus is defined as a vehicle with seating for nine or more occupants, including the driver, transported for compensation[2] or for 15 or more passengers, regardless of compensation. The data are from 1999. BIFA draws its cases from the FARS file, supplementing FARS data with a detailed description of the bus, the bus operator, type of trip, driver hours driving, type of driver compensation, and role of the bus in the crash.

Throughout we classify buses by the type of "carrier" operating them. Carrier here is determined by the type of operations. Thus, if a bus is used to transport pupils, it is classified as a school bus. If a "school bus" is used by a private company to transport employees, it is classified as a private company bus. However, the physical configuration of most school, transit, intercity, and charter buses corresponded to the expected type for each. The five carrier types distinguished here are defined as follows:

School—Any public or private school or district, or contracted carrier operation on behalf of the entity, providing transportation for K-12 pupils.

Transit—An entity providing passenger transportation over fixed, scheduled routes, within primarily urban geographical areas.

Intercity—A company providing for-hire, long-distance passenger transportation between cities over fixed routes with regular schedules.

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[2] "Compensation" includes transportation incidental to the provision of other services, such as a whitewater rafting company transporting customers to the launch point, as well as a fare for a specific trip.

Charter—A company providing transportation on a for-hire basis, usually round-trip service for a tour group or outing. The transportation can be for a specific event or as part of a regularly-scheduled tour.

Other—All bus operations not included in the previous categories. Includes private companies providing transportation to their own employees, non-governmental organizations such as churches or non-profit groups, non-educational units of government such as departments of corrections, and private individuals.

Only one year of the BIFA survey is currently available. Because of the number of cases available, many of the relationships identified here are suggestive rather than conclusive. Nevertheless, even with relatively small sample sizes, many of the most important relationships identified are statistically significant. As more years of the BIFA survey are added, trends and relationships suggested here will be evaluated further.

Results

Table 1 shows the distribution of buses involved in fatal crashes in 1999 by operator type. The most common operation type is transporting K-12 students to and from school. Almost 44% of fatal involvements in 1999 were accounted for by school buses. Urban transit buses are the second most common with over 30%. Intercity and charter/tour bus operators run large motor coaches designed for highway travel, and together they account for about 15% of fatal bus involvements, with charter buses accounting for 10.5% of involvements and scheduled intercity for 3.9%. Company buses, non-profits, buses operated by government agencies, hospitals, and medical service agencies accounted for the remaining buses.

Table 1 Buses involved in fatal crashes by operator type, BIFA 1999

Bus type	N	%
School	146	43.8
Transit	104	31.2
Intercity	13	3.9
Charter	35	10.5
Private company	5	1.5
Non-profit organization	7	2.1
Government	2	0.6
Personal	1	0.3
Other	7	2.1
Unknown	13	3.9
Total	333	100.0

The distribution of fatalities can usefully serve to illustrate the differences between different operators of buses. shows the distribution of fatally-injured persons in bus crashes, by the type

of bus involved in the crash. The table also identifies the person type of each fatality for each carrier type. (Only percentages are shown in the table to minimize the number of columns. The subtotal rows show the proportion of bus, other vehicle, and non-motorist fatalities for each bus type. The number of cases for each bus type is shown in the bottom row.)

Table 2 Distribution of Fatalities by Bus Carrier Type and Person Type, BIFA 1999

	School	Transit	Intercity	Charter	Other	Unk.	Total
Bus							
Driver	3.6	1.9	6.7	8.2	5.9	14.3	4.6
Passenger	1.8	0.9	6.7	45.9	35.3	7.1	11.6
Bus subtotal	5.5	2.8	13.3	54.1	41.2	21.4	16.2
Other vehicle							
Drivers	58.8	40.7	46.7	23.0	29.4	28.6	44.3
Passengers	20.6	11.1	33.3	11.5	14.7	7.1	15.9
Other vehicle subtotal	79.4	51.9	80.0	34.4	44.1	35.7	60.3
Non-motorists							
In parked vehicle	0.0	1.9	0.0	0.0	0.0	0.0	0.5
Pedestrian	13.3	38.9	6.7	11.5	11.8	42.9	20.8
Bicyclist	1.8	4.6	0.0	0.0	2.9	0.0	2.3
Non-motorist subtotal	15.2	45.4	6.7	11.5	14.7	42.9	23.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total fatalities	*165*	*108*	*15*	*61*	*34*	*14*	*395*

A total of 395 persons were killed in traffic crashes involving buses in 1999. The number of fatalities is highly correlated with the number of buses involved, so crashes involving school buses accounted for the greatest number, followed by transit buses and charter buses. For most bus types, only a small proportion of the fatal injuries are to occupants of the bus. (It should be noted that the total for charter buses is inflated by one tragic crash in which 22 occupants of a charter bus were killed.) One might expect a high proportion of pedestrian fatalities in school bus involvements, given that passengers are frequently boarding, getting off, and moving around the buses. But in fact, pedestrians and bicyclists only account for 15.2% of fatalities in school bus crashes, far less than the 45.4% in crashes involving transit buses. Instead, almost 80% of the fatalities in school bus crashes are occupants of other vehicles in the crash, indicating that the predominant crash type for school buses is a collision with another vehicle.

Over half the fatalities in transit bus crashes are to occupants of other motor vehicles, but pedestrians and bicyclists account for almost an equal proportion of fatalities. Over-the-road buses (intercity and charter) have a somewhat higher proportion of in-vehicle fatalities (though the charter bus category is exaggerated by a single crash with a very large loss of life), but 80% of fatalities in crashes with intercity buses are to occupants of other vehicles in the crash, and the proportion of pedestrian/bicyclist fatalities is low at 6.7%. On the other hand, non-motorists account for 11.5% of charter bus fatalities, a proportion that would be higher but for a single

anomalous crash. While scheduled intercity buses operate primarily on high-speed roads point-to-point, charter buses by the nature of the operation also add travel in and around various tourist attractions. Operational differences are reflected in who gets hurt in these crashes.

Distributions across months, day of week, and hour of the day also clearly separate the bus operator types distinguished here. Fatal traffic crashes involving school buses occur primarily between September and May, following the school year. Transit bus fatal involvements are more evenly distributed over the year, with only one month (February) accounting for more than 12% of the involvements, though with a marked decline in the summer months when school is out and some people take vacations. In Figure 1, intercity and charter/tour bus involvements are combined. The curve shows a peak in the fall, with November accounting for over 18% of the total.

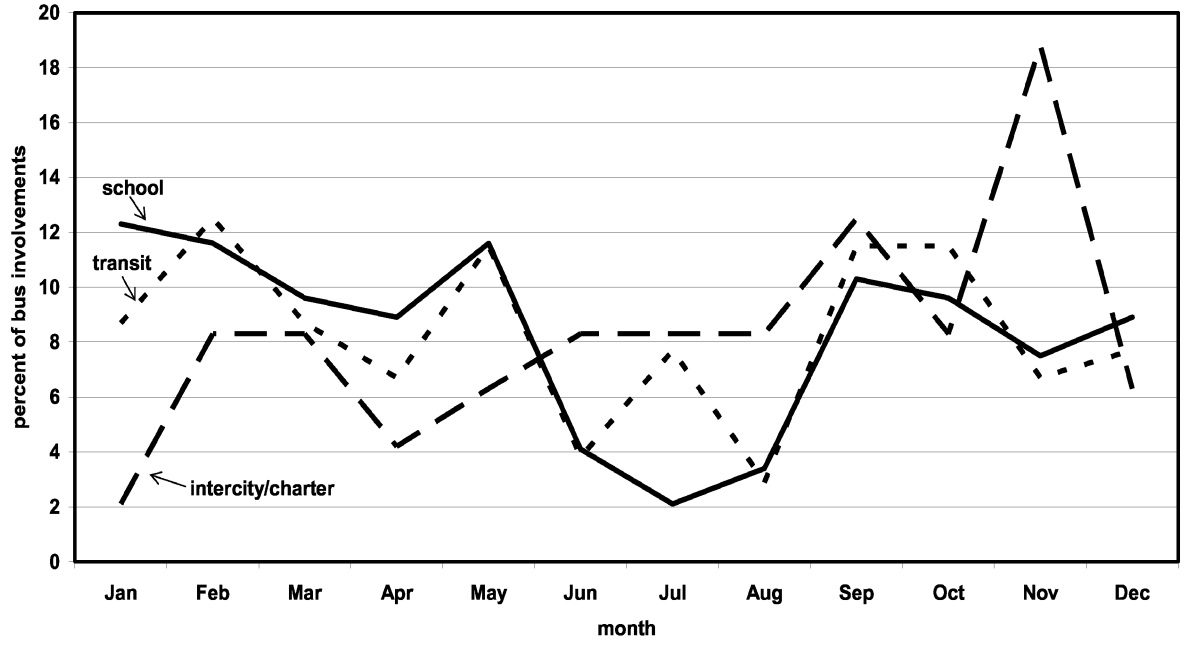

Figure 1 Bus Involvements in Fatal Crashes by Operator Type and Month, BIFA 1999

Across the week, school bus involvements occur almost entirely Monday through Friday, with only 2.8% on the weekend. In contrast, transit bus involvements are relatively evenly distributed across the week. Almost 25% of transit bus fatal involvements are on the weekend, because transit buses operate throughout the week. There were only 13 scheduled intercity buses involved in a fatal traffic accident in 1999, so the weekly distribution is probably not meaningful, but it should be noted that only 7.7% occurred on a weekend. In contrast, almost one-third of charter bus crashes occurred on the weekend, probably because much of their travel is related to leisure activities.

Figure 2 shows the distribution of bus involvements in fatal traffic crashes by time of day. Again the different operator types clearly show different patterns of occurrence. School bus

involvements peak around the times school begins and ends. Transit bus involvements are more evenly distributed across the 24 hours, with peaks in the morning and afternoon rush hours, and a lesser peak around noon. Intercity and charter bus involvements are again combined because of the small number of cases, but show relatively evenly distributed involvements, reflecting significant travel at all hours.

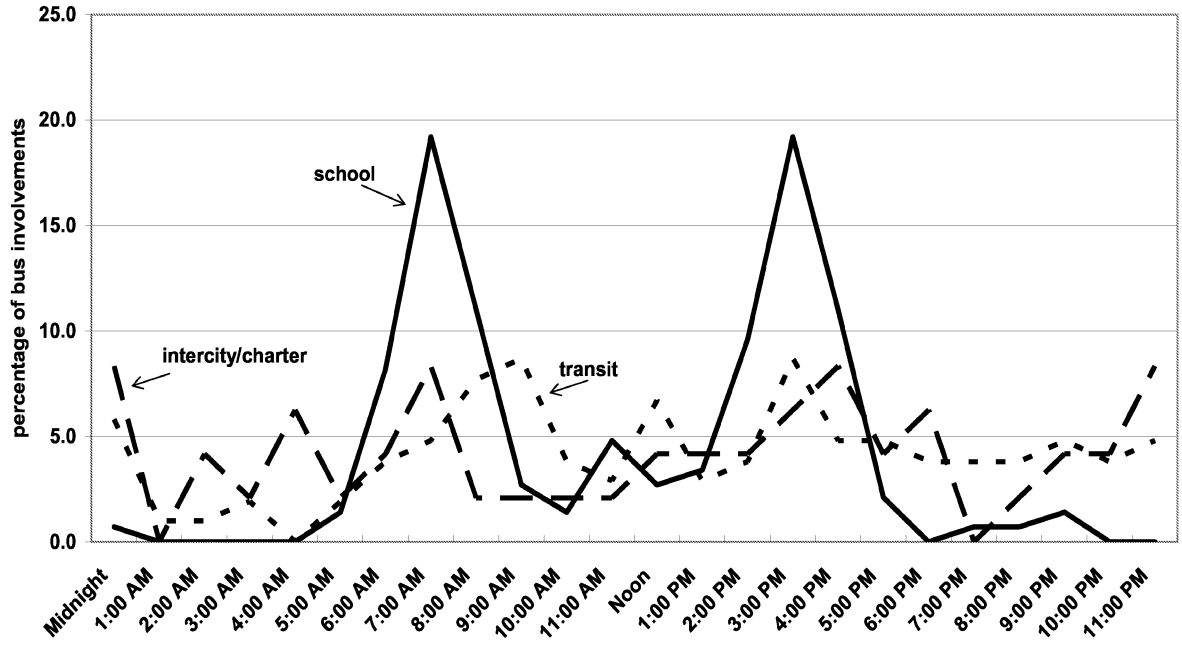

Figure 2 Bus Involvements in Fatal Crashes by Operator Type and Time of Day, BIFA 1999

The type of roads and where on the roads the crashes occur also differ significantly among the carrier types. These differences reflect differences in where and how the buses are operated and thus the risks to which they are exposed. About 40% of school bus fatal crash involvements occur in urban areas, and almost all of those on either large arterial roads or local streets, not freeways. About 60% of school bus crashes are in rural areas, and again, the crashes occur on arterial and local roads as the buses move through residential areas to pick up or drop off students. In contrast, over 90% of the fatal traffic crashes of transit buses happen on urban roads, and almost 8% on urban Interstates or freeways. Urban arterial roads account for almost 60% of the involvements.

The crash involvements of intercity and charter buses also reflect their usage, but differences between those carrier types probably also reflect contrasting modes of operation. Almost 70% of crashes involving intercity buses are in rural areas, with almost all of those on Interstate or freeways or other major, divided roads. Similarly, in urban areas the crashes of scheduled intercity occurred on major divided highways such as Interstates, expressways, or other principal arterial roads. Charter/tour bus fatal crashes also occurred primarily on Interstate or expressway-type roads, but a somewhat higher proportion occurred on local roads and streets. Rural areas accounted for about half of charter/tour bus fatal crashes.

There are also interesting differences in where on the road the crashes occurred. About half of school bus involvements were at or near intersections. The proportions were almost identical for transit buses. In contrast, over 90% of scheduled intercity bus fatal crashes were not related to intersections, but occurred on the open road. About two-thirds of charter bus involvements happened away from intersections, and the remaining third were intersection-related. Sample sizes for the scheduled intercity category are low, so these results are merely suggestive for that type.

The types of crashes also vary by bus operator type, reflecting differences in operations. Almost 20% of school bus fatal involvements are single-vehicle, but that proportion is actually lower than the overall percentage for all fatal bus crashes. (See Table 3.) Virtually all of these are collisions with pedestrians or bicyclists. Rear-end crashes account for about 15% of their involvements, and in almost all, the school bus is struck in the rear. Over 40% of transit bus crashes are single vehicle, and again almost all of these are pedestrian/bicyclist collisions. Transit buses have about the same proportion of rear-end crashes as school buses, and like school bus crashes, the bus was the struck in the rear in almost all their rear-end crashes, rather than striking the other vehicle in the rear. Intercity and charter bus crashes show strikingly different patterns, but patterns that are consistent with different usages shown in the road type results reported above. Almost 40% of scheduled intercity crashes are head-on collisions. (Note that all occurred in the bus's lane, rather than the bus crossing the centerline into the other vehicle.) Relatively few are single vehicle crashes, with more ran-off road types than collisions with pedestrians. Charter buses have about the same proportion of single-vehicle, hit object (typically a pedestrian), as school buses, but a higher proportion of ran-off road crashes. And while the proportion of rear-end crashes among charter buses is only somewhat higher than school or transit buses, charter buses are more likely to be the striking vehicle than the struck vehicle.

Table 3 Crash Type by Bus Operator Type, BIFA 1999

Accident type	School	Transit	Intercity	Charter	Other	Unknown	Total
Single vehicle							
Ran off road	1.4	0.0	15.4	14.3	9.1	0.0	3.3
Hit object in road	17.1	43.3	7.7	20.0	27.3	46.2	27.0
Same direction, same trafficway							
Rear-end, bus striking	1.4	1.9	7.7	11.4	0.0	0.0	2.7
Rear-end, bus struck	13.7	15.4	7.7	8.6	9.1	0.0	12.6
Sideswipe, in other's lane	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sideswipe, in bus's lane	0.0	1.0	0.0	0.0	0.0	0.0	0.3
Opposite direction, same trafficway							
Head-on, in other's lane	0.0	0.0	0.0	2.9	0.0	0.0	0.3
Head-on, in bus's lane	22.6	8.7	38.5	11.4	13.6	0.0	16.2
Sideswipe, in other's lane	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sideswipe, in bus's lane	3.4	1.0	0.0	0.0	9.1	7.7	2.7
Change trafficway, one vehicle turning							
Bus turn across path	9.6	3.8	7.7	0.0	4.5	0.0	6.0
Other turn across path	6.2	1.0	7.7	2.9	0.0	0.0	3.6
Intersecting paths, both going straight							
Bus into side of other	8.2	9.6	0.0	8.6	4.5	0.0	7.8
Other into side of bus	4.8	3.8	0.0	0.0	0.0	0.0	3.3
Other accident types							
Other	9.6	8.7	7.7	17.1	22.7	23.1	11.4
Unknown	2.1	1.9	0.0	2.9	0.0	23.1	2.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N =	146	104	13	35	22	13	333

Certain crash types can indicate driver error or driver contribution to the crash. In rear-end crashes, the error leading to the crash is much more likely to have occurred in the striking vehicle than in the struck. Similarly, in head-on crashes, the vehicle crossing the centerline line is much more often “at-fault” in the crash than the other vehicle. Other crash types are not so clear-cut in the absence of information on right-of-way. Currently there is not sufficient sample size to do more than note some suggestive differences between the carrier types.

However, the BIFA file includes information on driver errors and the previous driving record of the drivers, which show significant differences among the carrier types.

Table 4 shows driver errors and other “driver-related factors” coded for the drivers of the different bus carrier types. These driver-related factors are coded by FARS analysts when compiling the FARS file, which the BIFA survey supplements. The driver-related factors variables (up to four may be coded) are used to record driving errors and other driver actions or conditions that may have contributed to the crash. In the table, we have classified the factors as either “driver errors,” which are actions or omissions by the driver that in the FARS’ analysts judgment contributed to the crash, and “other factors,” which are typically conditions or events

present that may have contributed to the crash. The primary driver errors coded are "failure to yield," "excessive speed," and "ran off the road." "Fatigue" was coded for only three of the 333 bus involvements, and "inattention" for twelve. (Fatigue and inattention tend to be underreported, since, unlike alcohol or drug use, they are difficult to identify after the fact.) Typical other factors coded include vision obstructed by inclement weather or parts of the vehicle, and swerving to avoid a vehicle in the road.

Table 4 Driver Error and Other Driver-Related Factors by Carrier Type, BIFA 1999

	School	Transit	Intercity	Charter	Other	Unknown	Total
None	74.7	74.0	61.5	51.4*	68.2	61.5	70.6
Driver error	18.5	17.3	38.5	45.7*	31.8	23.1	22.8
Other factor coded	6.2	8.7	7.7	17.1*	13.6	15.4	9.0
Any factor coded	25.3	26.0	38.5	48.6*	31.8	38.5	29.4
N =	146	104	13	35	22	13	333

* Statistically different from school bus proportions at 0.05 level.

School buses were taken as the baseline case, to which the other carrier types were compared because they had the smallest proportion of factors coded and because of the relatively large sample of school bus fatal involvements. (Up to four driver-related factors may be coded, so the proportions do not sum to the "any factor coded" cell because both a driving error and another factor can be coded for the same driver.) Statistical tests were performed to determine the reliability of the differences, given sample sizes, at the 0.05 level.

The results were very similar for both school and transit bus drivers. A driver error was coded for 18.5% of school bus drivers, and another related factor was coded for 6.2%. For transit bus drivers, the proportions were 17.3% and 8.7%. In contrast, both scheduled intercity and charter/tour bus drivers had higher proportions of driver errors coded; charter/tour bus drivers also had a higher proportion of other factors coded. None of the differences were statistically significant at the 0.05 level for scheduled intercity drivers because of small sample sizes, but all of the differences were statistically significant for charter bus drivers. Over 45% of charter bus drivers were coded with a driving error in these crashes, compared with only 18.5% of school bus drivers and 22.8% overall. Over 17% were coded with another driving-related factor. Even though the number of cases is relatively small, the differences are large enough to be reliable.

There are also significant differences by carrier type with respect to the previous driving record of the drivers. Table 5 shows the incidence in the three years prior to the crash of accidents, suspensions, DWI convictions, speeding, and other moving violations. We have included the records of passenger car and truck drivers involved in fatal crashes for comparison. As with driver errors, school bus drivers were defined as the baseline case for other bus drivers, and statistical tests were performed to determine the reliability of the differences. The proportions for car and truck drivers are compared with the proportions for all bus drivers.

Table 5 Previous Driving History for Bus Drivers by Carrier Type, BIFA 1999, TIFA 1999, FARS 1999

Driver history	School	Transit	Inter-city	Charter	Other	All buses	Cars	Trucks
Accidents	17.8	28.3	20.0	34.4*	25.0	24.0	14.9**	18.9**
Suspensions	2.1	5.0	0.0	12.1*	19.1*	5.2	12.3**	8.7**
DWI	0.0	3.0*	0.0	0.0	0.0	0.9	3.2**	1.0
Speeding	11.1	14.9	15.4	21.2	14.3	14.2	19.5**	29.0**
Other moving violations	10.4	18.8	23.1	27.3*	38.1*	17.2	16.4	26.1**
All violations	19.4	33.7*	38.5	36.4*	47.6*	29.2	34.5**	46.1**
Violation or accident	33.6	47.5*	63.6	54.6*	61.9*	44.3	41.9	54.6**
N*** =	135	99	11	32	20	308	32,472	4,765

* Statistically different from school bus proportions at 0.05 level.

** Statistically different from all bus proportions at 0.05 level.

*** N shown is the smallest number of cases with complete data for any item. Significance tests were calculated using the number of cases with complete data for each item.

The previous driving record of school bus drivers shows the lowest incidence of previous accidents, suspensions (except scheduled intercity), speeding violations and other moving violations, when compared to other drivers for other bus operator types. But only some of the differences are statistically significant in these data. Three percent of transit drivers had a previous DWI conviction in the prior three years. Transit bus drivers also had higher proportions of previous accidents, speeding and other moving violations. These differences are not statistically significant taken separately, but when combined, to measure any previous moving violation or any violation or accident, transit bus drivers had significantly worse driving records than school bus drivers.

Scheduled intercity bus drivers also had driving records with higher proportions of violations or either a violation or a crash, but the sample size for intercity drivers is not large enough to attain statistical significance currently. However, charter/tour bus drivers had higher proportions on each measure except for DWI, and the differences were statistically significant at the 0.05 level for each measure except speeding convictions. Over one-third of charter bus drivers had a previous crash compared with 17.8% of school bus drivers. Over 12% of charter bus drivers had been suspended in the previous three years, compared with only 2.1% of school bus drivers. And 36.4% of charter bus drivers had some moving violation in recent years, compared with 19.4% for the baseline.

It was hypothesized that previous driving records are related to driver errors in the crash, as coded in the driver-related factors variables. The hypothesis would be that drivers with poor driving records would be more likely to commit driving errors in the present crash. However, no such relationship could be detected in these data. There was a weak association between other related factors in the current crash and any previous violation, but no other association was found.

Discussion

Motor carrier type has significant effect on virtually all aspects of the experience of buses in fatal traffic accidents. The four primary carrier types defined here—school, transit, scheduled intercity, and charter/tour—differed significantly in every dimension examined. These differences were reflected in the time of the crashes, the area and roads on which the crashes occurred, and even who in the crash is at greatest risk of fatal injury.

Fatal crashes involving school buses occur during the school year and work week, with peaks in the morning and afternoon. Most of the crashes occur on local roads and streets, as the students are picked up or dropped off. Though one might expect a higher proportion of pedestrian involvements, since children are moving around the bus as they board or egress, the pedestrian fatalities were actually less likely, compared with transit or other bus types. The most frequent crash type was a rear-end crash, in which the bus was struck by another vehicle. Almost 80% of fatalities occurred in other vehicles striking the bus.

The fatal involvements of transit buses are more evenly distributed around the year and across the week, though numbers are lower in the summer months than in the rest of the year. Almost 25% of transit bus crashes occur on the weekend, and while the daily pattern shows increases at the morning and evening rush hours, there are substantial numbers of transit bus fatal involvements up to midnight. Most transit bus fatal involvements occur in urban areas, as would be expected, and on primary arterial roads. Over 45% of the fatalities in transit bus crashes are non-motorists, either pedestrians or bicyclists, and about 52% occur to occupants of other vehicles. Collisions with pedestrians or bicyclists is the largest crash type for transit buses; and in rear-end crashes, most occur with the other vehicle striking the bus while stopped.

Scheduled intercity buses and charter buses have some similarities because both are operated more often on high-speed roads on a long-haul trip, but there are significant differences. The crashes of intercity buses most often occur on Interstate or expressway-type roads in rural areas. Charter bus crashes also occur primarily on high-speed roads; however, a higher proportion of charter bus than intercity bus crashes occur on local roads or in urban areas. The most common crash type for intercity buses was the head-on collision, occurring in every case in the bus's lane. Charter buses had higher proportions of single-vehicle crashes, including collisions with pedestrians or bicyclists. Rear-end crashes were proportionally of about the same magnitude as school bus and transit bus crashes, but in sharp contrast with those bus types, intercity and charter buses were about as likely to be the striking vehicle in rear-end crashes as they were to be struck. Small sample sizes, particularly for intercity buses, limit conclusions, but additional years of data may validate these relationships.

In terms of previous driver record and driver errors in the crash, significant differences were also found among the carrier types examined. Some of these differences were great enough to be

statistically significant, even given the limited data available. School bus drivers had the best driving record and were coded with the fewest driving errors in the crash, compared with the other bus carrier types. Both intercity and charter/tour bus drivers had much higher proportions than school bus drivers on most of the measures. Statistical significance could not be established for intercity drivers because there were only thirteen cases for 1999, but the differences for charter bus drivers were both large and statistically significant. Almost 55% of charter bus drivers had a conviction, suspension, or crash in the three years previous to the crash, compared with only about one-third of school bus drivers. And fully 45.7% of charter bus drivers were coded with a driving error in the current crash, compared with only 18.5% of school bus drivers.

The differences uncovered in this analysis have implications for safety improvements and validate the approach taken in the BIFA survey. Motor carrier type plays a major role in fatal bus crash involvements and, even at the exploratory level undertaken in this study, point to quite different safety interventions, depending on the operation type. Pedestrian/bicyclist crashes are of course a problem for school buses and improved driver vision around the bus remains an issue. But the high proportion of rear-end crashes in which the bus is struck suggests that conspicuity and awareness that the bus is stopped is also a target. Driver vision around the bus is clearly a major issue for transit bus drivers, given the very high proportion of pedestrian/bicyclist collisions.

Driver issues are more of a focus for intercity and charter/tour bus operations, although the very small sample size for intercity involvements make any conclusion very tentative. But charter/tour bus operators have a significantly higher proportion of poor driving records and driving errors in the current crash.

Finally, this analysis has clearly shown that bus operation type must be accounted for in any bus safety analysis. Significant differences were found among the different types of bus operations, whether the characteristic examined was related to time, road type, area of operation, crash configuration, driver action, or driver record. These differences validate the approach taken in the BIFA survey, which is to separate bus body type from how the bus is operated and to provide a detailed description of the bus operator. Only some of the details available in the BIFA data set have been displayed here. Not all of the differences discussed here have been validated statistically, but as more years of the BIFA survey are accumulated, further testing can be undertaken. It is likely that the BIFA survey data, supplementing FARS and supported by the FMCSA, will prove to be a valuable resource in the future in studying bus safety issues.