STUDENT TRANSPORTATION BENCHMARKING SURVEY

Michigan School Business Officials

in conjunction with

Management Partnership Services, Inc.

November 2009

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Introduction

The following report details the results of the 2009 survey of student transportation operations conducted by the Michigan School Business Officials. The survey was designed to continue the development of indicators that can be used to quantify the performance of individual transportation programs. The specific objectives of the survey process include:

1. Define a series of relevant indicators of operational performance.
2. Develop a mechanism whereby districts will be able to compare their performance internally and to comparable districts across the state.
3. Increase the availability of quantitative measures to evaluate operational performance.
4. Identify best management practices through analysis and interpretation of survey results.
5. Establish a mechanism to evaluate the impact of changes in policies or practices on transportation efficiency and cost effectiveness.

The inherent complexity of transportation operations, including the effect of topography, student density, traffic, school locations and bell times, requires a structured analytical approach to understand the performance of an operation. The empirical data available in modern accounting, fleet management, and routing software, permits transportation cost and quality to be measured more efficiently and effectively than ever before. Consistent use and analysis of performance measurement data allows school boards, superintendents, business managers, and transportation managers to spot important trends that may indicate whether or not further scrutiny and management controls are warranted.

The survey was conducted in conjunction with the Michigan Department of Education and Management Partnership Services, Inc.

Survey Results

The results of this survey were derived from two primary data sources:

- The 2007 – 2008 SE-4094
- The 2009 Transportation Benchmarking Survey

The SE-4094 is submitted annually by school districts across Michigan. It includes data on transportation costs, service volumes (number of buses, total miles traveled, and students transported), and personnel data. The transportation survey was conducted in April and May 2009. The survey collected data on the number of bus trips, fleet maintenance staffing, service delivery type, and transportation policy information. All of the analyses presented below represent a blend of regular education and special education costs and resources requirements, except where noted.

Of the 611 districts who submitted results for the SE-4094, 114 (19 percent) responded to the survey. The 114 districts who responded represented nearly 30 percent of all buses driven across the state and 31 percent of total students transported. The following table summarizes the responses by the number of students transported and the size of the bus fleet.

Table 1: Responses by number of students transported

Students Transported	Respondents	% of Total
<=1000	39	34%
1,001 to 2,000	41	36%
2,001 to 3,000	8	7%
3,001 to 4,000	7	6%
4,001 to 5,000	7	6%
5,001 to 6,000	6	5%
6,001 to 7,000	3	3%
7,001 to 8,000	2	2%
>=8,001	1	1%
Total	**114**	

Table 2: Responses by fleet size

Fleet Size	Respondents	% of Total
<= 25	63	55%
26 to 50	27	24%
51 to 75	12	11%
76 to 100	9	8%
>=101	3	3%
Total	**114**	

Overall, the "typical" district that responded to the survey was a district operated transportation program utilizing 33 buses in a single bell system that transported slightly more than 2,000 students. These values are reasonably comparable to statewide data available in the SE-4094 that indicated an average district used 21 buses and transported 1,300 students.

Structure of Report

The results of the survey are divided into two separate sections. The first section focuses on performance indicators for both transportation and fleet management operations. Within these areas, performance indicators have been established related to financial and operational considerations. To the extent possible, both state reported data and survey data is used to calculate performance indicators. Where data permitted, the indicators have been presented by region (as defined in Appendix 1), fleet size, and number of students transported. It is believed that these multi-variant breakdowns will offer users of the survey a more complete and nuanced understanding of survey results.

Use of Results

Throughout this report two primary metrics have been calculated for virtually all measures. The first metric is the average value. The average represents the arithmetic mean of all values in the set. This value is very sensitive to the influence of very large or very small relative values in the set and would, if looked at in isolation, provide an incomplete and potentially inaccurate perception of performance in the specific areas. Therefore, we have also calculated a median value for all measures where the data provided allowed us to do this. The median represents the point where exactly half of the values in the set would be smaller and half would be larger than this value. The median is not impacted by the extremely large or small values in the set and presents a reasonable representation of the "average" value of a group of data, provided that most of the values are clustered around the median. Both measures are provided to allow districts multiple points of comparison for use in evaluating their operations.

While a quantitative approach to reviewing performance is efficient and revealing, there are a number of inherent limitations that must be considered. These include:

- Data Quality – The results achieved are only as accurate and complete as the quality of the source data. There are certain inconsistencies in both SE-4094 and survey data that influence results but do not invalidate them. However, all uses of the data should take this factor into account.

- Qualitative Factors Affecting Performance – Calculating quantitative measures of performance generally only provides a starting point in analyzing performance. All information and conclusions should be considered in the context of the specific operational requirements and constraints faced by a school district. While some of these factors can be quantified, other important, albeit subjective areas, such as extra accommodations for special education students beyond those required for transportation, need to be considered as well.

- Performance Trends – The analysis presented in this document provides a "snapshot" view of performance at a specific point in time. It is equally important to track trends in performance over time in order to determine whether decisions made are having the desired effect, and to avoid misinterpreting a one-time calculation. However, developing a comprehensive history of performance trends will require implementation of many of the recommendations presented in this report to provide the data necessary to perform the desired calculations.

- Service Delivery Approach – Because different, but equally valid, approaches to providing student transportation services are found in many school districts, quantitative metrics do not provide the only true and accurate measure of performance without a thorough understanding of how the various approaches to service delivery will affect the quantitative comparison.

Despite these cautions, the results of the survey will be useful to everyone who is interested in analyzing transportation performance. In order to receive the most value from the survey results, a multi-step analytical process should be followed. The seven steps in the process are described briefly below:

1. **Calculate** – use the description of the measures provided to calculate your district's measures of performance.
2. **Compare** - use your results to compare to fleets of similar size and districts of similar student counts. In addition you can compare your results to other districts in your ISD for many of these measures.
3. **Evaluate** – use the measures to ask questions about how you do business and why some measures may be higher or lower than comparative districts.
4. **Focus** - identify how changing your business practices can have a positive impact on your results.
5. **Develop standards** – use historical trend information and comparative results to establish goals and objectives for the changes.
6. **Develop processes and tools** – identify what elements of your operation will need to be changed and identify a reasonable time frame for the change. Establish timelines for completing the goals and objectives and assign responsibility and accountability for accomplishing them to specific personnel.
7. **Measure** – recalculate and reevaluate the impacts that your changes had. Were they positive? Were they negative? Were they what you expected? Use the results of this review to begin the process again.

A regular program of performance measurement is a key tool to continually improving the cost competitiveness and quality of service provided by any operation. The results of this survey can be a useful component to all school districts who have committed themselves to providing the best, most cost effective services to the students in their district.

Glossary of Terms

Bell Tiers (Tiering)
The use of multiple bell tiers is a strategy in student transportation designed to increase efficiency. A two-tier system would have one group of schools with common bell times and

another group of schools with a different bell time. The purpose of this strategy is to stagger bell times to allow reuse of buses. Care must be taken to properly space the tiers to allow appropriate time for buses to complete all runs on the first tier before moving on to schools on a second or third tier.

Capacity Utilization
A percentage based on the number of riders actually transported and the total capacity of the vehicles in a district's fleet.

Routing Software
Any computer-based program used to design, maintain and optimize the routes traveled by a district's buses. Routing software programs use mathematical algorithms to help optimize various factors involved with route development including ride time, ride distance and capacity utilization.

Median
The median represents the point where exactly half of the values in the set would be smaller and half would be larger than this value. The median is not impacted by the extremely large or small values in the set and presents a reasonable representation of the "average" value of a group of data, provided that most of the values are clustered around the median.

Average
The average represents the arithmetic mean of all values in the set. It is the sum of all values divided by the number of observations. This value is very sensitive to the influence of very large or very small relative values in the set and would, if looked at in isolation, provide an incomplete and potentially inaccurate perception of performance in the specific areas.

Performance Indicators

The following section of the report will provide transportation managers and district administrators with a selection of highly relevant performance indicators for both transportation and fleet management operations. Where possible, trend information from the 2007 Student Transportation Benchmarking Report is also included for consideration.

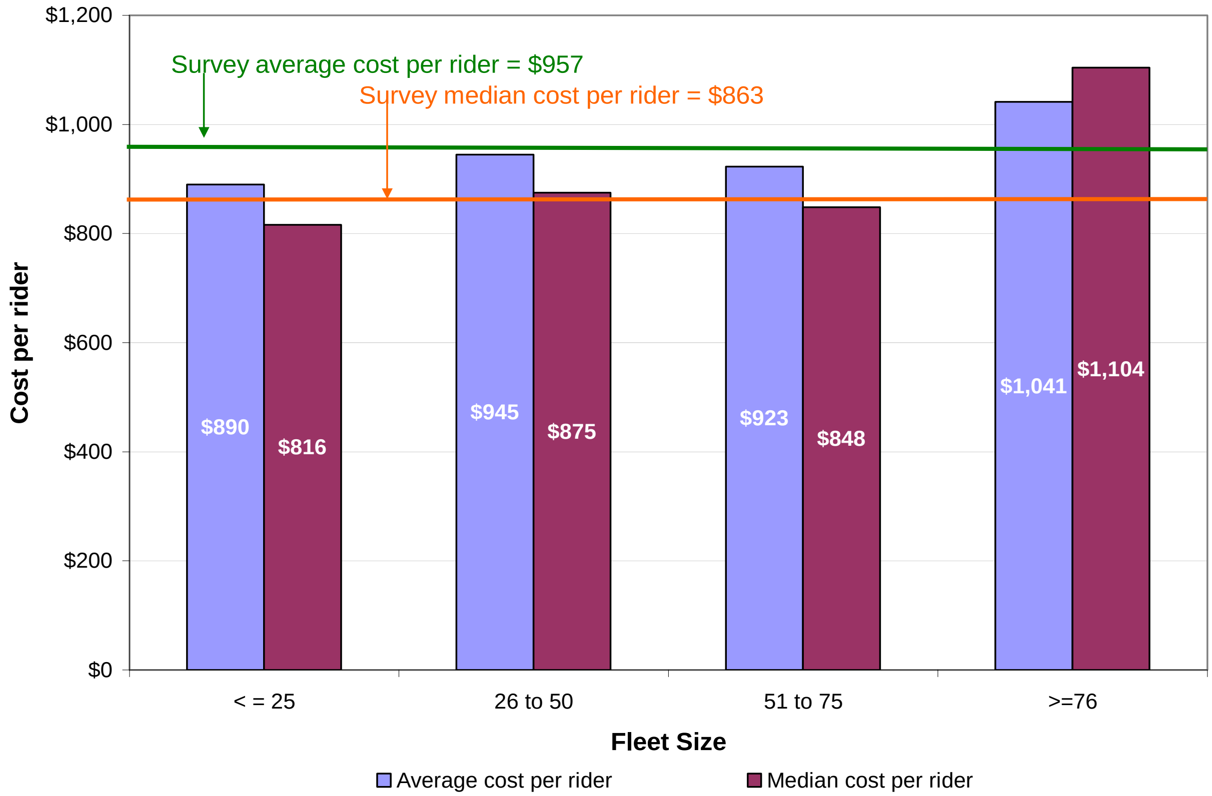
Transportation Operations Indicators

Transportation costs are based primarily on decisions that impact how many students can ride a given bus and how many times that given bus is used throughout a service day. An operation that is able to design bus runs and routes to transport more students on fewer buses will generally, all other factors being equal, have lower costs than its peer organizations. Therefore, fully understanding transportation requires an understanding of both cost and operational performance. To that end, the survey evaluated two key cost-related metrics (cost per rider and cost per bus) and three routing related metrics (buses used per 100 riders and simple capacity use, and daily runs per bus).

Cost Indicators: Cost per rider and Cost per bus

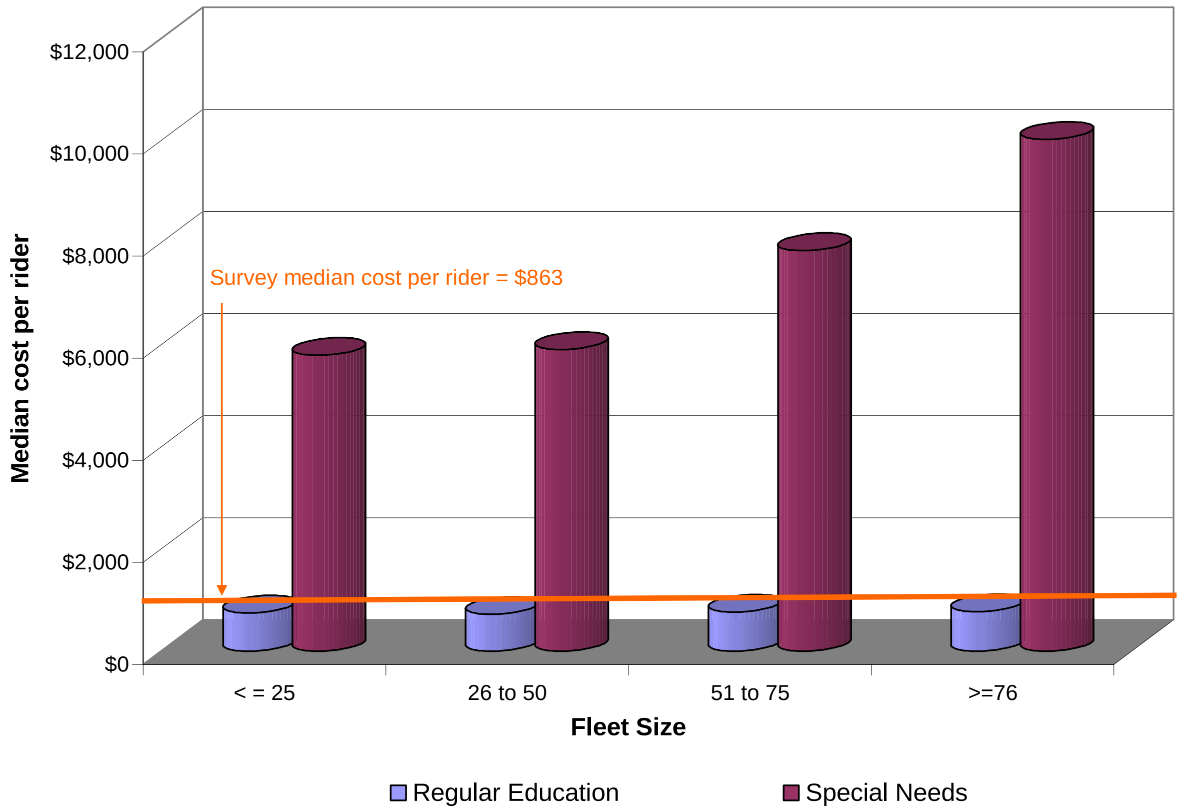
Transportation departments are in the business of moving students. As a result, what it costs to transport each student is a highly relevant indicator or performance. Analysis of survey responses indicates that transportation costs have increased 15 percent on the average value and 12 percent on the median value since the 2007 survey. These costs are primarily attributable to increases in fuel and personnel costs, particularly employee benefits. The following chart summarizes the average and median cost per rider from the 114 survey respondents.

Figure 1: Average and median cost per rider



Detailed analyses of these costs indicate that special needs transportation is approximately 10 times more expensive than regular education transportation. The following chart summarizes the median costs per rider for regular education and special needs transportation.

Figure 2: Median regular and special needs cost per rider



Also apparent in the responses were regional differences in per rider costs. The table below summarizes the average and median costs for regular education, special needs, and overall transportation costs by region.

Table 3: Cost per rider by region

Region	Count of responses	Regular Education		Special Education		All Transportation[1]	
		Average	Median	Average	Median	Average	Median
Upper Peninsula	4	$901	$888	$4,618	$6,692	$1,057	$1,090
Northern Lower Peninsula	12	$843	$928	$9,314	$5,289	$957	$999
Western	29	$697	$716	$6,753	$4,697	$842	$809
Thumb and surrounding area	17	$663	$665	$6,241	$6,104	$1,034	$774
South central	20	$739	$755	$6,473	$4,420	$834	$763
Southeast	32	$720	$748	$7,976	$8,256	$1,014	$1,045
Survey Totals	**114**	**$724**	**$737**	**$7,354**	**$6,219**	**$957**	**$863**

[1] All Transportation represents the combined totals of regular and special education transportation.

Table 3 indicates that transportation costs are generally highest in the northern areas of the state and in suburban Detroit. These results are consistent with the 2007 survey results. Also of note is the $327 per rider range in the high ($1,090 per rider in the Upper Peninsula) to low ($763 in the South central region) median values for All Transportation. It is important to consider that the $223 per rider value is significant in that it can represent a $654,000 range in transportation costs for the average district responding to the survey ($223 per rider multiplied by the average rider count of 2,000). In order to provide additional insight into comparison values, the following table summarizes overall, average and median values by the number of riders.

Table 4: Cost by ridership groupings

		Regular Education		Special Education		All Transportation	
Riders	Responses	Average	Median	Average	Median	Average	Median
< =1,000	39	$864	$871	$7,166	$6,728	$1,575	$1,020
1,001 to 2,000	41	$718	$703	$5,302	$5,265	$789	$767
2,001 to 3,000	15	$731	$685	$8,542	$7,874	$993	$832
3,001 to 4,000	7	$709	$714	$6,227	$6,871	$847	$852
4,001 to 5,000	6	$796	$819	$9,428	$9,554	$1,028	$1,056
> = 5,001	6	$620	$636	$7,128	$6,907	$856	$873
Survey Totals	**114**	**$724**	**$737**	**$7,354**	**$6,219**	**$957**	**$863**

As with the previous charts and tables, there is a significant difference between regular education and special needs transportation costs in all ridership groupings. Again, there is also a significant high-to-low range in median value of All Transportation costs ($289 per rider). Consequently, it is critical that each district carefully select the comparative values it uses to evaluate its own performance. It is recommended that multiple measures be selected and used for comparison to evaluate performance.

Comparative results on a per bus basis are similar to the per rider results in that costs have increased significantly since the 2007 survey. Average cost per bus increased 24 percent and median costs are 14 percent greater in the 2009 results. Significant differences also exist in costs related to fleet size, regions, and ridership groupings. The tables below summarize the fleet, regional, and ridership grouping costs overall and for regular and special needs.

Table 5: Cost per bus by fleet size

Number of Buses	Responses	Regular Education		Special Education		All Transportation	
		Average	Median	Average	Median	Average	Median
< = 25	63	$50,920	$43,559	$99,501	$62,043	$56,941	$46,556
26 to 50	27	$50,212	$51,374	$66,247	$64,959	$53,352	$52,290
51 to 75	12	$52,266	$52,677	$76,592	$67,535	$56,720	$53,486
>=76	12	$64,194	$65,946	$86,449	$90,682	$70,293	$73,475
Survey Totals	**114**	**$54,601**	**$47,637**	**$81,812**	**$66,648**	**$59,993**	**$50,958**

Table 6: Cost per bus by region

Region	Responses	Regular Education		Special Education		All Transportation	
		Average	Median	Average	Median	Average	Median
Upper Peninsula	4	$36,824	$34,886	$77,189	$82,759	$40,748	$38,966
Northern Lower Peninsula	12	$52,944	$42,854	$81,131	$38,627	$55,459	$43,430
Western	29	$49,579	$42,470	$89,920	$55,927	$54,277	$43,181
Thumb and surrounding area	17	$52,091	$49,242	$74,230	$62,201	$59,183	$51,812
South central	20	$47,425	$45,128	$89,627	$67,600	$50,452	$47,774
Southeast	32	$61,467	$57,383	$82,379	$83,255	$66,878	$62,463
Survey Totals	**114**	**$54,601**	**$47,637**	**$81,812**	**$66,648**	**$59,993**	**$50,958**

Table 7: Cost per bus by ridership group

Number of Riders	Responses	Regular Education		Special Education		All Transportation	
		Average	Median	Average	Median	Average	Median
< =1,000	39	$42,231	$40,834	$87,993	$67,028	$57,608	$45,641
1,001 to 2,000	41	$51,953	$46,390	$60,368	$50,174	$52,719	$46,556
2,001 to 3,000	15	$53,727	$57,264	$88,628	$92,625	$60,621	$61,299
3,001 to 4,000	7	$56,027	$56,192	$64,878	$65,201	$57,470	$53,679
4,001 to 5,000	6	$62,698	$56,789	$94,930	$93,030	$68,409	$59,914
> = 5,001	6	$63,710	$66,241	$78,880	$83,521	$67,647	$73,475
Survey Totals	**114**	**$54,601**	**$47,637**	**$81,812**	**$66,648**	**$59,993**	**$50,958**

The results of the 2009 survey are consistent with the 2007 results in that the highest costs are in larger districts located in the southeastern part of the state. This is again due in major part to differences in benefit related costs for these larger districts.

Operational indicators: Simple capacity use, Daily runs per bus, and Buses per 100 riders

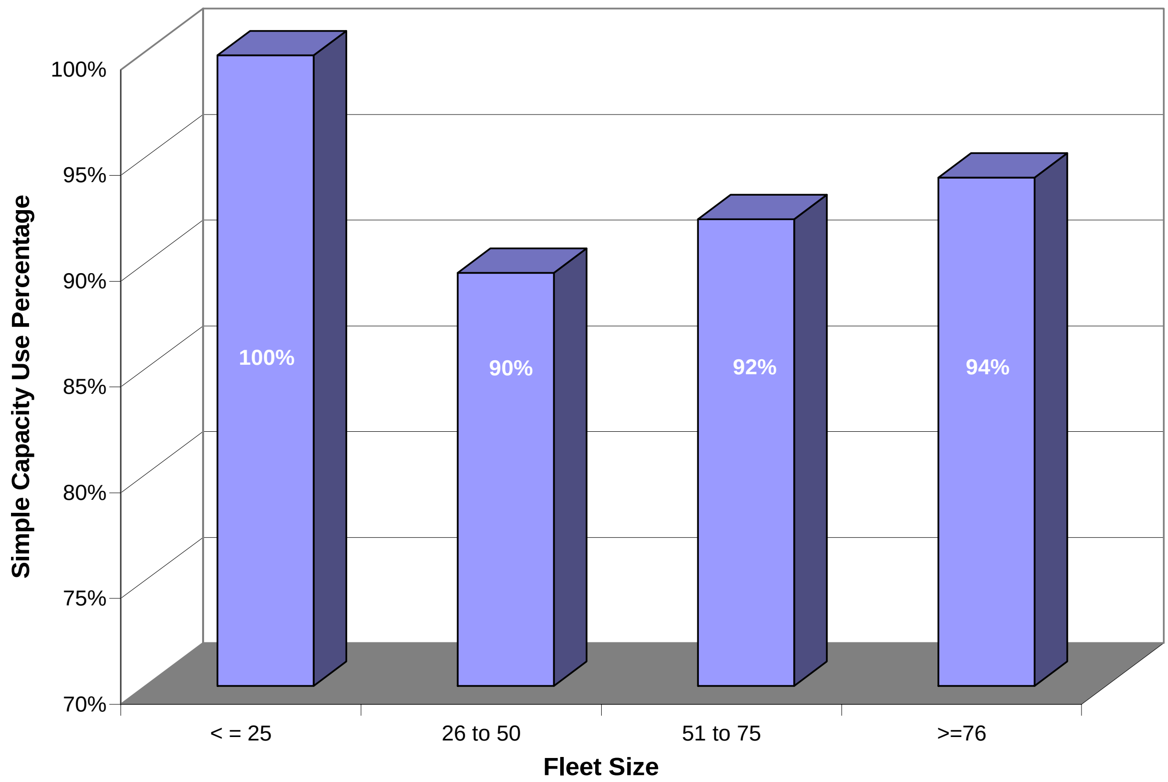
Key indicators of transportation efficiency focus on how many students are riding each bus and how many times a bus is used throughout a given day. Using the survey data, three performance indicators were calculated:

- Simple capacity use – Effective use of seating capacity is a fundamental component of transportation efficiency. This measure evaluates how many available seats are used in a given day.
- Daily runs per bus - Reusing a school bus throughout the day is a critical element of overall efficiency and cost effectiveness. The more opportunities that exist to reuse an asset, through changes to bell times or routing strategies, the more opportunities there are to distribute fixed and semi-fixed costs. This reuse will generally help lower total costs.
- Buses per 100 riders – This is an aggregate measure that incorporates both capacity use and runs per bus. As a result, it becomes an efficient way to evaluate and understand overall routing efficiency.

The results of these calculations are detailed below.

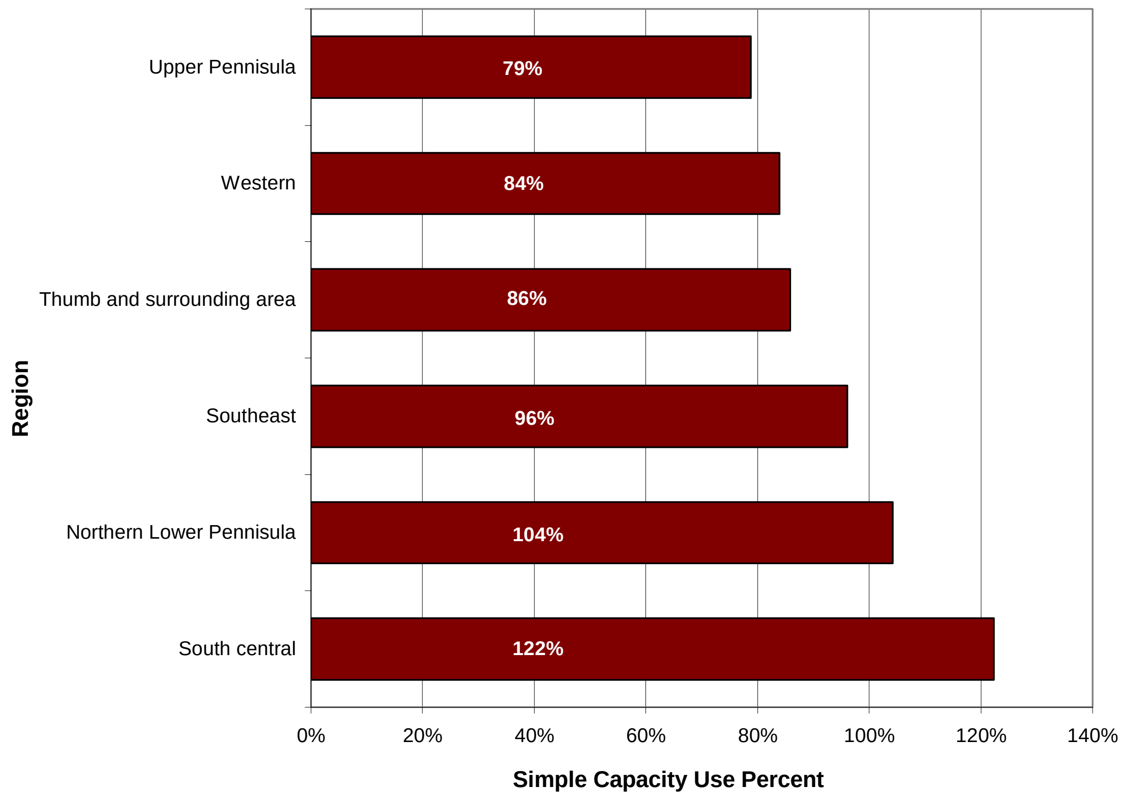
Analysis of simple capacity use presents some interesting contrasts to the 2007 survey. In the 2007 survey the range of values was 77 to 118 percent. Current results indicate a much narrower range of 90 to 100 percent. The data provided no clear indication of why the ranges would have narrowed so dramatically, but a plausible explanation may include differences in responding districts and improvements in routing efficiency due to financial constraints. Figure 3 below shows simple capacity use by fleet size.

Figure 3: Simple capacity use by fleet size



Evaluating capacity use by region, it is apparent that more rural areas have greater difficulty maximizing seating capacity. This is likely a reflection of time constraints due to the distances that must be traveled. The chart below shows simple capacity use by region.

Figure 4: Simple capacity use by region



Of particular concern is that for districts with single tier bell schedules (a practice common in the Upper Peninsula and the Western part of the state according to the survey responses), an inability to effectively use seating capacity will result in increased costs. In regions and in fleets where less than 100 percent of available seating capacity is being used, consideration should be given to the efficiency of current routing strategies.

In school districts where all of the schools start and end at the same time, the maximum number of trips a bus can perform per day is, generally, two (one in the morning and one in the afternoon). In school districts where elementary, middle, and high schools all start at *different* times, the maximum number of trips a bus can perform is six (three in the morning and three in the afternoon). While there are a number of variations on this theme, it is important to understand that this measure looks at the *total* runs a bus performs for home to school trips in a given day. Maximizing the use of the asset throughout the day is a key routing challenge and a significant indicator of overall efficiency. The following three tables summarize the average number of runs each bus is performing by fleet size, rider count, and region.

Table 8: Average runs per bus by fleet size

Fleet Size	Responses	Average Runs Per Bus Per Day
< = 25	63	2.1
26 to 50	27	2.4
51 to 75	12	3.4
>=76	12	4.4
Survey Total	**114**	**2.6**

Table 9: Average runs per bus by ridership group

Rider Group	Responses	Average Runs Per Bus Per Day
< =1,000	39	1.9
1,001 to 2,000	41	2.3
2,001 to 3,000	15	2.9
3,001 to 4,000	7	3.8
4,001 to 5,000	6	3.5
> = 5,001	6	5.0
Survey Total	**114**	**2.6**

Table 10: Average runs per bus by region

Region	Responses	Average Buses per 100 Students Overall
Upper Peninsula	4	1.6
Northern Lower Peninsula	12	1.4
Western	29	2.7
Thumb and surrounding area	17	2.4
South central	20	2.7
Southeast	32	3.1
Survey Total	**114**	**2.6**

Similar to the 2007 study, these results indicate that a two tier bell structure is still the most common bell structure across the state and larger districts, particularly in the southeast, use a three or more tiered structure. The limited opportunities for reusing a bus in a single or two tier system as part of efficiency efforts requires that transportation managers focus on maximizing capacity use in order to control or reduce transportation costs. In larger systems using multiple tiers transportation managers must carefully evaluate school times to ensure they offer the best possible options for promoting high levels of capacity use and frequent reuse of buses.

One measure that combines the principles associated with filling and reusing a bus is to evaluate the number of buses required to transport 100 riders. The principle of this measure is that in order to transport 100 students with one or fewer buses, it will be necessary to establish a multi-tier system that allows a bus to be reused. In addition, it would be necessary to place a sufficient number of students on the bus. Consequently, if a district were able to average 1.0 to 1.25 buses or less to transport 100 students it would be an indication of both effective capacity utilization and asset reuse. The charts below show the average and median number of buses required to transport 100 riders by region, fleet size and rider count.

Figure 5: Buses required to transport 100 riders by region

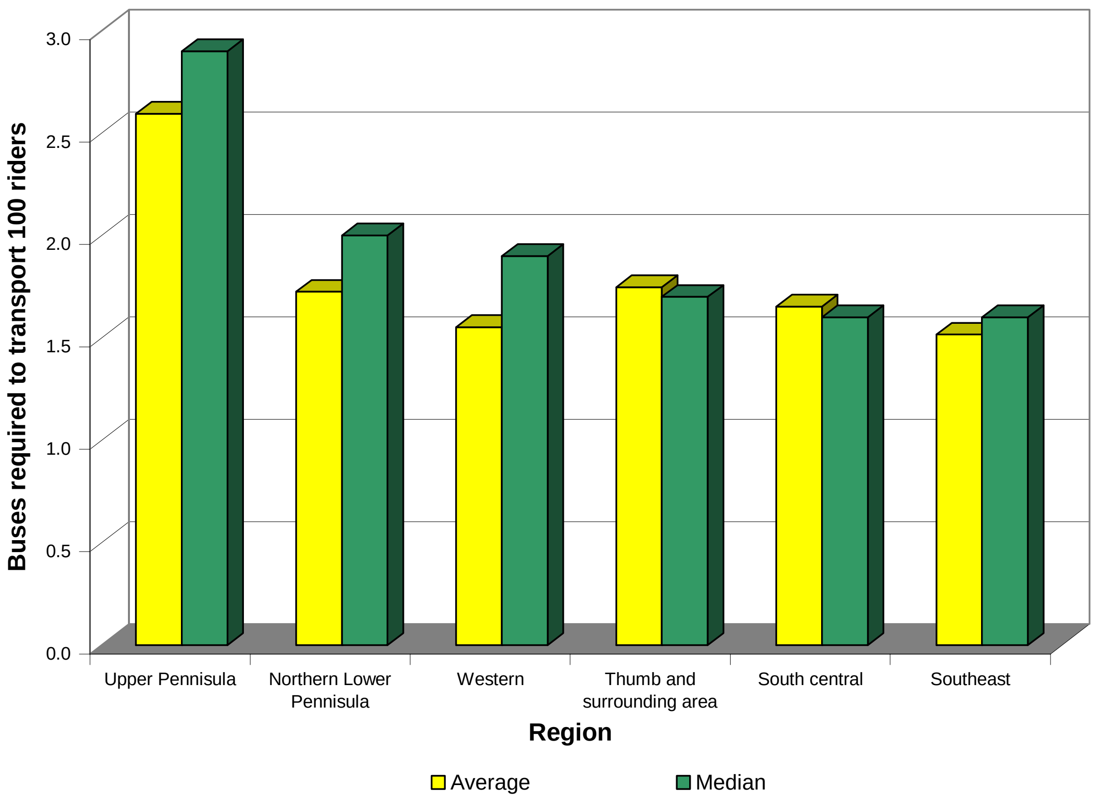


Figure 6: Buses required to transport 100 riders by fleet size

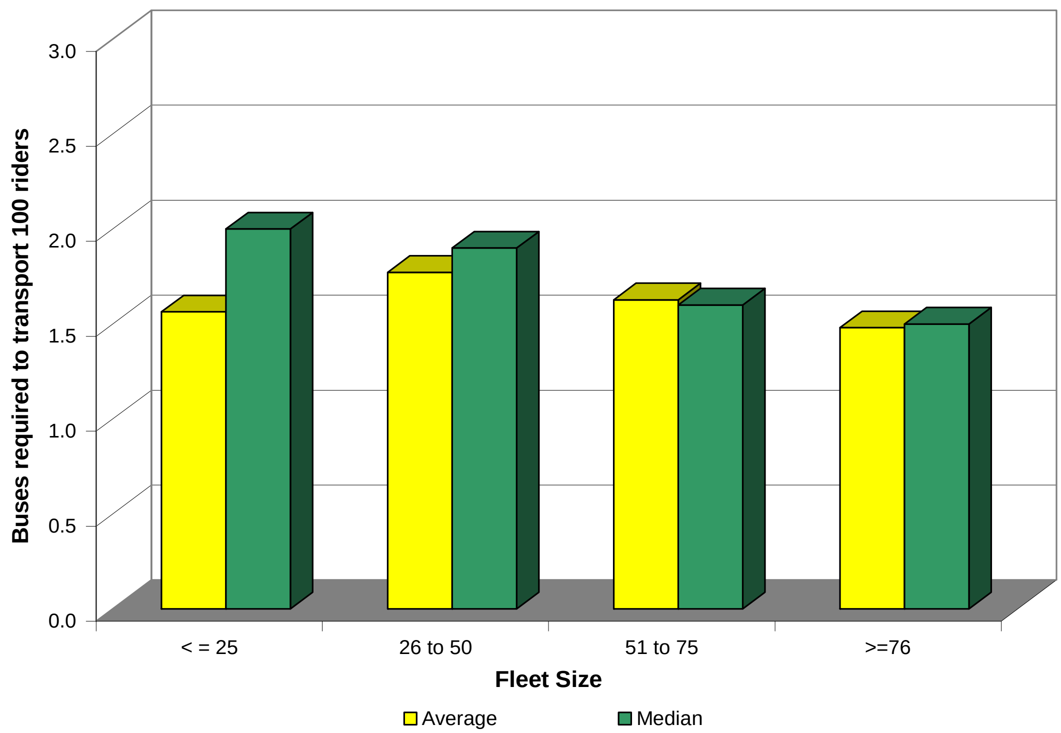
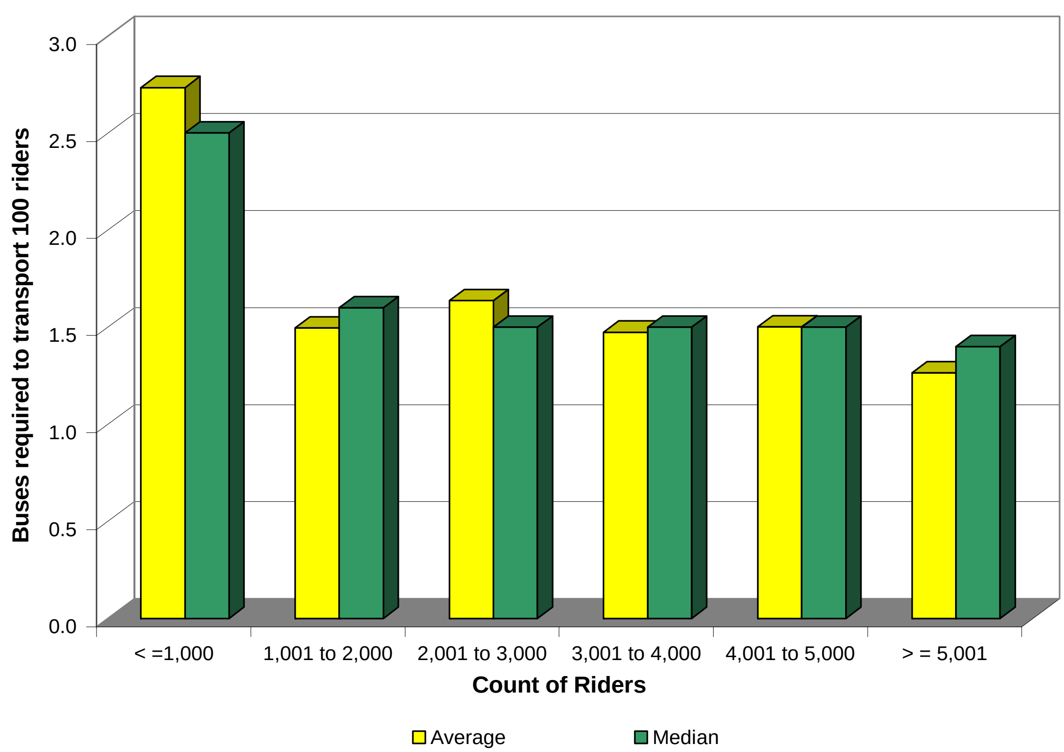


Figure 7: Buses required to transport 100 riders by rider grouping



The results of the survey, similar to the 2007 results, indicate that larger fleets in more densely populated areas are generally better able to fill and reuse a given bus. Continued efforts to evaluate alternative routing schemes to increase both the use of seats and the use of buses will be necessary as districts attempt to control or reduce transportation costs.

Fleet Management Indicators

Providing a fleet of vehicles that is safe, reliable and economical to operate is a critical function of the fleet management component of a transportation department. Effective fleet management includes vehicle and equipment maintenance and repair; managing technician resources; managing parts inventory; and ensuring shop safety. The challenge is to perform these tasks with the minimum number of resources possible in order to ensure the cost-effective delivery of services. An organization cannot be a high quality and low cost provider of transportation services without having a cost effective and high quality maintenance operation.

Survey data was used to calculate two key measures that assist in the evaluation of the appropriateness of maintenance staffing. Buses per technician and vehicle equivalent units per technician can be used to analyze where sufficient maintenance technicians are available to fully address the maintenance demand presented by the school bus fleet and the general district fleet of buses, vehicles, and equipment. Fleet age and mileage analyses were also conducted to understand fleet replacement practices.

Buses maintained per technician

The survey provided 96 usable responses to evaluate the number of buses maintained per technician. The results indicate that the average full time technician, that is a technician with no other duties besides maintaining vehicles and equipment, is responsible for 19 buses. This is an increase of two buses (12 percent) over the 2007 benchmarking survey. The following tables summarize the average and median number of buses maintained per technician by region, fleet size, and ridership.

Table 11: Buses maintained per technician by region

Region	Count of responses	Average buses per technician	Median buses per technician
Upper Peninsula	4	33	27
Northern Lower Peninsula	12	21	18
Western	29	20	20
Thumb and surrounding area	17	15	14
South central	20	17	14
Southeast	32	18	19
Grand Total	**114**	**19**	**19**

Table 12: Buses maintained per technician by fleet size

Bus Group	Count of responses	Average buses per technician	Median buses per technician
< = 25	63	17	15
26 to 50	27	22	21
51 to 75	12	20	21
>=76	12	18	19
Grand Total	**114**	**19**	**19**

Table 13: Buses maintained per technician by ridership

Rider Group	Count of responses	Average buses per technician	Median buses per technician
< =1,000	39	18	15
1,001 to 2,000	41	18	19
2,001 to 3,000	15	20	20
3,001 to 4,000	7	22	25
4,001 to 5,000	6	16	16
> = 5,001	6	19	19
Grand Total	**114**	**19**	**19**

Evaluating the appropriateness of the average and median values would require additional information on technician productivity. While not available as part of the survey, districts should expect 1,400 to 1,500 billable hours per technician per year. Fewer than 1,400 hours per technician would be an indication that staffing levels may be too high, while more than 1,500 hours would indicate that staffing levels may be too low.

Vehicle equivalent units maintained per technician

Fully analyzing the appropriateness of maintenance staffing requires a consideration of other vehicles and equipment that technicians must maintain. Typically, these include administrative sedans, pickup trucks used for buildings and grounds operations, grounds maintenance equipment, and large trucks. The most common method in the maintenance industry to evaluate the supply of mechanics necessary to maintain the demand presented by a fleet of vehicles and equipment is through the use of a concept known as vehicle equivalent units. This concept was originally developed by the United States Air Force and relates all vehicles to a standard, baseline unit. The baseline unit used is the average aged administrative sedan. The sedan is given a value of 1.0 vehicle equivalent unit (VEU) and all other vehicles and equipment are compared to this value. For purposes of the analysis of survey results, the following values were utilized:

- Auto – 1.0 VEU
- Pickup – 1.5 VEU
- Large Truck – 2.5 VEU

- Miscellaneous equipment - .75 VEU
- School Buses – 3.7 VEU

Industry data indicates that one full time equivalent technician should be able to maintain approximately 100 to 125 vehicle equivalent units. This is equal to one technician maintaining approximately 27 to 34 school buses, a value much higher than the average buses per technician of 19 calculated in the Buses per Technician section. The following table summarizes the results of the survey by fleet size.

Table 14: VEU per technician by fleet size

Bus Group	Count of responses	Average VEU per technician	Median VEU per technician
< = 25	63	78	70
26 to 50	27	94	90
51 to 75	12	81	87
>=76	12	78	79
Grand Total	**114**	**83**	**79**

Table 14 shows no fleet size grouping reaches the industry standard for vehicle equivalent units per technician. This would indicate that either there is excess maintenance capacity or an overstatement of full time equivalent technician positions. Evaluating the appropriateness of the VEU per technician ratio should consider a number of factors including:

- Preventive maintenance schedules;
- In-house versus outsourced repairs;
- Available facility space and tooling;
- Fleet age and condition; and
- Technician training and skills.

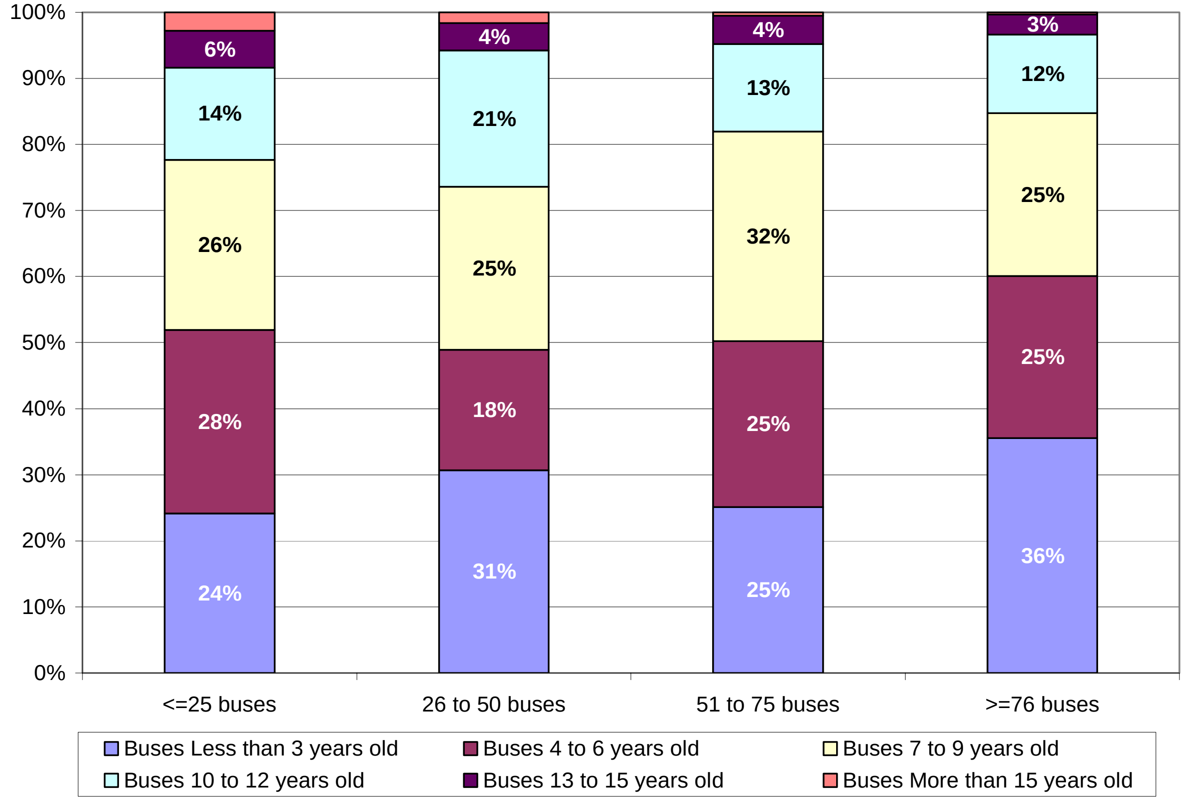
Determining the appropriate ratio between fleet size and the number of technicians required is critical to ensuring both high levels of technician productivity and cost effective maintenance.

Fleet age and use

It is generally understood that older, higher mileage vehicles will have a greater maintenance demand and higher costs. Fleet age and mileage will also impact the design and scope of maintenance programs and the number of technicians required. The survey process did not include the collection of individual asset data that would allow for a unit based calculation of bus age or mileage. As an alternative, respondents were asked to identify the number of buses within given age and mileage parameters.

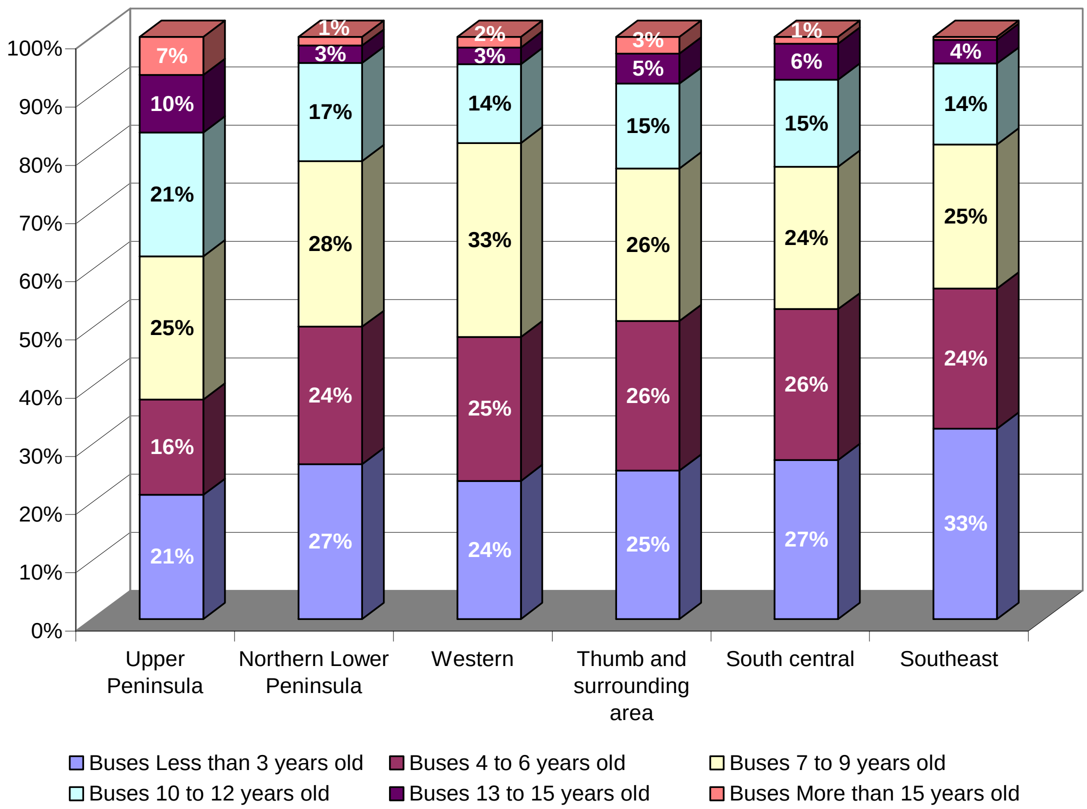
Figure 8 below shows the relative age of vehicles by fleet size. As can be seen in the chart, the largest fleets are also generally the newest.

Figure 8: Fleet age by fleet size



A regional breakdown of fleet age indicates that districts in the Upper Peninsula are having the most difficult time replacing vehicles as they have the largest percentage of vehicles 13 years or older. Figure 9 shows the distribution of age by region:

Figure 9: Fleet age by region



The charts indicate that buses average approximately 12 years as a replacement cycle. This is consistent with industry best practices. However, as funding becomes increasingly constrained districts will have to be vigilant in their analysis of vehicle replacement practices. Decisions to extend replacement cycles must consider the implications on maintenance cost and personnel requirements to ensure that safe and reliable transportation can continue to be provided.

A review of the accumulated fleet mileage by fleet size indicates that the overall distribution is relatively consistent across all fleet sizes. A concern is that fleet replacement cycles, as indicated by the range values that total 50 percent of the fleet, appear to be between 120,000 and 180,000 miles. Given the environmental conditions in Michigan, consideration must be given to establishing a replacement cycle that minimizes the total cost of owning and operating the bus. To the extent that the actual criteria is closer to the 180,000 mile end of the range, districts should evaluate whether they are experiencing relatively higher maintenance and repair costs. The following charts summarize accumulated miles by fleet size and region.

Figure 10: Fleet miles by fleet size

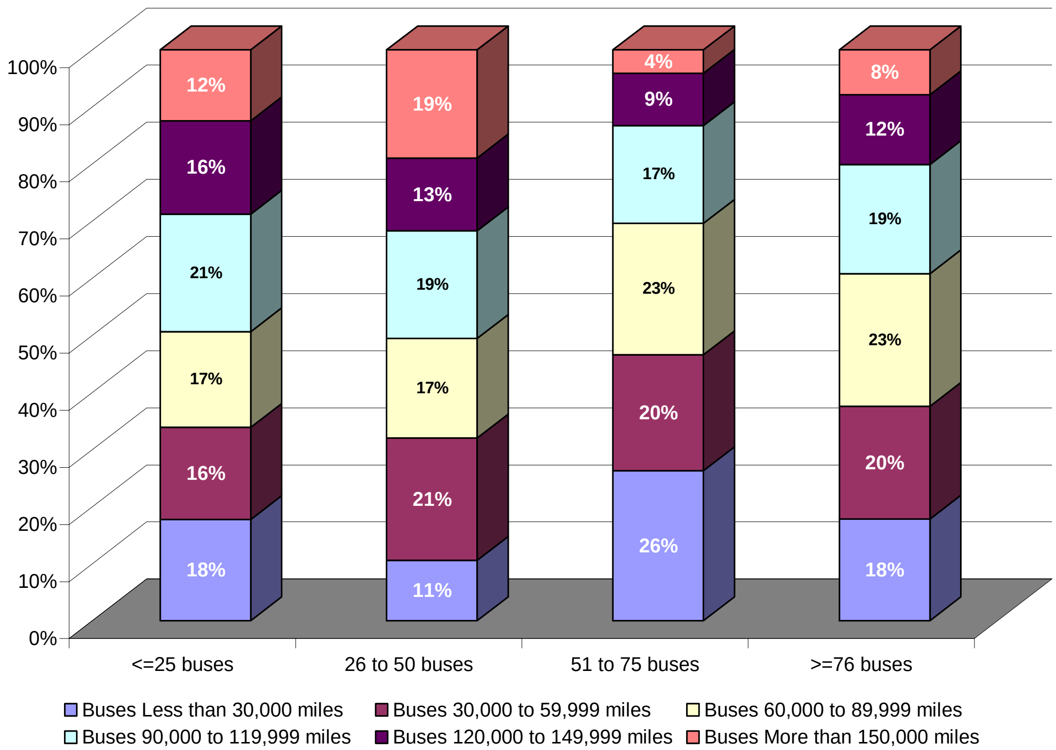
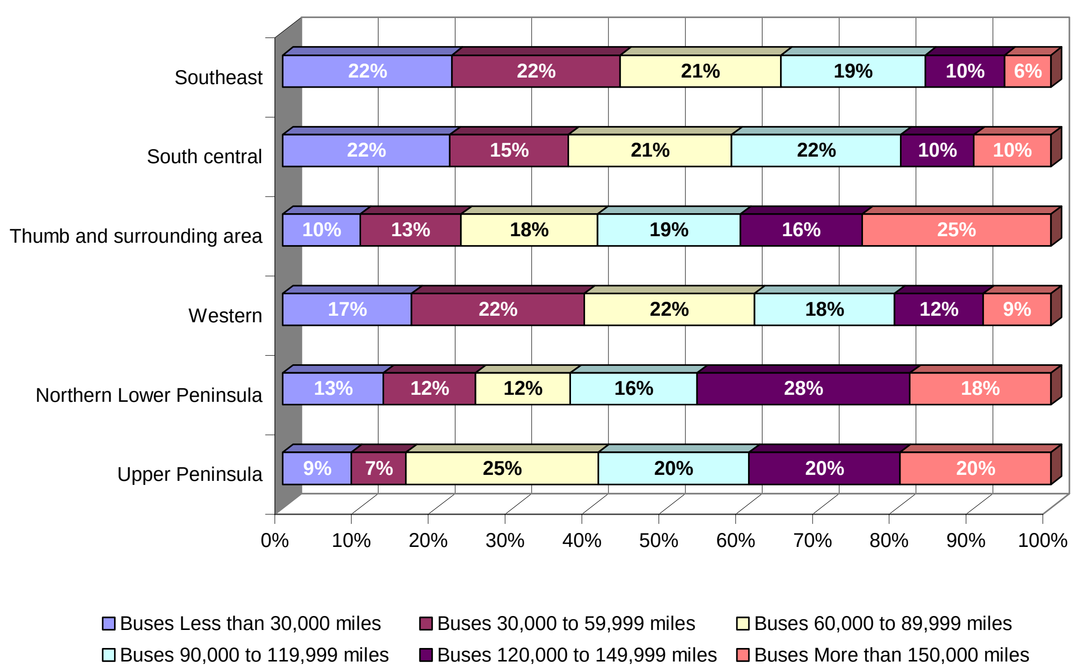


Figure 11: Fleet mileage by region



Policy and Practice Considerations

A primary goal of the transportation survey process is to identify best operating practices. As part of this effort, a selection of policy issues was identified and survey respondents were asked to provide insight into established practices. The following section summarizes the results of the policy inquiry and offers insights into best practices and additional operational considerations.

Idling policies

The confluence of environmentalism and fuel conservation has led districts across the country to consider adopting policies designed to reduce the amount of time school buses are at idle. As part of the survey, districts were asked whether they had adopted an idling policy, and if so, briefly describe the specifics of the policy requirements.

From the total responses, 110 usable responses were received. Of the 110 responses, 85 (77 percent) school districts indicated they had a policy while 25 did not. Of districts with an established policy, the general guidance was related to the amount of time that a bus could be at idle prior to run starts in the morning and at school locations between trips. Reference to the School Bus Emissions/Idling best practice section of the Pupil Transportation section of the Michigan Department of Education website was also common. Typical idling allowances included in the policies ranged from 10 to 15 minutes. A more limited number of responses also included some reference to atmospheric conditions (such as ambient temperature or wind chill temperatures) that dictated when idling was allowed and for how long. The final discriminating characteristics were distinctions between daily home-to-school transportation and extra curricular trips. The clear intent of these distinctions was to ensure that buses are not at idle throughout an entire sporting or extra curricular event.

Of note was that an extremely limited number of descriptions indicated how the idling policy is enforced. For this, or any policy, to be effective a rigorous enforcement procedure must be established concurrently with policy implementation that details how the specific requirements will be enforced. No reference to compliance monitoring procedures such as periodic spot checks or engine analysis was included in the brief descriptions offered. In instances where compliance monitoring procedures are not clearly established, the effectiveness of these policies would be increased if consideration was given to the enforcement approach and the associated monitoring procedures were detailed.

Ride time policies

Student ride times serve several useful functions in both transportation planning and analysis. For purposes of planning, ride time guidelines serve as a fundamental constraint in run design and can have significant influence over the type of routing strategies used by a transportation service provider. Student ride times are also a key indicator of service effectiveness.

Of the 114 survey responses, only 47 (41 percent) indicated that they had established ride time guidelines. Of the 47 responses, the majority indicated that guidelines had been set at 45 to 60 minutes for all grades. These results are somewhat surprising given the importance of this planning parameter.

The transportation sector, through both MSBO and the Michigan Association for Pupil Transportation, should consider establishing a model policy and procedure statement regarding student ride times. The purpose of the statement would be to identify the rationale for ride time guidelines, detail the specific requirements of the policy, and establish the oversight and monitoring procedures and techniques required to evaluate compliance. The model policy could then be distributed to all districts across the state to be customized to individual operating characteristics and concerns.

Seating and route pairing guidelines

Efficiently and effectively managing the inventory of available seats is the key challenge of every transportation manager. Two key concerns related to bus route design are: what students are allowed to ride together and how many students can be scheduled for a given bus. In student transportation management these two concepts are known as ridership pairing and seating guidelines.

Ridership pairing generally refers to the integration of multiple grades on an individual school bus. Districts were asked to identify whether existing policies or historical practices prevented students from different grades from riding on the same bus. The purpose of this question was to evaluate whether restricting rider grouping was having a negative impact on overall costs and to evaluate the prevalence of multi-tier routing across the state. The table below summarizes the responses to the question[2]:

Table 15: Ridership pairing summary

Ride Guidelines	Tier Structure	Count of responses	Cost Per Rider	Cost Per Bus	Average Riders Per Bus
K - 12 ride together	Single	30	$1,040	$46,377	45
HS & MS together; elementary alone	Two	51	$875	$57,823	66
HS, MS, ESL ride separate	Three	23	$976	$66,609	68

The results in the table indicate that as the amount of tiering increases, per student costs are reduced and the use of available seating capacity increases. However, it is also apparent that the cost per bus increases. These apparently contradictory results are actually indicative of increased levels of efficiency. The contradiction is due to the fact that in a multi-tier structure, fewer buses transport more students. Consequently, the fixed or semi-fixed costs (i.e., the driver and the bus) are allocated over fewer units, thus increasing the apparent per unit cost.

While the table demonstrates the multi-tier routing schemes are more cost effective than single tier systems, the results are ambiguous when analyzing two versus three tier schemes. In the sample districts with a two and three tier structure, it is clear that the three tier districts incur a more significant personnel cost burden, especially related to employee benefits. This burden is

[2] Of 106 total responses, 104 were usable for purposes of this analysis.

a significant factor in the higher per rider and per bus cost shown in the table. These results demonstrate that districts trying to reduce or control the cost of transportation should consider multi-tier routing strategies, but that those considerations must carefully balance the incremental cost considerations associated with fewer drivers operating longer routes.

The establishment of seating guidelines, such as allowing two high school and three middle or elementary school students per seat, is a common practice in transportation operations. The importance of effectively managing seating inventory necessitates a consideration of whether limiting capacity use to something less than that allowed by the manufacturer (72-passengers for a "typical" school bus) has an adverse impact on cost. The following table summarizes the responses from the survey.

Table 16: Seating guidelines

Description	Count	Total Costs	Total Riders	Total Buses	Cost per Rider	Cost Per Bus
3 per seat all grades	17	$39,102,777	43,009	594	$909	$65,830
2 per seat all grades	11	$20,992,436	8,470	281	$2,478	$74,706
3 ES or MS and 2 HS	25	$44,962,191	52,185	791	$862	$56,842
3 ES or 2 MS and HS	57	$116,234,600	128,216	2,017	$907	$57,627

The table, not unexpectedly, shows that the districts that most severely constrain transportation planning options by allowing only two students per seat also incur the highest relative costs. This would indicate that policy decisions or operational practices that artificially reduce the number of riders on a given bus will increase overall costs. Districts must consider the balance between effectiveness (i.e., allowing for a more comfortable ride for each student) and efficiency (i.e., the higher cost of service) when establishing policies or operational practices related to seating guidelines.

Use of routing software

The survey was designed to evaluate whether the availability of routing software had a positive influence on the cost of transportation. It should be noted that no attempts were made to evaluate the effectiveness of software use, but only if its availability and presumed use resulted in lower transportation costs. The survey results included 108 usable responses that are summarized in the table below.

Table 17: Use of routing software

	Uses Routing Software	Do Not Use Routing Software
Responses	73	35
Average Rider Count	2,768	828
Average Buses Used	41	18
Cost per rider	$993	$1,085
Cost per bus	$62,130	$49,957

As can be seen from the table, the districts using routing software transport more students and use more buses, on average, than districts without software. These larger districts have lower per rider costs but higher per bus costs than the smaller districts. These higher costs, as mentioned previously, are significantly influenced by the employee benefit costs being incurred by the larger districts. Analysis of benefit cost data included on the SE-4094 indicates that average per district benefit costs are nearly four times higher in the districts that use routing software ($483,562 versus $125,714). In these districts, use of routing software to evaluate the influence of transportation policy changes and control benefit costs is of critical importance to overall cost effectiveness.

While the results in Table 17 would appear to indicate that routing software can have a positive influence on controlling costs, the diversity of the districts included in the two sample sets makes it difficult to fully evaluate the influence. Therefore, a sample of all respondents who transported between 1,000 and 2,000 riders was selected for a more detailed evaluation. This subgroup was selected because it reflects the most common group in both the survey responses and in districts across the state.

A total of 39 usable responses (49 percent of the 80 total responses) were received from districts who transport 1,000 to 2,000 students. Within this population, 26 districts used software and 13 districts did not. The table below summarizes the cost and operational performance indicators for these districts.

Table 18: Software use by 1,000 to 2,000 rider districts

	Cost Per Rider	Cost Per Bus	Cost Per Mile	Simple Capacity Use	Buses Per 100 Riders
Uses a system	$771	$55,667	$3.86	99%	1.5
Does not use a system	$809	$46,321	$3.85	84%	1.9

Table 18 indicates that cost per student, buses per 100 riders and simple capacity use rates are more favorable for districts using routing software versus those that do not. These are all indications that the routing schemes developed by districts with routing software are more efficient than the schemes in districts that do not use software. Again, the cost per bus is higher, an apparent contradiction given the greater efficiency demonstrated in the other measures. As was mentioned earlier, this is due to the fixed or semi-fixed costs (i.e., the driver and the bus) being allocated over fewer units, thus increasing the apparent per unit cost.

The results of this analysis indicate that school districts should consider the potential return on investment associated with the acquisition of routing software. Continued budget pressures will require transportation managers to evaluate all possible efficiency opportunities and this can be greatly facilitated by the use of routing software. In addition to the efficiency benefits identified in the table above, additional potential benefits associated with risk management, policy analysis, and cost containment should be considered.

Appendix 1 – Regional Groupings of Intermediate School Districts

Region 1 - Upper Peninsula
COPPER COUNTRY ISD
EASTERN UPPER PENINSULA ISD
DELTA SCHOOLCRAFT ISD
DICKINSON-IRON ISD
GOGEBIC ONTONAGON ISD
MARQUETTE ALGER ISD
MENOMINEE ISD

Region 2 - Northern Lower Peninsula
ALPENA-MONTMORENCY-ALCONA ESD
CHARLEVOIX EMMET ISD
CLARE GLADWIN ISD
COOR ISD
COP ISD
IOSCO RESA
MANISTEE ISD
MASON LAKE ISD
MECOSTA OSCEOLA ISD
NEWAYGO COUNTY ISD
OCEANA ISD
TRAVERSE BAY ISD
WEXFORD MISSAUKEE ISD

Region 3 - Western
ALLEGAN COUNTY ISD
BARRY ISD
BERRIEN ISD
IONIA COUNTY ISD
KALAMAZOO RESA
KENT ISD
LEWIS CASS ISD
MONTCALM AREA ISD
MUSKEGON ISD
OTTAWA AREA ISD
ST. JOSEPH ISD
VAN BUREN ISD

Region 4 - Thumb and surrounding areas
BAY ARENAC ISD
GENESEE ISD
GRATIOT-ISABELLA ISD
HURON ISD
LAPEER ISD
MIDLAND ISD
SAGINAW ISD
SANILAC ISD
SHIAWASSEE RESD
ST. CLAIR ISD
TUSCOLA ISD

Region 5 - South Central
BRANCH ISD
CALHOUN ISD
CLINTON ISD
EATON ISD
HILLSDALE ISD
INGHAM ISD
JACKSON ISD
LENAWEE ISD
LIVINGSTON ESA
MONROE ISD

Region 6 - Southeast
MACOMB ISD
OAKLAND ISD
WASHTENAW ISD
WAYNE RESA