ASSESSING THE RELATIVE RISKS OF SCHOOL TRAVEL IN RURAL COMMUNITIES

FINAL PROJECT REPORT

by

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for

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16. Abstract

This study examined school travel safety and risk and explored the potential differences between conditions that are present today with those that existed nearly two decades ago, when the Transportation Research Board published its landmark study on school travel safety. For this study, thirty transportation professionals were interviewed and a twenty-year crash data set from the Fatality Analysis Reporting System (FARS) was analyzed.

The responses from the interviews were separated into ten common themes. The three most mentioned themes were education programs, concerns of roadway environments, and school bus safety. Based on the responses, concerns about the roadway environment, poor driver behavior, and the role of parents on mode choice have not changed in the last twenty years; however, safety education programs, vehicle centric travel, community planning, and pick up/drop off safety have evolved over time.

With regard to the FARS data set, which was used as a benchmark to assess school transportation safety, the overall trends indicate that the trip to and from school remains a relatively safe activity, particularly along rural facilities where positive results were identified across four key metrics. Along urban facilities, slightly increasing trends were observed in the annual number of fatalities and in the number of non-motorists involved in a fatal crash, suggesting that opportunities remain to enhance and to improve the travel environment for school children.

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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 yard	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 degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°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		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	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 degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°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.
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EXECUTIVE SUMMARY

The daily trip to and from school represents an important and necessary travel activity for millions of children across the United States. Depending on several factors such as proximity from home, parent or guardian preference, and availability of travel mode options, school children may walk, bicycle, ride in a personal vehicle, travel in a yellow school bus, or use some form of public transportation. These travel decisions are also influenced by safety or perceived safety concerns.

In this study, thirty transportation professionals were interviewed and a twenty-year crash data set from the Fatality Analysis Reporting System (FARS) was analyzed. The interview questions were written to examine how topic experts in school transportation viewed school travel safety and risk today and how those perceptions may have differed from twenty years ago. The questions included topics ranging from school travel mode trends to future needs. The participants were also given the opportunity to ask questions about the study at the end of the interview. The interviews were conducted and recorded through the Zoom teleconferencing software program. Transcripts were created by Zoom using the live-transcript function. Each transcript was then manually checked and edited by listening to the recording afterwards to correct for any misspelling, grammar, and punctuation mistakes made by the program. A total of 11.8 interview hours were ultimately collected as part of this study.

After the transcripts were manually corrected for errors, these qualitative response data were imported into a research application called Dedoose. This program takes different types of media sources as data and performs a study-specific analysis. Before importing the transcripts into Dedoose, the title and field for each of the 30 participants had to be defined in the program. The set of transcripts was then analyzed for common ideas and then manually consolidated into ten carefully considered themes. These ten themes were coded into Dedoose to organize the responses for analysis. The ten common themes ranged from concerns of the roadway environment and pick up and drop off safety to the role of parents and poor driver behavior, from better data collection and school bus technology to school travel demand and community planning. The distance / time spent of school buses and education programs were also themes that were identified. For this study, the three themes mentioned the most frequently were education programs, roadway environment concerns, and school bus technology.

In order to measure school transportation safety trends using this prescribed framework, data from the Fatality Analysis Reporting System (FARS) were analyzed from 2000 to 2019. FARS provides users with annual fatal injury data from motor vehicle traffic crashes (NHTSA, n.d.; NCSA, 2017; NCSA, 2021). Using the data set from each calendar year, the six sources that were pertinent to this study included the ACCIDENT (crash), VEHICLE (motor vehicle and driver), PERSON (motorist and non-motorist), PBTYPE (pedestrian and bicycle), VIOLATN (violation) and NMPRIOR (non-motorist activity) data files.

From the ACCIDENT data file, four specific metrics were selected and tallied for reporting purposes. For this study, the fatality (FATALS), person (PERSONS), pedestrian (PEDS) and school bus (SCH_BUS) attributes were analyzed and the results from 2000 to 2019 were determined. The fatality attribute identifies the number of lives lost in a crash. The person attribute is the count of motor vehicle occupants involved. The pedestrian attribute is the total number of persons not in a motor vehicle that were applicable to a particular crash. The school bus attribute captured the total number of school buses involved in a crash.

Based on the cumulative results, trendlines for each data set were calculated. School transportation-related crashes on rural facilities trended favorably across all four metrics, with the number of persons involved declining by an average annual percentage of 2.82% and the number of school buses involved declining by an average annual percentage of 2.11%.

School transportation-related crashes on urban facilities presented a less favorable outcome in two categories. While the number of people and school buses involved in a fatal crash annually declined over the twenty-year review period by 0.35% and 0.52%, respectively, the total number of fatalities and the number of non-motorists involved in a fatal crash trended upward, resulting in annual increases of 1.26% and 3.61%, respectively.

While school transportation remains a relatively safe travel activity overall for the millions of students who make at least two daily trips each school day, school children, parents, transportation operators, school teachers and administrators, and community members must remain vigilant. As land availability and costs push schools further away from established neighborhoods, the trip to school for the next generation of boys and girls will present new transportation safety challenges. The results from this study will help guide the transportation decision-making process moving forward, while recognizing that present-day opportunities still remain to protect our nation's elementary, middle and high school students during their trip to and from school.

CHAPTER 1. INTRODUCTION

In 2002, the Transportation Research Board published a report on school travel safety called *The Relative Risks of School Travel (Special Report 269).* The report contained travel information data which were used to estimate the number of trips taken and miles traveled by school aged-children for all modes and provided a nationally stratified sample of police-reported traffic crashes that occurred on public roadways. Additionally, a review of available data and information on injuries, fatalities, exposure, operational factors, vehicle design, operator training, and other factors relevant to school travel was provided in this report. Based on this data, it was determined that approximately 800 school-aged children were killed in motor vehicle crashes during normal school travel hours each year (TRB, 2002). This represented 14% of the child deaths that occurred annually on domestic roadways and about 2% of these deaths were school bus related (TRB, 2002). The risk management of school travel is complex and has many variables that influence safety including vehicle design and equipment, daily operations, infrastructure and environmental factors, and societal issues. In some cases, parents and students alike will prioritize convenience, flexibility, and cost over maximizing safety.

The purposes of this research study were to explore school travel risk in all modes and determine how things like travel safety, risk, behavior, and needs have changed, or have not changed, in the last two decades since the release of Special Report 269. To achieve these purposes, 1) thirty experts in the field of school transportation were interviewed and 2) crash data from the Fatality Analysis Reporting System (FARS) were analyzed for school travel-related fatalities and school bus injuries and fatalities. This data also compared trends between urban and rural areas. It should be noted that FARS does not necessarily account for non-vehicle modes which represent the active modes of travel to and from school and are also important areas of study.

A literature review describing the risk and safety of school travel is provided in Chapter 2. This is followed, in Chapter 3, by a discussion of the data collection process and methods used to conduct the interviews and collect the FARS data. The results from these methods are then described and analyzed in Chapter 4. Specifically, the results of the interviews revealed ten common response themes while the results from the FARS data showed declining trends of school travel fatalities from 2000 to 2019 across all modes including school buses. Lastly, in Chapter 5, the conclusions from this study and a discussion for future work in this area are described.

CHAPTER 2. LITERATURE REVIEW

In the United States, over 57 million students attend either a public or private K-12 (kindergarten to grade 12) school (NCES, 2022). The safety and potential risk of these students on the trip to and from school is measured by fatality and injury data as well as travel surveys. While fatality and injury data are typically associated with school buses and vehicle modes, each mode of travel to and from school is a necessary area of study.

According to Special Report 269, the main concern associated with school transportation was accurately identifying and managing risk. Different levels of risk, depending on travel, resulted from each school district having different environmental and operational characteristics. This report offered a risk management framework to guide those who made safety-related school travel decisions. This helped with decisions like school siting, student parking policies, and changes in the minimum walking distance required for school bus transportation to be offered.

Based on this risk framework, five major recommendations were developed. First, transportation risks related to school travel should be comprehensively analyzed by transportation planners and policy makers in the decision-making process. Second, school districts should identify prominent risk factors for school travel used by children in the community and identify methods that can manage and reduce those risks. Third, the U.S. Department of Transportation should widely disseminate Special Report 269 and use this information to determine a role for federal policy makers to improve school transportation safety and the cost-effectiveness of certain safety measures used. Fourth, to develop better risk estimates, the existing databases for school transportation data should be examined and improved upon by the U.S. Department of Transportation and other agencies. Lastly, the U.S. Department of Transportation and other agencies should analyze the cost-effectiveness and feasibility of establishing and maintaining new school transportation-related databases.

The background information from Special Report 269 provided the basis for this study and the reasons why school travel risk research is meaningful. In this literature review, key studies were grouped by pedestrian and bicycle school travel risk, the Safe Routes to School program, and school bus travel risk and safety. Topics in pedestrian and bicycle school travel risk included the difficulties of gathering data, the declining number of children using these modes, and the reasons why this decline exists. The studies reported in the Safe Routes to School section contributed to the knowledge of bicycling and walking safety as this is the primary focus for the Safe Routes to School program. School bus travel risk and safety studies covered concerns with school bus transportation, school bus technologies, and ways of improving safety like driver training.

2.1. Pedestrian and Bicycle School Travel Risk

School travel risk data pertaining to pedestrians and bicyclists is typically unavailable or difficult to gather (Kavta and Adhvaryu, 2019). For example, most of the fatal injuries in school bus related crashes occur to pedestrians and occupants of other vehicles. This outcome guides researchers to seek more information about pedestrians travelling to or from the bus stops, as this information is typically not coded as school bus-related. From 2007 to 2016, 62% of the school age-pedestrian fatally injured in crashes were struck by school buses or vehicles functioning as school buses and 38% were struck by other vehicles (NHTSA, 2018).

There is more data available regarding walk to school and bicycle to school trends. The rates of active travel to school have declined while rates of car travel to school have increased in the United States (Chriqui et al., 2012). Forty years ago, 40.7% of school age children in the United States walked or biked to school. By 2001, these modes accounted for 12.9% of the trips to school (Craddock et al., 2011). A 2012 study on United States school mode transportation concluded that 46.6% of all children rode in passenger vehicles to school and 41.8% utilized the same mode for the trip home (Beck, 2017). As an aside, these trends mirror walking trips by the general population, where commuters walking to work in the United States was estimated to be 2.6% in 2018, while 9.9% of commuters did so in 1960. Reductions in walking trips correlate to higher levels of car ownership and the increased reliance on the automobile (Loukaitou-Sideris, 2020).

One reason that students would walk or bicycle to school is because they were ineligible for school bus service as 39.9% of schools operate in a state with a minimum bussing distance requirement (Chriqui et al., 2012). However, where students lived less than 1 mile away, only 21.9% and 28.4% of them walked or bicycled to and from school, respectively (Beck, 2017). The most common reported barriers to walking/biking to school were traffic, distance, lack of sidewalks, lack of crossing guards, lack of bike racks, and crime. Only 22.2% and 38.6% of all states required sidewalk construction or traffic control measures around schools, respectively (Chriqui et al., 2012).

Specific changes to the existing infrastructure and traffic operations may help to improve the travel environment for school-aged pedestrians and bicyclists. SAFER-SIM University Transportation Center discovered that decreasing the number of driveways and adding a two-step speed reduction significantly improved safety in school zones (Lee & Abdel-Aty, 2018). Another study examined the effectiveness of speed monitoring devices in lowering speeds near urban schools. Reductions in average speeds were observed when speed monitoring displays were in place, and so long as schools were located on or near high-speed roads under specific circumstances (Chang et al., 2005; Palley, 2016).

Because students today rely so much on motorized transport, most children do not receive sufficient levels of physical activity. Many authoritative bodies worldwide recommend that children have at least 60 minutes of daily physical activity (Chriqui et al., 2012). Most walking to school studies emphasize the social and cognitive development benefits as well as personal agency and competencies, but they have not always focused on the health benefits or the safety and security aspects of walking in inner city spaces. In one study, fifth graders from five grade schools within inner city Los Angeles were able to provide a “child’s-eye view of a safe and walkable environment” (Banerjee, 2014). Public health experts encourage children to walk as being essential to their health to combat obesity.

2.2. Safe Routes to School Studies

The Safe Routes to School Program (SRTS) promotes walking and bicycling safety and has conducted studies measuring the decline in active modes of travel (i.e., pedestrian and bicycle). SRTS addresses school travel safety, promotes children’s health, and focuses on walking and bicycling modes in urban communities. They have covered other considerations related to school travel risk including seat belts on buses, minimum bussing distance laws, crossing guards, speed zones, and traffic control measures around schools.

Safe Routes to School projects that include infrastructure improvements to reduce speed and support signalized intersection projects help to improve safety among both children and adults for walking and

bicycling. The investment in infrastructure may have positive impacts on injury prevention and decrease potential barriers towards participating in active transportation to school (Craddock et al., 2011).

SRTS programs have been associated with a 14% to 16% decline in pedestrian and bicyclist injury risk and a 13% decline in pedestrian and bicyclist fatality risk (after controlling for temporal trends represented by the reduction in adult injuries and restricting to school-travel hours). Since the built environment can be manipulated to control injury rates, SRTS provided funding based on the population density of school-aged children. Examples of SRTS projects included separating play areas from roadways, improving visibility at intersections, establishing conspicuous stop signs, enhancing pavement markings, and improving lighting (DiMaggio et al., 2016).

The Safe Routes to School National Partnership published the Local School Projects report which detailed a project in which SRTS activities were implemented at ten schools in low-income communities. The overall goals were to develop and evaluate a school-based SRTS program, build local capacity to apply for state or federal SRTS funding, and increase safe walking and bicycling to and from school in these communities. The results found that almost all the school sites exhibited some form of policy and environmental change occurring in the academic year in support of walking and bicycling to and from school. Nine out of the ten schools had successful walk and bicycle activities that encouraged and educated children on safety (Cooper and McMillan, 2010).

2.3. School Bus Travel Risk and Safety

Federal, state, and local government agencies gather and use data to improve the safety of school buses. The National Highway Traffic Safety Administration (NHTSA) and the Federal Motor Carrier Safety Administration (FMCSA) collect data on motor vehicle crashes including school buses to develop federal requirements for school bus safety. Based on the Fatality Analysis Reporting System (FARS), fatality information can be broken down into school age fatalities by time of day, school bus occupant fatalities by impact point and crash point, school bus occupant fatalities by year, and vehicle maneuver and pedestrian fatalities (NHTSA, 2016). However, there is limited data for school bus crashes beyond fatal school bus crashes such as the type of bus or if the driver is from the school district or privately contracted (Thune et al., 2017). Based on a 2015 study, there was no clear evidence that the number of school bus related crashes during the preceding decade had declined when normalized by the number of school buses used each year in the United States. While there was a downward trend in the number of fatal crashes, the number of school bus related crashes and fatalities remained stagnant and most fatal injuries in school bus related crashes occurred to pedestrians and occupants of other vehicles (Donoughe & Katz, 2015).

There are many potential contributors to school bus travel risk and safety. Some studies have focused on occupant safety within the school bus. In 2002, NHTSA created a report covering the effectiveness of current federal requirements for school bus occupant crash protection. Alternative occupant crash protection systems in controlled laboratory tests that represent the types of real-world school bus crashes were evaluated, and findings that support agency activities related to the next generation of occupant protection requirements for school buses were published (NHTSA, 2016). The Minnesota School Bus Safety Advisory Committee identified safety issues including the effectiveness of school bus occupant protection systems, effectiveness of federal motorcoach bus crashworthiness standards and occupant protection systems, discrepancies with different federal bus definitions, deficiencies in the

NHTSA's Fatality Analysis Reporting Systems bus ejection data, and a lack of school bus injury data. Compartmentalization has made school bus passengers safer, but it does not protect school bus passengers during lateral impacts with vehicles of large mass and in rollovers (Lazenberry & Anderson, 1999).

Based on NHTSA testing, lap belts have little or no benefit in reducing serious-to-fatal injuries in severe frontal crashes of school buses and could increase the incidence of serious neck injuries and possibly abdominal injury. However, lap/shoulder belts could provide some benefit, particularly in rollover crashes, unless misused (Chang et al., 2015; Thune et al., 2017). The unintended consequences associated with lap/shoulder restraints include increased capital costs and reduced seating capacities.

School bus travel risk and safety can also be examined from a travel environment standpoint. The National Transportation Safety Board (NTSB) identified several issues tied to driver inattentiveness or a lack of awareness. Roadway drivers often fail to stop or otherwise respond safely when approaching a school bus with activated warning lights (NTSB, 2018). Stop arm cameras are only effective to aid in enforcement of motor vehicle laws and enhance safety if there is a sustainable process to turn camera images into violations (Hawkins et al., 2012). Students crossing a roadway after departing a school bus face a risk of death or injury because motorists do not always stop for school buses even when the bus is located at a proper bus stop with lights flashing and the stop arm extended. For this reason, home side loading for all stops has been proven to be safer than having the children cross the street but has dramatic impact on routing efficiency (Hawkins et al., 2012). Since deficiencies exist in establishing safe school bus routes and stop locations, there is a need to increase technology usage to prevent future collisions with pedestrians and bicycles (NTSB, 2018).

One naturalistic driving experiment evaluated driver response to an in-vehicle message warning drivers of when approaching stopped school buses around a curve. The data from this study indicated that the warning message instantly changed driver speed. This study also evaluated the impact of using control algorithms to reduce vehicle speeds on high-speed roads near bus stops. The results found that the connected vehicle system would increase safety while providing a small increase in average travel time and emissions (Donoughe, 2016).

The operations and maintenance of school buses represent a third area of school bus travel and risk. All fifty states require school bus inspections, and forty-four states require a refresher training for school bus drivers. However, requirements vary by state for school bus inspections, driver training, and vehicles. Local level school districts have the responsibility of implementing and supervising school bus operations (Thune et al., 2017).

The complexities of school bus travel and risk may be best illustrated by a survey given to both parents and students attending a private high school in Greece. This study identified 23 qualitative factors affecting a school bus transport system. Some of the highlighted factors included travel cost, road network and traffic conditions, cleanliness of the school bus, and the existence of three-point seatbelts on school buses (Sakellariou et al., 2016).

In conclusion, the range of concerns and risks identified in this literature review helped to both shape the interview questions for this study and determine the best approach to synthesize the FARS data. The process and methods for conducting the interviews and analyzing FARS, specifically for school travel fatality and injury data, are provided in the next chapter.

CHAPTER 3. METHODS

This study conducted interviews of school transportation professionals to examine the present risks associated with all modes of school transportation. In addition, data from FARS were analyzed for fatalities related to school travel to identify current trends. This analysis compared urban and rural areas in terms of school travel fatalities, people involved in school travel fatal crash events, and buses involved in school travel fatal crash events. School bus injuries and fatalities to and from school were also analyzed.

3.1. Expert Interviews

3.1.1. Gathering Participants

A total of thirty school transportation professionals agreed to be interviewed for this study. These participants were from various locations around the United States including highly populated and less populated regions. The interview participants represented company or agency presidents, vice presidents, managers, coordinators, policy analysts, engineers, consultants, planners, and directors affiliated with the school transportation field. These titles were used to evenly group the participants into categories and the responses were collectively consolidated and then analyzed (see Figure 3.1).

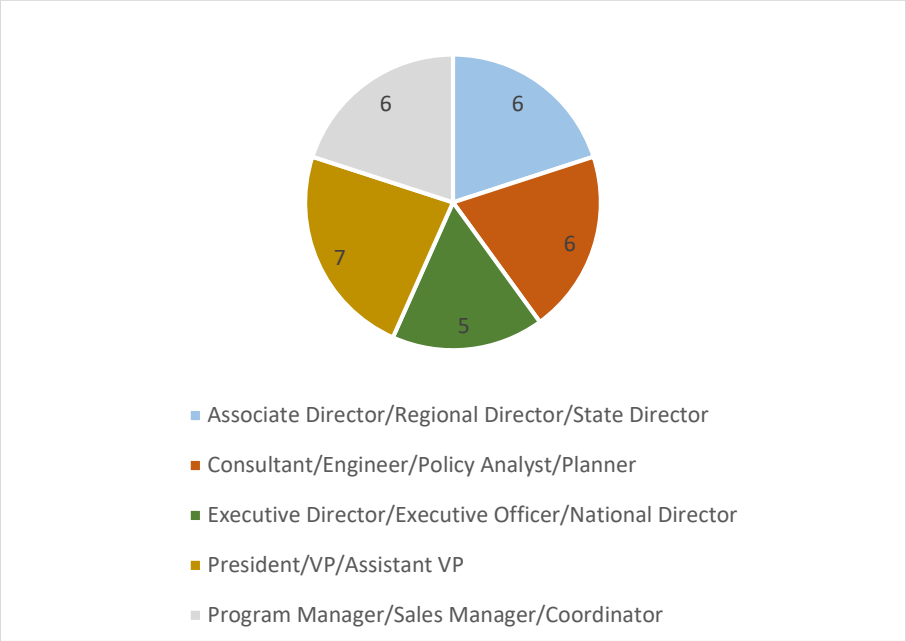

Figure 3.1 Interview Participation Breakdown by Title

The participants were involved with various school transportation organizations including, but not limited to, Safe Routes to School (SRTS), National Association for Pupil Transportation (NAPT), National Association of State Directors of Pupil Transportation Services (NASDPTS), and the National School Transportation Association (NSTA). To perform a secondary level of analysis, the participants were also categorized by field (see Figure 3.2).

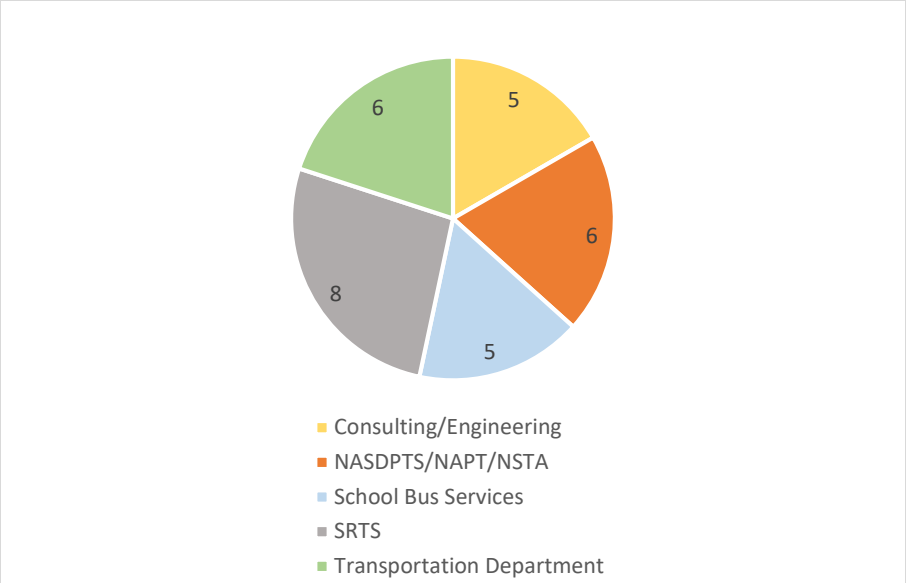

Figure 3.2 Interview Participation Breakdown by Field

To make certain that all participants understood the study and the types of questions they would be asked, a brief introduction and description of the study was read to each participant before the interview began:

> *Hi. I am […] from the Department of Civil and Environmental Engineering at the University of Idaho. This interview will be part of my research study. The purpose of the research is to explore school travel risk and to determine how things may have changed over the last two decades. You are being asked to participate in this study because of your knowledge and involvement in this field.*
>
> *Your participation will involve answering approximately ten questions. The interview should take about 20 minutes to complete. The interview includes questions such as school travel mode trends and explores future needs. Your involvement in the study is voluntary, and you may choose not to participate. You can refuse to answer any of the questions at any time. There are no known risks in this study, and all data collected will be stored at the University of Idaho.*
>
> *The findings from this project will provide information on how topic experts like you view school travel safety and risk today, and how those perceptions may be different from twenty years ago. If published, results will be presented in summary form and you will not be directly linked to your responses in any final reports, unless you specifically request us to do so.*
>
> *If you have any questions about this research project, please feel free to contact […]. If you have questions regarding your rights as a research subject, or if you want to obtain information or offer input you may call the Office of Research Assurances at […].*
>
> *By your verbal consent, you certify that you are at least 18 years of age and agree to participate in the above-described research study.*
>
> *Do we have your consent to participate?*

3.1.2. Interview Questioning and Recording

The interview questions were written to examine how topic experts in school transportation viewed school travel safety and risk today and how those perceptions may have differed from twenty years ago. The questions included topics ranging from school travel mode trends to future needs. The participants were also given the opportunity to ask questions about the study at the end of the interview.

- In your opinion, how has school travel evolved in the last twenty years?
- Do you think it is safer for kids to travel to and from school than it was twenty years ago? If yes, why? If no, why not?
- In your opinion, what would be the greatest danger or concern associated with school transportation today?
- In your opinion, how has the role of parents affected school transportation behavior in the last two decades?
- Please share any notable school transportation safety programs or outreach activities that have occurred in the last twenty years.
- Have we made any progress regarding better school transportation safety data collection?
- Are there any transportation challenges that school children in rural communities uniquely face?
- Walking and bicycling to school numbers remain low compared with results from a generation or two ago, though data suggests that recent efforts are making a positive impact. Where should communities be focusing their attention to spur more walking and bicycling behavior?
- What school transportation safety efforts should be we be focusing on as we look ahead to the next twenty years?
- Would you recommend anyone else who might have an interest in this research and want to participate in this study?

The interviews were conducted and recorded through the Zoom teleconferencing software program. Transcripts were created by Zoom using the live-transcript function. Each transcript was then manually checked and edited by listening to the recording afterwards to correct for any misspelling, grammar, and punctuation mistakes made by the program. A total of 11.8 interview hours was ultimately collected as part of this study.

3.2. FARS Data Analysis

In order to measure school transportation safety trends using this prescribed framework, data from the Fatality Analysis Reporting System (FARS) were analyzed from 2000 to 2019. FARS provides users with annual fatal injury data from motor vehicle traffic crashes (NHTSA, n.d.; NCSA, 2017; NCSA, 2021). Using the data set from each calendar year, the six sources that were pertinent to this study included the ACCIDENT (crash), VEHICLE (motor vehicle and driver), PERSON (motorist and non-motorist), PBTYPE (pedestrian and bicycle), VIOLATN (violation) and NMPRIOR (non-motorist activity) data files.

In the following descriptions, a detailed explanation for each of these data files is provided and includes any coding changes that occurred over the twenty-year analysis period. Tables 3.1 to 3.6 provide a summary of the relevant attributes from each file that were used for this study. In addition to listing the name used by the Statistical Analysis System (SAS), the attribute code(s) and description(s) are provided. If an attribute code changed during the analysis period, then this information was also noted in the table.

3.2.1. ACCIDENT Data File

From the ACCIDENT data file, three attributes were linked to school transportation (see Table 3.1).

- SCH_BUS (School Bus Related) – This data element "identifies if a school bus, or motor vehicle functioning as a school bus, is related to the crash." During the crash, the school bus may be the contact or non-contact vehicle, and pupils may or may not be on board at the time of the crash.
- CF1, CF2, CF3 (Related Factors, Crash Level) – This data element "records factors related to the crash expressed in the case materials." Since 1995, code 21 has been used to identify any crash that occurs "within (a) designated school zone".
- TRA_CONT (Traffic Control Device) – This data element "identifies the attribute that best describes the traffic controls in the vehicle's environment just prior to this vehicle's critical precrash event, based on the case materials." This element was discontinued and replaced as a VEHICLE data file element (VTRAFCON) starting in 2010. Prior to 2010, four attribute codes were applicable to school transportation and included 30 (School Speed Limit Sign), 31 (School Advance or Crossing Sign), 38 (Other School-Related Sign), and 39 (Unknown Type School Zone Sign).

Table 3.1 ACCIDENT Data File

SAS Name	Attribute Code(s)	Description	Year(s) Applicable
SCH_BUS	1	Yes	2000-2019
CF1, CF2, CF3	21	Within Designated School Zone	2000-2019
TRA_CONT	30	School Speed Limit Sign	2000-2009
	31	School Advance or Crossing Sign	2000-2009
	38	Other School-Related Sign	2000-2009
	39	Unknown Type School Zone Sign	2000-2009

3.2.2. VEHICLE Data File

The VEHICLE data file included "in-transport motor vehicle data as well as driver and precrash data." Seven attributes were school transportation-related (see Table 3.2).

- BODY_TYP (School Bus Related) – This data element "identifies a classification of this vehicle based on its general body configuration, size, shape, doors, etc." It should be noted that "when defining school buses (from) 1993 and later, include the new body type 24 (van-based school bus), (even though) body type 24 is not part of Buses."
- BUS_USE (Bus Use) – This data element "describes the common type of bus service this vehicle was being used as at the time of the crash or the primary use for the bus if not in service at the time of the crash."
- SPEC_USE (Special Use) – This data element "identifies any special use associated with this vehicle at the time of the crash."

- DR_CF1, DR_CF2, DR_CF3, DR_CF4 and DR_SF1, DR_SF2, DR_SF3, DR_SF4 (Related Factors – Driver Level) – This data element "records factors related to this driver expressed in the case materials." Under "miscellaneous causes", attribute code 33 includes "Passing Where Prohibited by Posted Signs, Pavement Markings, Hill or Curve, or School Bus Displaying Warning Not to Pass." The DR_CFx SAS name was replaced with the DR_SFx name starting in 2010.
- VTRAFCON (Traffic Control Device) – This data element "identifies the attribute that best describes the traffic controls in the vehicle's environment just prior to this vehicle's critical precrash event." Prior to 2010, this data element was collected in the ACCIDENT data file (as noted earlier).
- VIOLCHG1, VIOLCHG2, VIOLCHG3 (Violations Charged) – This data element "identifies violations charged to this driver in the crash." Under "speed-related offenses", attribute code 24 includes "exceeding Special Speed Limit (e.g., for Trucks, Buses, Cycles, or on Bridge, in School Zone, etc.)."

3.2.3. PERSON Data File

The PERSON data file included both motorist and non-motorist data. Only one attribute was school transportation-related (see Table 3.3).

- P_CF1, P_CF2, P_CF3 and P_SF1, P_SF2, P_SF3 (Related Factors – Person Level) – This data element "records factors related to motor vehicle occupants other than drivers and persons not in motor vehicles as expressed in the case materials." Attribute code 33 categorizes conditions that include "Passing where Prohibited by Posted Signs, Pavement Markings, Hill or Curve, or School Bus Displaying Warning not to Pass Line." A name change occurred starting in 2015.

Table 3.2 VEHICLE Data File

SAS Name	Attribute Code	Description	Year(s) Applicable
BODY_TYP	24	Van-Based School Bus	2000-2009
	50	School Bus	2000-2019
BUS_USE	1	Used as a Public School Bus	2000-2009
	1	School Bus	2010-2019
	2	Used as a Private School Bus	2000-2009
	3	Used as a School Bus, Public or Private Unknown	2000-2009
SPEC_USE	2	Vehicle Used for School Bus	2000-2011
	2	Vehicle Used for School Transport	2012-2019
DR_CF1, DR_CF2, DR_CF3, DR_CF4	33	Passing Where Prohibited by Posted Signs, Pavement Markings, Hill or Curve, or School Bus Displaying Warning Not to Pass	2000-2009
DR_SF1, DR_SF2, DR_SF3, DR_SF4	33	Passing Where Prohibited by Posted Signs, Pavement Markings, Hill or Curve, or School Bus Displaying Warning Not to Pass	2010-2014
	33	Passing Where Prohibited by Posted Signs, Pavement Markings, or School Bus Displaying Warning Not to Pass	2015-2019
VTRAFCON	32	School Zone Sign / Device	2010
	23	School Zone Sign / Device	2011-2019
VIOLCHG1, VIOLCHG2, VIOLCHG3	24	Exceeding Special Speed Limit (e.g., for Trucks, Buses, Cycles, or on Bridge, in School Zone, etc.)	2000-2009
	55	Pass stopped school bus	2000-2009

Table 3.3 PERSON Data File

SAS Name	Attribute Code	Description	Year(s) Applicable
P_CF1, P_CF2, P_CF3	33	Passing Where Prohibited by Posted Signs, Pavement Markings, Hill, or Curve, or School Bus Displaying Warning Not to Pass	2000-2014
P_SF1, P_SF2, P_SF3	33	Passing Where Prohibited by Posted Signs, Pavement Markings, or School Bus Displaying Warning Not to Pass	2015-2019

3.2.4. PBTYPE Data File

The PBTYPE data file "included data on pedestrians, bicyclists and people on personal conveyances." Two attributes were school transportation-related (see Table 3.4).

- PBSZONE (School Zone) – This data element "indicates if the crash occurred in a school zone," and applies to both pedestrians and bicyclists.
- PEDCTYPE (Crash Type – Pedestrian) – This data element "summarizes the circumstances of the crash for this pedestrian." Attribute code 342 categorizes conditions which are "school bus stop-related."

Table 3.4 PBTYPE Data File

SAS Name	Attribute Code	Description	Year(s) Applicable
PBSZONE	1	Yes	2014-2019
PEDCTYPE	342	School Bus Stop-Related	2014-2019

3.2.5. VIOLATN Data File

The VIOLATN data file "identifies each violation (as a separate record)." One data element was school transportation-related (see Table 3.5).

- MVIOLATN (Violations Charged) – This data element "identifies all violations charged to the driver." One speed-related offense and one rules of the road violation (wrong side, passing, and following) is identified as school transportation-related.

Table 3.5 VIOLATN Data File

SAS Name	Attribute Code	Description	Year(s) Applicable
MVIOLATN	24	Exceeding Special Speed Limit (e.g., for Trucks, Buses, Cycles, or on Bridge, in School Zone, etc.)	2010-2019
	55	Pass Stopped School Bus	2010-2019

3.2.6. NMPRIOR Data File

The NMPRIOR data file "identifies each non-motorist action at the time of their involvement in the crash (as a separate record)." One attribute was school transportation-related (see Table 3.6).

- MPR_ACT (Non-Motorist Action / Circumstances) – This data element "describes the action(s) of the non-motorist immediately prior to their involvement in the crash." The attribute of "Going to or From School (K-12) is specifically listed as one of the identified attributes.

Table 3.6 NMPRIOR Data File

SAS Name	Attribute Code	Description	Year(s) Applicable
MPR_ACT	1	Going To or From School (K-12)	2010-2019

3.2.7. Consolidation and Refinement of School Transportation-Related Crashes

With the school transportation-related crashes identified from each of the six data files, the corresponding case numbers were combined into a single list. This step was necessary because the case numbers from a particular data file did not identify all of the potential school transportation-related crashes. As an example, a crash record from the VEHICLE data file with school transportation-related attributes may or may not have been identified in an ACCIDENT or PERSON data file from the same calendar year. Conversely, duplicate case numbers were removed.

The consolidated list of case numbers was further screened based on several conditions, and any crash that did not meet these criteria were not included as part of the study results.

- Since the typical school day occurs on a weekday (i.e., Monday through Friday), weekend (i.e., Saturday and Sunday) crashes were removed. In FARS, the DAY_WEEK attribute for Saturday and Sunday was 1 and 7, respectively.
- Since a typical school year does not extend into the summer months, all cases with a recorded calendar date starting on June 16th and ending on August 31st were removed. While it is acknowledged that individual school districts may deviate from these dates, and winter snow

days and in-service days may also affect a school calendar, a representative timeframe needed to be chosen for analysis purposes.

- A three-hour travel window during both the morning (e.g., 6:00 AM to 8:59 AM) and afternoon (e.g., 2:00 PM to 4:59 PM) was assumed. Morning arrival and afternoon departure times will greatly vary from student to student depending on several factors that include, but are not limited to, an individual student's before school or after school activities, their mode of transportation to and from school, and travel distance and duration.

Furthermore, to assess trends based on roadway functional classification, the data were sorted depending on whether the crash occurred in a rural or urban setting. This factor was included in the ACCIDENT data file and two attributes were relevant to this study (see Table 3.7). A very limited number of crashes that were not categorized as either urban or rural (i.e., "not reported" or "unknown") were not included in the final tally of this study.

- ROAD_FNC (Roadway Function Class) – This data element "identifies the functional classification of the trafficway on which the crash occurred." This element was discontinued in 2015 and replaced with RUR_URB (see next bullet item).
- RUR_URB (Land Use) – This data element "identifies the classification of the segment of the trafficway on which the crash occurred based on FHWA-approved adjusted Census boundaries of small urban and urbanized areas."

Table 3.7 Rural / Urban Data Elements

SAS Name	Attribute Code	Description	Year(s) Applicable
ROAD_FNC	1	Rural Principal Arterial - Interstate	2000-2014
	2	Rural Principal Arterial - Other	2000-2014
	3	Rural Minor Arterial	2000-2014
	4	Rural Major Collector	2000-2014
	5	Rural Minor Collector	2000-2014
	6	Rural Local Road or Street	2000-2014
	9	Rural Unknown	2000-2014
	11	Urban Principal Arterial - Interstate	2000-2014
	12	Urban Principal Arterial – Other Freeways or Expressways	2000-2014
	13	Urban Other Principal Arterial	2000-2014
	14	Urban Minor Arterial	2000-2014
	15	Urban Collector	2000-2014
	16	Urban Local Road or Street	2000-2014
	19	Urban Unknown	2000-2014
RUR_URB	1	Rural	2015-2019
	2	Urban	2015-2019

A flowchart describing the overall process used by this study is shown as Figure 3.3.

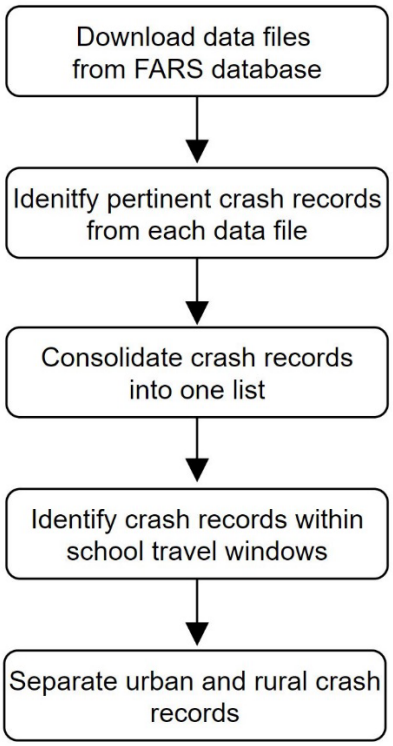

Figure 3.3 Evaluation Process for FARS Datasets

CHAPTER 4. RESULTS AND ANALYSIS

4.1. Interview Recordings

After the transcripts were manually corrected for errors, the qualitative response data were imported into a research application called Dedoose. This program takes different types of media sources as data and performs a study-specific analysis. Before importing the transcripts into Dedoose, the title and field for each of the thirty participants was defined in the program. The set of transcripts was then analyzed for common ideas and then manually consolidated into ten carefully considered themes. These ten themes were coded into Dedoose to organize the responses for analysis. The ten common themes ranged from concerns of the roadway environment and pick up and drop off safety to the role of parents and poor driver behavior, from better data collection and school bus technology to school travel demand and community planning. The time spent of school buses and education programs were also themes that were identified.

The responses were sorted into these ten themes if the context of the response could be determined. If the response was considered influential and discussed by at least one other participant but did not fit within one of the ten themes, then the response was placed into “Other Concerns”. A few responses were excluded because they did not contribute to any of the themes or “Other Concerns”. Because of these considerations, each theme and “Other Concerns” had a range of responses, so a description for each theme has been provided in this section to explain how the responses were sorted into that theme. Participant quotes are presented for each theme to capture the insights and concepts that were shared.

The responses were then analyzed using Dedoose to highlight the themes that were more highly discussed among the participants than others. For reader convenience, the information about each theme is sequentially reported later in this chapter based on how frequently the theme was mentioned. Comparisons of these common responses were conducted between the participant title categories and between the participant field categories. The charts and tables presented in this chapter were initially created by Dedoose and then exported and edited in Microsoft Excel for clarity.

The interview methods of this study enabled participants to provide responses that otherwise may not have been predicted or provided from a typical online or paper survey unless write-in answers were in place. The interviews allowed participants to express their concerns associated with each question completely.

4.2. Findings

Based on the organized responses, it was found that the three most common themes were education programs, roadway environment concerns, and school bus technology. This finding was determined by the number of times each theme was mentioned in the participant responses and every response related to a particular theme was individually counted. To be specific, education programs had 66 mentions, while roadway environment concerns and school bus technology had 55 and 49 mentions, respectively.

The next two tables show the number of mentions for each theme from most to least common. Table 4.1 displays the number of mentions based on the participant’s title and Table 4.2 reports these results based on the participant’s field. The organization of the participants was explained in the previous chapter. The colors in the tables represent the number of mentions from lowest to highest: dark blue,

light blue, green, yellow, and lastly orange. For example, in Table 4.1, it is noted that the program manager/sales manager/coordinator title discussed the roadway environment concerns theme the most while the associate/regional/state director title discussed education programs the most.

Based on the feedback, the survey participants felt that the implementation of education programs and infrastructure would make a meaningful difference and impact to school travel. School bus technology has positively addressed safety and risk. Parents remain as the key decision makers for school mode choice, and mode choice in the last two decades continues to shift exclusively to vehicle travel. Additional data collection would show how specific measures have improved safety and determine how well bicycle lanes, sidewalks, and bus systems have been utilized. The implementation of walking and bicycling infrastructure and other methods to enhance safety (narrow lanes, bulb-outs, green strips, etc.) will promote those modes of travel and make them lower risk. The collective outcomes suggest that school travel safety and risk must be a priority for the public.

Table 4.1 Interview Themes Mentioned by Participant Title

	Education Programs	Concerns of Roadway Environment	School Bus Technology	Role of Parents	Better Data Collection	Poor Driver Behavior	School Travel Demands	Community/School Planning	Pick Up and Drop Off Safety	Distance/Time Spent on School Buses	Other Concerns
Associate Director/Regional Director/State Director	16	13	13	7	5	6	2	3	6	3	10
Consultant/Engineer/Policy Analyst/Planner	9	9	12	6	4	3	4	3	3	3	9
Executive Director/Executive Officer/National Director	17	7	7	8	4	5	4	8	2	4	8
Program Manager/Sales Manager/Coordinator	12	20	3	5	6	1	7	5	5	1	13
President/VP/Assistant VP	12	6	14	5	7	8	4	1	2	4	6
Total Mentions	**66**	**55**	**49**	31	26	23	21	20	18	15	46

Table 4.2 Interview Themes Mentioned by Participant Field

	Education Programs	Concerns of Roadway Environment	School Bus Technology	Role of Parents	Better Data Collection	Poor Driver Behavior	School Travel Demands	Community/School Planning	Pick Up and Drop Off Safety	Distance/Time Spent on School Buses	Other Concerns
Consulting/Engineering	8	4	11	5	4	1	4	3	3	3	6
Transportation Department	13	5	8	6	5	6	3	4	2	4	5
School Bus Services	8	5	13	4	5	7	1	1	3	2	5
NASDPTS/NAPT/NSTA	21	12	17	8	5	8	5	1	7	3	9
SRTS	16	29	0	8	7	1	8	11	3	3	21
Total Mentions	**66**	**55**	**49**	31	26	23	21	20	18	15	46

In the following sections, descriptions of each category, along with specific participant quotes, are provided in greater detail. The order is based on how frequently each theme was mentioned by the participants.

4.2.1. Education Programs

Transportation education programs range from the operation of school buses to serving the needs of students travelling using other modes. For example, there has been an increase in training requirements for school bus drivers in the last two decades which has inherently improved safety. The concept of implementing more education programs for both students and drivers was the most common theme from the experts in this study. Student safety would improve for all modes if students learn basic pedestrian safety skills such as looking both ways before entering a crosswalk or crossing a street to access a vehicle or bus. Some school districts have implemented this kind of learning to their physical education classes as life skills. Overall, the education programs have had positive impacts on school transportation safety, but many of these experts believe that there is room for improvement.

> *"… our schools will provide training for these students that drive to school themselves on the risks of being a young driver… the requirement is that the schools, before they give on-premise parking permits, these kids have to complete a class. That has been well received by our school communities. And I like to think it has saved some lives."*

> *"… lack of education around what options exist from a non-infrastructure standpoint. Our Safe Routes to School Program does fund improvements for education and encouragement initiatives like we have flagship days for walk, bike, and roll to school day. But … there's lack of education and capacity for kids to learn how to ride a bike and the benefits of walking..."*

"… in a lot of communities where there is no bicycle pedestrian infrastructure, bicycle and pedestrian safety education is not emphasized whether in school or at home environment because nobody's walking or biking on roadways. So, [the teaching] is not felt to be [needed]. And so, we try to get into rural communities as well, even though they say oh nobody's going to walk or bike here… everybody's a pedestrian at some point, even if it just means they're crossing the parking lot of their local grocery store. So, that education piece is key."

"I think the efforts that have been made regarding motorists' awareness about the school bus, particularly the flashing red lights and the need to stop when loading and unloading. I think that has been helpful."

"[Kids] should still be looking at incoming traffic and making sure that it's safe for them to proceed up and get on the bus. And that goes the same for when they're getting off the bus, they should be taught to look both ways before they step out onto the pavement. Crossing, they should also look both ways… there's a lot of little things like that, [which] could make transportation a lot safer."

"I think there's been a lot of great new tools that have appeared in the last 20 years. The concept to educate kids on walking and biking safety as part of school has sort of come up it's not caught on everywhere but there are some school districts that sort of teach safe walking and biking during the school day as part of their health or PE curriculum as a life skill. Walking school buses are a sort of a new concept to try to really help with the safety in numbers concept of walking, where like stranger danger is way less if there's a group of kids. It's also easier to see a group of kids walking together than it is to see one individual kid … bike trains are [similar to] walking school buses…"

"I think that teaching kids how to ride a bicycle has [become less] in the past 20 years. The number of kids that knew how to ride a bike when I first got into this work and say a fourth-grade class, there might be like one kid in the class, who didn't know how to ride a bike, and everyone else did. Over that time… out of a fourth-grade class maybe there's six or seven students that don't know how to ride a bike. And if you don't know how to ride a bike by the time, you're in fourth grade, you're probably never going to learn … I think it's really a shame that we're going to have a really large number of people that don't even know how to ride and so they could never choose this [mode] even if they wanted to. So, some sort of like learn to ride as part of our education system. Making sure that every kid knows … how to ride a bike. I felt like the pedestrian safety stuff is a little bit easier. Although I do think that is a skill that should be taught to kids as well. I feel like you can learn pedestrian safety at any point but if you miss learning how to ride, you're out of luck because adults usually don't learn new things like that, easily."

"The measurement that I use for safe walking is if you wouldn't put your grandma or your grandpa or somebody out there and tell them to do it, it's probably not safe to begin with. The idea of making it safe, whether that's funding it to make it safe, whether that's the public education to make it safe, we know how to make biking and walking a safe form transportation. It's making the commitment to make it a safe form of transportation. We have a ton of great research from planners and engineers, and social scientists and public health and all these great fields. We know how to do it. We just need to do it."

4.2.2. Concerns of Roadway Environments

Most of the responses in this theme were tied to the lack of infrastructure involved with walking and bicycling school travel. Parents influence a child's school travel choices, and this decision is often based on the roadway environment, especially for walking and bicycling. It is difficult to promote these modes if there is limited access to a safe facility. The design of roadways to efficiently move vehicles has also negatively impacted these non-motorized modes. Straight and wide roadways lead drivers to speed because the drivers perceive it safe to do so, which increases the risk to pedestrians and bicyclists. The experts believe that is important to identify and focus on areas of high need and high risk for these modes around school zones and make them safer with infrastructure improvements. This is especially important in rural communities because these communities often have little to no infrastructure for walking or bicycling.

> *"… we have built our roads over the last 20 years to be more vehicle friendly and less bicycle and pedestrian, or people friendly. I would have to say that. But at the same time, I think traffic collisions are on the rise and so children are safest on a school bus, but those modes have declined..."*

> *"I think we should be focusing our attention where the need is the highest. So, looking at current infrastructure, places where there are high speeds or there is a history of crashes, where there is a wide crossing distance, and where there is a high number of average annual daily traffic… So, I think we should be using data like that to focus where our infrastructure dollars go. That kind of on the ground safety data, as well as income related data to choose where the funding goes as well, so prioritize low-income communities that generally have more kids walking and fewer safety features."*

> *"In some places, safety will go up as infrastructure is being built, I feel like there is a … slow burn movement to complete safe infrastructure near schools, so that kids have the options to walk and bike to school, like key crossings, sidewalk infill, things like that. But I also think that in areas where there is not safe infrastructure and there hasn't been a lot of support or resources to community in a long time. They're way far behind some of the other communities...they never got that infrastructure to begin with."*

> *"Another way that we can improve is just generally improve walking and biking infrastructure especially around schools. Crossings are probably the most dangerous places for kids. And there are many simple relatively low-cost things that can be done to improve those crossings, particularly like curb extensions or refuge islands to shorten the crossing distance and give kids a safe place to wait when they're not in the street."*

> *"I think adequate infrastructure and adequate crosswalks, lighting, signaling at crosswalks and sidewalks to make sure there's adequate space on the road that separate from vehicle paths that keep folks walking and bicycling safe. Those are the biggest barriers, just because those don't often exist."*

> *"There's a lack of sidewalks and sort of busy roads in a lot of our rural areas so as far as, encouraging kids to walk and bike to school, that can also be a challenge. I think the condition of the roadways tends to be a little bit more challenging to maintain as well in rural areas. It's the*

distance, the lack of good infrastructure and lack of transit service can be challenges that are unique to rural areas..."

"… many of the main roads in a rural community are some of the fastest roads out there. And that's where they'll put the bus stop because it's a centralized location. That's a problem but they have to because they don't have a school nearby. They have to get bussed into somewhere else and they simply cannot walk or bike to school."

4.2.3. School Bus Technology

School bus technology has improved significantly in the last twenty years to better protect students. Internal and stop arm cameras, compartmentalization improvements, LED lighting, and seatbelts are some of the most recent improvements. The technology for school buses is improving faster than what school districts can implement because of funding limitations. Many of these technological advances are considered optional and do not come standard. The implementation of "black boxes" like those found on airplanes to record data before a crash is under consideration by some manufacturers. Some of the experts who spoke about this theme mentioned the future of school bus technology with electric school buses and vehicle to vehicle communication but noted that additional safety measures must be considered before this type of technology is placed into operation.

"There's been tremendous gains in in safety and technology. In general, I would say our industry is well behind the curve. But we are getting there. [Over] the last 20 years there's been a tremendous amount of difference, and improvement in that area, specifically the use of video cameras on vehicles, the use of GPS or ABL vehicle location systems. Computerized routing and data that has been of students have all improved greatly in that time."

"Technology has certainly been the biggest improvement or detriment in some regards. On board GPS, object monitoring systems are all great they're all intended to help the driver and the models in and around the bus, but they are they also serve as a distraction to some regard."

"I think that in the last 20 years we've benefited from a lot of technology such as LED lighting, improvements with the stop arms. I think that there's been some design changes, especially with technology related. We can control the speeds of vehicles, along with the braking. So, there's a lot of technology available on the buses, should a state, or a school district specify it that way."

"We've seen a lot more states and more school buses that are now using lap shoulder belts rather than just relying on compartmentalization for the safety of the students. There have been other safety features added to the school buses such as more emergency exits in the roofs and window side exits, that sort of thing… We've had the addition of the cross gates on the front of the school buses which forces the kids to walk at least six feet in front of the bus before they cross the road to get to the other side so that is eliminated a lot of the danger zone fatalities that we have experienced..."

"Technology is on the cusp of being able to have what is referred to as vehicle-to-vehicle communication, where a school bus could send a message to the vehicle approaching a stop, and either notify that driver there is a stop school bus ahead with a visual and an audible signal or eventually maybe even take control of that vehicle and stop, you know like, adaptive cruise control does today... I think it will start with just visual and audible communication to the driver

over apps like Waze and Google Maps and vehicle to vehicle communication, depending upon the, the automobile manufacturer. But eventually I think you're going to see vehicle to vehicle communication actually learn to take control of that vehicle to protect the children in a loading and unloading situation."

4.2.4. Role of Parents

Parents dramatically influence school travel demands. Safety concerns at pick up and drop off points are becoming more of a concern with increasing vehicle travel. As stated earlier, parents decide what mode or modes their children will use. Parents will preference walking and bicycling modes when safe sidewalks and bicycle lanes are present for their children to use. Parents are more actively involved in school travel safety education for their children, but sometimes there is missed information such as crossing safety that the child does not receive; this would be a safety issue for the child. There are also perspectives that being a good parent means that they should be driving their child to school and that their child is safer when being driven compared to the other transportation modes.

"Parents ultimately are the decision makers and how children get to and from school, typically. Sometimes children can influence their parents on the decision but usually ultimately the parents decide whether to put them on a bus or to let them walk or bike or to put them in the vehicle."

"In addition to the many parents deciding to drive their kids in situations where they shouldn't, parents put a tremendous strain on the pupil transportation management to provide busing in situations where busing is not appropriate, either where there are no safe stops to pick up the children, or where walking is much more sensible and safer. You don't want to bus kids a quarter of a mile unless they're special needs children or the environment is just so dangerous that you can't walk but if you've got good sidewalks from home to school, and you're talking about a quarter or maybe even a half a mile, then walking probably is the safer way to go than put a child on a school bus and yet parents want universal busing. 'We paid our taxes; we're entitled to it' and so that sort of pressure is not productive either."

"The parents today are sort of that first generation that grew up with the car focused mentality and so many of them aren't comfortable on a bike themselves. So, allowing their children to get on a bike is a little bit unnerving..."

"I think that, in looking at the way parents have been, the culture has been, last 8-10 years, almost helicopter parents that are very insecure about putting their students on the bus, they'd rather transport them."

"I think parents are concerned about safety and there is a perception that driving their children makes it safer for their children."

"I would say that my experience, there's less of an acceptance of responsibility for student behavior by parents."

"I think that the role of parents has always been, whether they enforce discipline when needed whether it was today or 20 years ago. That certainly is less today than it, it has been. Parents do not enforce rules like they used to. And that is a serious problem."

4.2.5. Better Data Collection

All the responding experts stated that data collection could be better, especially in terms of standardization and consistent collection. These conditions would help to analyze trends occurring across different modes of travel and help to make decisions on where improvements should be made to make transportation safer. Some states seem to collect and store data better than others. In terms of technology, additional resources will increase the availability and amount of data. As an example, cameras could be used to automate the counting of students boarding the school bus.

> *"That was a major issue in our work, almost 20 years ago, national database for school transportation data is weak, at best, there's not been much progress, even though we made those recommendations. It's, it hasn't advanced much at all."*
>
> *"I'll say certain states have gotten much better and do a very good job of tracking that data. I can also say that it's still a challenge, nationally, because states track data. All states track the data differently. For various reasons, sometimes because their state specific legislation is different than other states and just what they how they characterize make it very difficult to combine into a national database. Some states have improved greatly. And on a national basis we just don't have it right yet."*
>
> *"I don't think we've made a heck of a lot of progress. I mean, we have several school transportation publications that do try to collect the information on a yearly basis, but it's pretty minimal what they collect, and I know if you go state to state to state, every state collects their data in a different process, and it would really be nice, I think if we had just one main database of nationwide database where we could collect that type of information so that's certainly one place where I believe that that we could really improve our processes."*
>
> *"Those Safe Routes programs I talked about, or in other instances the local transportation folks do a really good job of collecting data. There are many volunteer groups around the country who collect data on walking and biking counts. And that's been very helpful. A few of those counts are now being done mechanically, either through video or other means, and collected regularly, that data has been helpful. I think the data that probably is still missing is the trend data on are more kids walking and biking, are more being driven, are more being bused. That data is hard to collect consistently over time because the nature of the programs is typically at the school level run by volunteers and making sure that you get that data collected every year so you can have the trends is quite difficult."*
>
> *"I think that collecting this data is problematic. Yes, it's super time intensive and you can't really do it on a regular basis, and we don't have a great way to gather a small sample size, and then estimate out for the state…we've never had the push nationally to [have] a long-term study. We need to do a simpler version of it over a long period of time so we can show trends… if there was a simpler way to get it and extrapolate, I think that there would be a lot of support behind that which is a big step forward to where we were years ago when I don't think that there was as much support for data collection around this type of thing. I also think that we kind of shoot ourselves in the foot when we collect data around number of kids walking and biking and make assumptions off that data. For example, if you are at a school and want to build a sidewalk and the engineer says, we shouldn't build a sidewalk here because nobody walks here, the counts*

aren't there… I think that the desire to have a more national number or more statewide number is there, but the best practice and how we gather it is not tenable to reach the goal. The resources it would take to get those numbers outweigh the usefulness of it in my opinion."

4.2.6. Poor Driver Behavior

There are many different aspects that fall under the poor driver behavior umbrella. One main trend is drivers passing school buses during loading or unloading periods. Distracted driving is another common aspect that contributes to the illegal passing of school buses and crashes. Even some of the technologies provided in vehicles can be distractions such as navigation, blind spot indicators, and 360-degree view cameras. The experts also noted drivers rolling through stop signs and speeding.

"It's kind of ironic that years ago we did a study into neighborhoods on behaviors and who's blowing the stop arms and things like that, and it was mostly moms and dads of the kids. And [they] don't know that [their] kid is potentially on this road. Wow, it was kind of mind blowing. So again, trying to get people out of their own heads to pay attention."

"The greatest danger would be the awareness of the stopped school bus, and that awareness is somehow illusive to most drivers. The fact that with all the safety technologies that we have, we still have vehicles striking a stopped school bus or hitting passengers disembarking or boarding a stopped school bus. I think that technology has got to play a role in that. And so active collision avoidance systems must be able to recognize a stopped school bus, and then start providing feedback to the driver, if the driver does not respond to that feedback, the car needs to then take over and stop the vehicle. When it comes to the bus, because as we've watched the data for many decades now, we see the dangers outside the school bus are still the biggest ones."

"Passing motorist. So that specifically means the motorist does not obey the red stop lights and comes through while the bus is stopped either loading or unloading students...the number one cause of fatalities throughout the country of students is passing motorists."

"People just don't pay attention. It's changed, people used to be a lot more conscientious with how they drove. Now they're not, they just they you know their heads on their phone, they're texting they're talking on the phone. You know that's a child being hit by a passing motorist is probably the most likely safety issue."

"I think it's the illegal passing issue of stopped school buses and vehicles not stopping around it. I mean, we as an industry can have the greatest impact on safety and safety is our number one concern by focusing on that exchange that happens when a child either boards the bus or exits the bus and the vehicles recognizing they need to stop around the school bus."

"...I think the risk of crash increases for everyone, the more distractions there are, and again distracted driving being one of the larger factors for general drivers. But anyone walking riding bicycles, etc. or parents transporting in their own vehicles, everyone is I think at a higher risk because of the pervasiveness of distracted driving. And of course, there are many other factors road safety as well. But I think that's probably the one that seems to be the most pernicious and probably the most common."

4.2.7. School Travel Demands

The shift to consolidate schools and site schools on the edges of communities has impacted how school travel has changed. Today, student travel modes have shifted to vehicle centric travel and continued reliance on school buses. There are many contributors to car centric travel demand that are also embedded in the other themes. The role of parents and the lack of safe infrastructure for bicycling and walking are the two main influences causing the shift to vehicle centric travel. Schools are also enforcing the one-mile minimum bussing distance so children who were bussed will now have to find another mode, most likely a ride in a passenger vehicle. There are also economic factors and constraints that influence whether bussing levels can be maintained to meet increased demand. Wealthier communities are likely to have more walking and bicycling opportunities, while geography will influence the demand with less walking and biking in areas where hills are present or where required crossings of rivers and streams make these non-motorized mode options less desirable due to increased travel distances.

> *"Basically, where we see increases at all tend to be in wealthier locales where biking is more popular. So there seems to be something of associated economic divide among kids who walk and bike. Walking tends to be on your lower income communities, not always, but on average, and then biking is more the higher, wealthier income students. We see the last 20 years more kids being chaperoned by parents, usually in a personal vehicle, sometimes in carpooling. We are starting to see in the last few years of kind of ride sharing, especially in the kind of wealthier enclaves."*

> *"Well, just based on what I know more kids are riding in family vehicles, fewer kids are riding the bus, fewer kids are walking and biking, and fewer families are carpooling so right now most kids are in a single-family vehicle, but it kind of depends on the community and the school demographics as well as geography."*

> *"I believe that it has become more car centric, I think that parents are more likely to drive their children to school whether or not they have access to a safe walking or biking route, or if they have access to busing, they still often choose to drive. That has created congestion issues around many schools. It's created problems for drop off and pick up which creates safety concerns for all of the children but particularly children that do arrive by other means."*

4.2.8. Community Planning

The community planning theme is complex because it involves a combination of long-term visions, goals, policies, and strategies to achieve sustainability within a community. School siting is one aspect of community planning where the current trend is to plan for larger schools and physically locate schools on the periphery of communities. The consolidation of schools is another concern associated with community planning and contributes to larger schools. The experts who provided input on this theme noted the increased travel risk associated with consolidating schools or school siting issues. This increased risk includes all modes where children will have to travel further to reach their school and are less likely to walk or ride a bicycle. This increases the number of vehicles traveling to and from school.

> *"One of the things that's happened in the United States is that we are trending toward much bigger schools, and more distant locations. That's an economic choice, but if you factor in all the busing and the other costs that it spurs over time, if you do a full cost accounting of that location, you may find that that the more distant consolidated location is actually more*

expensive over time than the smaller campuses that are in neighborhoods...In addition, there's a fair amount of evidence again going back to academics, those smaller schools make it easier for kids to perform better academically because they're more connected. They have a smaller community if they need help people recognize it. And so, there are some real benefits to that."

"We continue to build schools on the edges of communities in, in places that don't have good infrastructure for walking and biking, and where students need to travel a fair distance in order to access that school."

"Schools consolidating and serving really large regions, there's just so many barriers, physical, social, to getting to school safely outside of the vehicle especially."

"We're also up against school consolidation which has been one of the biggest factors in the last five to seven years with budget changes in school systems and so forth. So, literally the opportunity has changed for students because they don't live within that proximity to school and then you also have programs such as magnet schools and kids moving around to schools which are nowhere near their home. We've really moved away from a community school environment where walking and biking was more readily accessible."

4.2.9. Pick Up and Drop Off Safety

The "car centric" environment has increased risk at pick up and drop off locations. This is because traffic has increased going to and from the school so there will be more congestion. Some parents may be inclined to drop their child off just outside school property or a block away to avoid dealing with the congestion. The added traffic increases risk to those students who may not be seen getting out of the vehicle or who cross in front of a vehicle when it is unsafe to do so. Visibility will be reduced because of the congestion and the vehicles parked on the side of a road.

School bus stops are included in this theme because the location of the stops can influence safety. Higher speed roads without sidewalks are hazardous locations for school bus stops. The experts that discussed this topic felt that this was the most dangerous concern for school transportation because of the children's exposure to passing motorists.

"It's always been this case the greatest danger to the children. When it comes to the use of the yellow school bus, it has nothing to do with the bus itself. It's the loading and unloading processes, and it's not the bus that is the greatest danger to the children, its oncoming traffic...The majority of injuries and fatalities in pupil transportation, come from outside of the bus, not inside of the bus. The bus itself is a very safe piece of equipment, and unless it is something that's catastrophic in nature, like a Class A truck hitting a school bus or train hitting a school bus, every other vehicle on the road is going to lose when it tangles with a school bus in a [crash], so the kids are very safe. But the real danger to them is either when they're getting on the bus, or they're getting off the bus with passing traffic."

"As far as school buses we really need to continue work on our pickup and drop offs and our red-light violations. That takes a lot of cooperation between industry, law enforcement, schools, and the general public."

"I don't think that the issue of safety on school buses is much of an issue as convenience. I think it's far more convenient for a school bus to be there to get to and from school. Safety, regarding school transportation is more of an issue during loading and unloading of the school bus, not during transportation."

"If we're talking specifically about school buses the greatest danger for school children is drop off and pick up points."

4.2.10. Distance / Time Spent on School Buses

Another concern associated with school bus transportation is the time and distance children spend using this mode. School bus routes can be optimized, and improvements such as on-board Wi-Fi would allow some children to use their time more effectively. This is much more of a problem in rural areas where children will have longer distances and geographical barriers to overcome when travelling to school. Rural communities often face higher speed roads and no sidewalks, so children have no safe options other than taking the school bus.

"There's so many challenges. One, their schools tend to be quite far away from home… We've done a lot of surveys around schools. A lot of these kids are living 15-20 miles away from school, that's just, you know, simply not doable on foot or bike for most people. So, you have distance but then you also have, you know, when you, when you get into the rural areas you tend to have more of a focus right in terms of transportation planning on movement of goods and people less about sort of access and kind of what you'd want to be where you want to concern yourself with in terms of active transportation. Depending on where you are if you're in mountainous regions, there tends to be topographical barriers, just really difficult to kind of travel around on foot."

"Yeah, I think in the rural communities, the biggest concern is that the long distances they have. Many of them have to be bussed to school just because of distances, and the lack of sidewalks in rural areas."

"I mean the obvious, the distance. You know school consolidation and rural communities, has been so vast over the last five to seven years where, there used to be somewhat of a community orientation to schools they weren't so spread out and the consolidation has happened so much that kids that [have] 45-minute, hour long bus rides. And that is the only alternative, there's not a walking and biking option."

"Yeah, long bus rides and long bus rides that are unusable to them in any way. I feel like school buses in rural areas need Wi-Fi on them so kids can do homework on them."

"One of the big challenges for the rural communities is… the best use of their time. They're spending a lot of time on the bus, and they've got a long way to go. They're trying to find ways to use their time efficiently. Some companies have been very successful and coming into those environments and adding Wi-Fi to buses and making it more of a moving school type environment where kids can do their homework."

4.2.11. Other Concerns

Concerns among the experts that did not fit into the other themes were consolidated into this category. Stranger danger and crime are concerns that parents have that discourage them from allowing their

children to walk or bicycle to school, though the experts believe that this factor should be less of a concern. The design of larger passenger vehicles in the last 20 years poses more risk to children because it can be difficult to see children in front of or behind sport utility vehicles (SUVs) and trucks. Funding issues that were mentioned included adding technology to existing buses, purchasing new school buses, paying drivers adequately, and affording infrastructure to support walking and bicycling modes. These expenses may be a barrier for school districts to enhance safety. A universal issue that many communities are currently dealing with is the lack of bus drivers. The health of children was another area of concern, as vehicle emissions in congested school zones is problematic.

> *"The probably the newest thing in school transportation is the emergence of electric buses and the school transportation industry has tried to ignore over the years the danger of diesel emissions on the buses. And so, the changeover to electric is expensive and a lot of government funding is being put towards it… it's a danger breathing what's on the buses and even though the diesel engines have been cleaned up to an incredible amount over the last couple of decades."*

> *"The major challenge is just getting a bus, funding is difficult. In some states, it relies on parents to get kids to and from school and not all parents have been able to do that. I think that obviously in the last year, we've seen how parents struggle because of the pandemic. And when you have schools shut down, there's all kinds of issues that have come out of the last year that really focus on some of the problems, particularly in rural communities. And when we talk about transportation in some of the urban, suburban areas, you not only have school bus transportation, you have public transit, which also provides services in some of those areas. And you also have parents that are more economically capable of providing their own transportation to their children are hiring that out and having it done by cab services, Uber, those types of transportation. The ride sharing transportation companies have really come a long way in the last probably five years, and they are transporting far more children today than they did five years ago."*

> *"… I think the biggest problem that I've seen so far across the board, and this isn't just rural, but it certainly affects rural communities as well, is driver availability. It's becoming more difficult with the number of requirements on a professional school bus driver, it's more difficult to recruit for, and it's one of those things that I think makes it difficult for folks to get the transportation. There's a mandate for that transportation to happen. But the ease at which a transportation operation can recruit folks and retain employees may not match the need and how many folks are able to be transported with the staffing they have..."*

> *"I think in other ways it's less safe I think our roadways have gotten bigger and faster. Vehicles have gotten bigger. There's a lot of evidence emerging. The, the, especially SUVs and pickups are much more dangerous for children, if they are struck by those vehicles because they're more likely to get knocked down and run over than a smaller vehicle. The mass of those vehicles is so big that if they do get hit by those vehicles, they are much more likely to be injured seriously or killed."*

> *"We could do better job educating parents about the lack of danger, lack of stranger danger, and the potential benefits of allowing their kids to walk and bike."*

"I think it's safer in one case and that case is I think the fear of stranger danger is much overblown. In very few cases around the country when children are endangered by others around the school, it's not a stranger, quite often, it's a non-custodial parent, for instance, and yet those stories drive other parents to determine that is not safe for their children."

"We actually believe the greatest concern is that kids aren't walking and biking to school. We have physical activity and obesity rates of kids, especially post pandemic, that are going through the roof. This is the first generation that will live less time than their parents, if we continue this trajectory of obesity, diabetes, and heart disease and inactivity is a root cause of all of that. But kids are not getting the minimum physical activity that they need and when you look at walking and biking to school…"

"By the way there's another phenomenon that does happen from time to time and that is school bus fires. And so, suppression systems are being installed on buses. In fact, I think we're the only fleet that makes it mandatory that every one of our buses has a fire suppression system on it."

4.3. FARS Outcomes

From the ACCIDENT data file, four specific metrics were selected and tallied for reporting purposes. For this study, the fatality (FATALS), person (PERSONS), pedestrian (PEDS) and school bus (SCH_BUS) attributes were analyzed and the results from 2000 to 2019 were determined. The fatality attribute identifies the number of lives lost in a crash. The person attribute is the count of motor vehicle occupants involved. The pedestrian attribute is the total number of persons not in a motor vehicle that were applicable to a particular crash. The school bus attribute captured the total number of school buses involved in a crash.

The fatality metric, representing an unfortunate loss of life, is one of the key measures in FARS. As noted earlier, a crash would not have been entered in this database had there not been at least one fatality. Figure 4.1 shows that the total number of fatalities on rural facilities exceeded those on urban facilities in each year prior to 2014, with the results fluctuating over the last six years. The number of fatalities in rural areas peaked in 2000 (113 fatalities) and reached a low point in 2014 (43 fatalities). The annual number of fatalities on urban facilities ranged from 45 to 72 fatalities between 2000 to 2015. Since 2016, when the number of fatalities along urban facilities peaked at 84 fatalities, the total number has exceeded at least 71 fatalities each year.

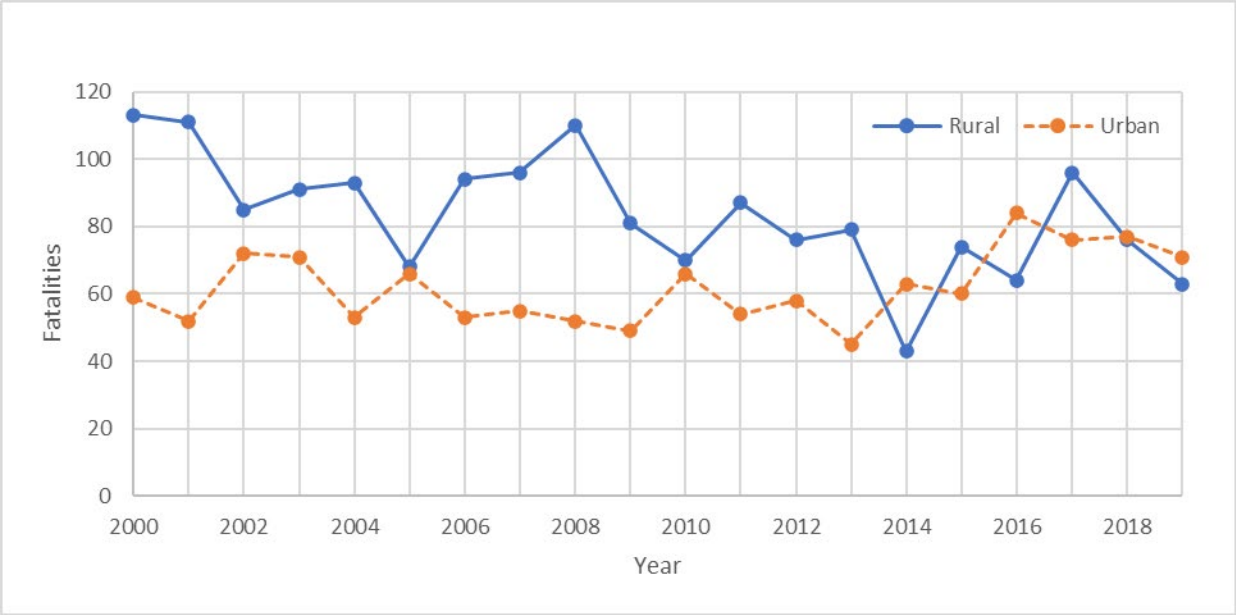

Figure 4.1 Annual Number of School Transportation-Related Fatalities

In addition to providing data regarding the number of fatalities, FARS identifies the total number of motor vehicle occupants involved in the crash, which is formally described as the "count of the number of Person Level (Motor Vehicle Occupant) Forms that are applicable to (a) case (e.g., occupants)". FARS also provides data on the total number of non-motor vehicle occupants, or the "number of Person Forms (Not a Motor Vehicle Occupant) that are applicable to (a) case (e.g., non-occupants)." The historical results from these two metrics, with the attributes of PEOPLE and PEDS, are shown as Figures 4.2 and 4.3, respectively.

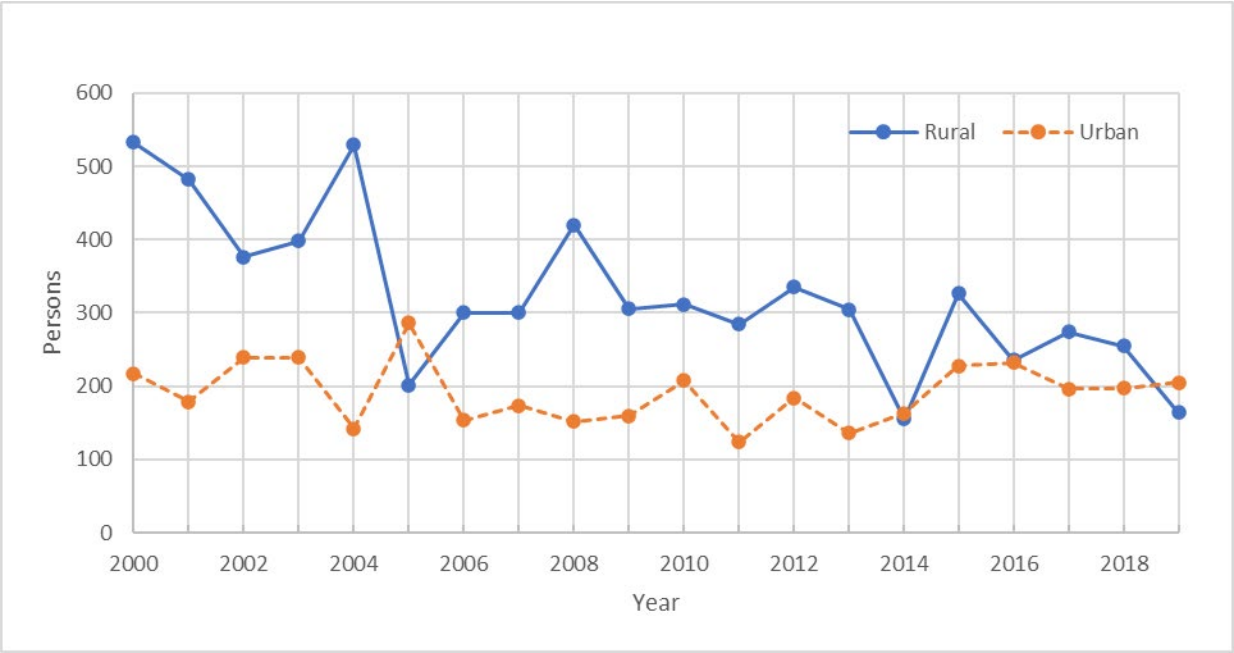

Figure 4.2 Annual Number of Motorists Involved in School Transportation-Related Fatalities

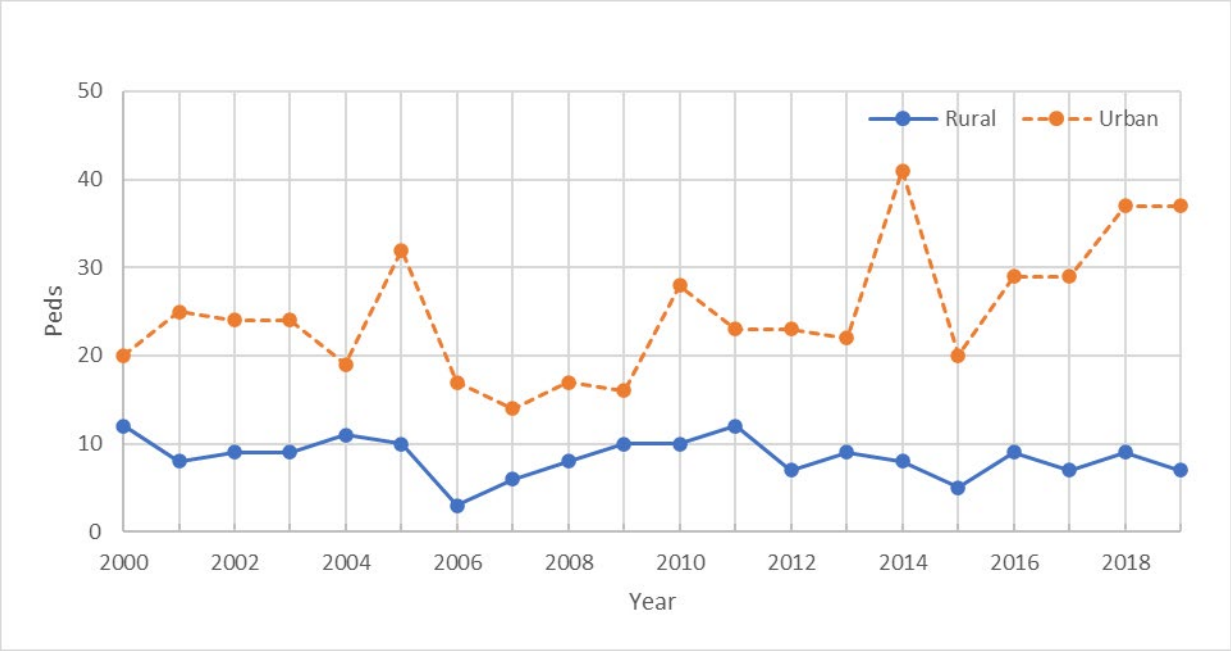

Figure 4.3 Annual Number of Non-Motorists Involved in School Transportation-Related Fatalities

These results provide several outcomes of interest. First, while rural facilities account for a greater number of motor vehicle occupants involved in a fatal, school transportation-related crash, urban facilities, by comparison, constitute a higher number of non-motor vehicle occupants involved in a fatal, school transportation-related crash. Non-motor vehicle occupants, or pedestrians and bicyclists, are more likely to walk or bicycle from home to school in an urban environment where the location of the school is not distance-prohibitive and sidewalks and walkways are present.

The results from Figures 4.2 and 4.3 also highlight four distinct trends. While the total number of motor vehicle occupants involved in an urban school transportation-related crash and the total number of non-motor vehicle occupants involved in a rural school transportation-related crash have remained relatively constant over the last two decades, the total number of motor vehicle occupants involved in a rural school transportation-related crash has declined, from a peak of 533 people in 2000 down to 155 people in 2014. However, the number of non-motor vehicle occupants in urban areas has been trending upward since 2014, so protecting the walking and bicycling environment for students who travel or cross an urban facility must remain a high priority.

The final outcome focused on the number of school buses involved in a school transportation-related fatality crash. In this case, the total number of school buses in urban crashes has remained in a narrow band over the years, ranging from a high of 51 crashes in 2005 to a low of 31 in 2017. School buses involved in rural crashes have been trending downward, peaking in 2008 (63 buses) and declining to a low of 26 buses in 2014.

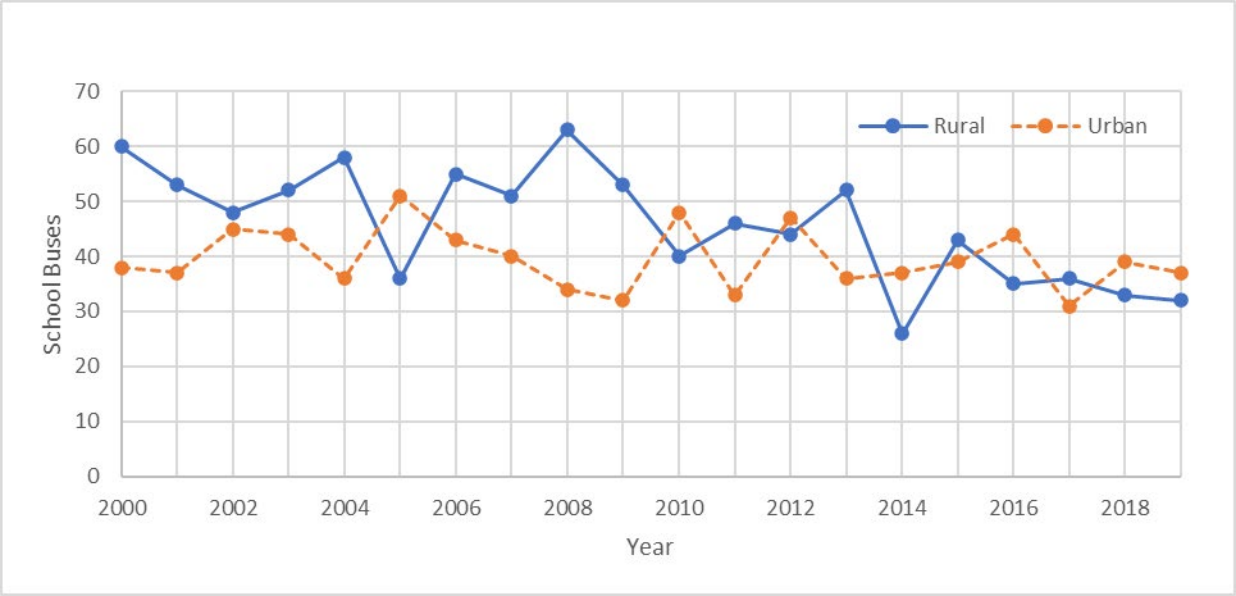

Figure 4.4 Annual Number of School Buses Involved in School Transportation-Related Fatalities

Based on the cumulative results, trendlines for each data set were calculated and are summarized in Table 4.3. School transportation-related crashes on rural facilities trended favorably across all four metrics, with the number of persons involved declining by an average annual percentage of 2.82% and the number of school buses involved declining by an average annual percentage of 2.11%.

School transportation-related crashes on urban facilities presented a less favorable outcome in two categories. While the number of people and school buses involved in a fatal crash annually declined over the twenty-year review period by 0.35% and 0.52%, respectively, the total number of fatalities and the number of non-motorists involved in a fatal crash trended upward, resulting in annual increases of 1.26% and 3.61%, respectively.

Table 4.3 School Transportation Data Trends

SAS Name	Attribute Code	Trendline	Annual % Change
Rural	Fatals	y = -1.84x + 102.84	-1.79%
	Persons	y = -13.04x + 461.59	-2.82%
	Peds	y = -0.10x + 9.50	-1.05%
	SchBus	y = -1.24x + 58.81	-2.11%
Urban	Fatals	y = 0.69x + 54.58	+1.26%
	Persons	y = -0.70x + 198.10	-0.35%
	Peds	y = 0.65x + 17.99	+3.61%
	SchBus	y = -0.22x + 41.83	-0.52%

The results presented here represent a next step at looking at school transportation-related data. As noted earlier, the framework makes several assumptions and these assumptions need to be carefully scrutinized. While the parameters of the calendar year dates, days of the week, and morning and afternoon time windows were thoughtfully established, it is acknowledged that some non-school transportation-related crashes will have been absorbed into this analysis. Conversely, some school transportation-related crashes attributed to a weekend school-related field trip or activity will have been missed. There are opportunities to refine the approaches that have been taken, and further discussion is provided in the conclusion section.

The individual attributes of the FARS dataset also required some assumptions to be made. While some attributes were specific to school transportation (e.g., school bus, school advance or crossing sign, etc.), other attributes broadly captured a wide range of issues, so school-related issues were only part of an indistinguishable subset. For example, attribute code 33, which was identified in both the VEHICLE and PERSON data files, recorded factors "related to motor vehicle occupants other than drivers and persons not in motor vehicles as expressed in the case materials." In this case, these factors included "Passing Where Prohibited by Posted Signs, Pavement Markings, Hill, or Curve, or School Bus Displaying Warning Not to Pass." In other words, while a particular case number was included in this analysis because the crash could have been due to a "school bus displaying (a) warning not to pass", the actual crash could have been due to a driver "passing where prohibited by posted signs." Based on the available information in the FARS database, it was not possible to tell whether the former or latter assumption contributed to the actual crash. Similarly, in the VIOLATN data file, attribute code 22 was attributed to "exceeding (a) special speed limit". This special speed limit, which could have occurred in a school zone, also included special cases for trucks, buses, cycles, or when traveling on a bridge.

Lastly, it should be noted that while the results presented here represent the actual number of fatalities, people, pedestrians, and school buses involved, the total number of trips has steadily increased over this twenty-year period. As a result, calculated crash and fatality rates based on vehicle miles traveled would likely yield more favorable results, but would require additional volume data that exceeded the scope of this study.

CHAPTER 5. CONCLUSIONS

This study explored school travel risk to determine existing and potential changes over the last two decades. This analysis was achieved by interviewing transportation professionals and analyzing a twenty-year FARS data set. The results suggest that education programs and school bus technologies have improved over time with a net positive safety benefit. However, other aspects such as general concerns about the roadway environment and the need for better data collection have only changed a small amount or remained essentially stagnant.

The complexities associated with the management and variables that influence school safety and risk included vehicle design and equipment, operations, infrastructure/environmental conditions, and societal factors. Key themes based on the interviews with transportation professionals provided a better understanding of trending concerns associated with school transportation and many of these complexities. As stated before, some of these concerns have not changed since Special Report 269 such as the environmental factors (i.e., sidewalks, crosswalks, roadway conditions) and poor driver behavior (i.e., distracted driving, speeding). The concerns that have shifted since then were safety education programs, vehicle centric travel, community planning (i.e., school siting, consolidation), and pick up/drop off safety.

Education programs that are integrated into school curriculum can be more successful in decreasing fatalities but have not been universally implemented. This education need could target issues such as children not knowing how to ride a bicycle, health benefits from active modes of travel, crosswalk safety, and awareness of safety dangers when boarding a vehicle. Other safety education program options for parents and student drivers covering all modes of travel would be constructive as well. These programs could further inform parents about walking school buses/bicycle trains, safe walking/bicycling routes, safe drop off/pick up locations around the school, safe driving related to school zones, school bus safety, and school bus routes. Enhancing school bus driver education should be considered when looking to improve that specific mode of travel.

Roadway environment factors will always be a concern for most transportation modes. The implementation of walking and bicycling infrastructure and other methods of safety infrastructure (narrow roads, green strips, bulb outs, etc.) would promote active modes of travel. This would potentially increase the use of these modes and reduce the risk around schools. These enhancements in turn will improve the safety of drop off/pick up by school buses and passenger vehicles.

School bus and vehicle technology will continue to improve with the evolution in camera technology, development of electric vehicles, and communication between vehicles. This will contribute to better and more data collection which may help to identify the causes or contributors of related walking and bicycling crashes. The camera information will be constructive to help analyze specific crashes. Recorded camera footage from buses and vehicles could be used to collect trip and passenger data. More research and development of methods and standard practices for data collection of all school travel modes would improve the overall process for understanding the trending needs and demands of school travel.

Better data collection methods remain to further walking and bicycling behaviors and to identify overall trends. The standardization of data collection is desired but would be complicated to organize and implement due to the various methods and different coding systems used by each state. Better data collection on all modes for school travel would allow further assessment on how well the different

modes are utilized. Each mode could be analyzed in more detail to find the highest risk. Key decisions related to school transportation safety spending like school bus technology improvements can be made using this data, however it can be challenging to decide if little data exists. This challenge is true for walking and bicycling infrastructure decisions.

The increasing number of parents driving their children to school, due to a variety of reasons, continues to affect safety around school zones. Traffic congestion around schools at drop off/pick up locations and crosswalks near schools contributes to school-related risk and safety concerns. The location of schools and availability of safe walking and bicycling infrastructure affects mode choice for school travel. Establishing neighborhood schools and safe active modes of transportation will alleviate the congestion and provide a lower risk environment around schools.

This study also conducted a comprehensive review of the FARS database by identifying all of the possible attributes that could be linked to a school-related crash. Based on a review of all pertinent data files, a set of attributes specific to school-related travel was identified, and all applicable crash records were then gathered, screened based on typical school travel window parameters, and categorized depending on whether the crash occurred on a rural or urban facility. The analysis concluded that on rural facilities, the number of fatalities, number of motorists and non-motorists, and school buses involved in a fatal crash have trended lower in the last twenty years. On urban facilities, however, the number of fatalities and non-motorists involved in a fatal crash have trended higher, while the number of motorists and school buses have trended marginally lower. These outcomes suggest that school transportation activities such as, but not limited to, prioritizing infrastructure improvements, exploring student walking behaviors, and implementing school bus safety enhancements serve as opportunities to contribute to impactful change (Sundstrom et al., 2010; Chang et al., 2018). The minimum y-axis value for each figure presented in this study was intentionally set at zero to emphasize that work remains before the ideal benchmark of zero fatalities and injuries is reached.

As noted earlier, the outcomes from this study were based on FARS database attributes that were not always exclusive to school transportation and on a set of a screening criteria that sought to capture crashes occurring during typical school travel windows. As a next step, the results should be further analyzed to target the specific contributors to the fatal crashes that have occurred. For example, data elements such as age (AGE) and gender (SEX) of the driver could help to determine if male high school drivers are overrepresented in the data set. The state (STATE), county (COUNTY), and city (CITY) data elements could be used to identify geographic trends. The assumed time windows could be further stratified based on the specific hour (HOUR) and minute (MINUTE) of the crash and the month (MONTH) and day (DAY) of the crash to explore how daylight, or lack thereof, may have contributed to varying crash trends during the fall, winter, and spring seasons.

While school transportation remains a relatively safe travel activity overall for the 57 million students who make at least two daily trips each school day, school children, parents, transportation operators, school teachers and administrators, and community members must remain vigilant. As land availability and costs push schools further away from established neighborhoods, the trip to school for the next generation of boys and girls will present new transportation safety challenges. The results from this study will help guide the transportation decision-making process moving forward, while recognizing that present-day opportunities still remain to protect our nation’s elementary, middle and high school students during their trip to and from school.

CHAPTER 6. REFERENCES

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