Analysis of Rural Public Transit in Alabama

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Prepared by

UTCA

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The University of Alabama, The University of Alabama at Birmingham, and
The University of Alabama in Huntsville

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University Transportation Center for Alabama

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16.Abstract

As rural America continues to "age", access to basic necessities and health care will continue to strain rural transit providers. The state of Alabama has numerous Rural Public Transportation Providers, and while every provider is unique, each can benefit from a performance assessment and identification of methods to improve performance. This project uses recently published guides on measuring, assessing, and improving performance for rural transit operators and collects data from the rural transit providers in Alabama to evaluate the operations of the metrics and the providers, analyze performance measures, and suggest improvements. The data was collected from the Alabama Department of Transportation as well as individual agencies. The project presents alternative performance measures to evaluate rural transit providers.

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Executive Summary

As rural public transit systems are vital to the livelihood of rural Americans, improving the operations of these systems is the focus of this work. The use of performance measures to evaluate performance is essential to maintain growth and avoid becoming stagnant. The main goal of this project was to examine performance measures and modify them, if necessary, to allow for comparison of performance between rural transit agencies in Alabama. The tasks presented in this report are a review of performance measures, data collection, and data analysis for agencies in Alabama. The report concludes that performance measures were developed that balance external factors in the analysis and allow for a fair comparison of agencies.

The main contribution of the study was to formulate new performance measures that eliminate the influences of uncontrollable factors, thus standardizing the performance measures to make a better comparison among rural transit systems in Alabama. Finally, existing measures were modified to adjust the measure for comparison purposes in Alabama. After excluding correlated uncontrollable factors, it can be seen that the ranking of individual performance measures were changed. Sometimes, the lower ranking turns out the best ranking after standardization. The aggregated ranking also shows significant difference for aggregated existing and updated ranking. It can be concluded that this methodology provides a useful effort to standardize the performance measures by eliminating the effects of uncontrollable factors such as different terrain, population, road coverage conditions, etc., and rank those by maintaining a fair scale of judgment. The final recommendation is to use this tool to make a fair individual or aggregated ranking of performance measures among different rural transit systems.

Section 1
Introduction

Continually improving performance is necessary to avoid becoming stagnant or obsolete. Recently, the Transit Cooperative Research Program (TCRP) published Report 136 titled "Guidebook for Rural Demand-Response Transportation: Measuring, Assessing, and Improving Performance". This guidebook is intended to serve as a typology for rural demand-response systems, identify factors that influence performance, and quantify performance improvements from specific actions.

The importance of transit in rural locations is obvious when considering that rural America is 75 percent of the land area, but only 17 percent of the population (Institute, 2006). The trend nationally is for the "aging" of the rural population, influenced by migration patterns away from rural America to urban America for younger people. The opposite trend is occurring for the older people, with many rural locations growing in the over 50 age group, both by total population and percent (Ellis & McCollom, 2009). In rural locations, access to health care and basic necessities is complicated by distance, terrain, and a population facing increase mobility challenges. This is where rural public transit systems fill mobility gaps.

As rural public transit systems are vital to the livelihood of rural Americans, improving the operations of these systems is the focus of this work. The work was stimulated by the publication of TCRP Report 136 which provides guidance into performance measures that were used to evaluate rural transit systems. Data to support the analysis presented in the guide were collected from the Alabama Department of Transportation and from specific agencies to determine the current levels of performance as the guide indicates. The measures presented in the guide were then modified to allow comparisons across rural transit agencies in Alabama.

The main goal of this project was to examine published performance measures and modify them, if necessary, to allow for comparison of performance between rural transit agencies in Alabama. The tasks presented in this report are a review of performance measures in the TCRP Report 136 and other sources, data collection, and data analysis for agencies in Alabama. The report concludes that performance measures can be developed that balance external factors in the analysis and allow for a fair comparison of agencies.

Section 2
Literature Review

Even though this project used the recently published TCRP Report 136 as the guide for selecting performance measures, literature related to defining the proper performance measures for rural transit, making comparison of different systems, and peer grouping methodology were reviewed and summarized.

A dissertation on Performance Indicators and Policy Evaluation in Rural Transit proposes a list of 32 rural performance measures that reflects six specific conditions such as output, effectiveness, efficiency, cost-effectiveness, quality, and impact (Stephanedes, 1979). Later, Radow and Winters state four ways to measure rural transit performance -- effectiveness, efficiency, quality, and impact -- and describes how rural transportation providers face unique challenges compared to urban transit system and how a fixed route system is different from demand responsive service (Radow & Winters).

A paper by Kosky (2007) indicates selecting Proper Performance Measures depends on data availability, reliability, and cost of collection, while the key is simplicity and minimal overlapping. It presents eight key elements to measure system performance (both efficiency and effectiveness) including total expenses, variable expenses (i.e., fuel costs, maintenance, insurance and employee salaries), vehicle hours, passengers, miles and number of vehicles, and a number of ways to look at the relationships between these numbers as particular ratios of key elements (Kosky, 2007).

As presented by Reilly et al., the main goal of rural demand responsive transportation (DRT) should be broken down to a small number of objectives that are measured by clearly defined performance statistics, provide for the most effective evaluation process and, therefore, the resource limitations of a system do not preclude an effective evaluation process. This paper proposes a number of financial and non-financial indicators and describes how performance evaluation process should be carried out (Reilly, Beimborn, & Schmitt, 1998).

Upon investigating traditional transit performance measures in TCRP Report 88, ten different categories of performance measures were summarized: availability, service delivery, community impacts, travel time, safety and security, maintenance and construction, economics, capacity, paratransit, and comfort (Cottrell & James, 2009). One of the papers demonstrates how Transit Performance Measures (TPMs) can be extracted from the bus dispatch system **(**consisting of automatic vehicle location, communications, automatic passenger counters, and a central dispatch center) data and can assist a transit agency in improving the quality and reliability of its service, leading to improvements for customers and operators alike while the measures are related to accessibility, mobility, and economic development across all modes (Bertini & El-Geneidy, 2003).

For allocating subsidies to rural public transit, Evans proposes an allocation formula applying equalization models that incorporates elements of cost (cost per trip or cost per mile), need (proportion of households in the service area), and performance (number of trips or passenger miles per unit of subsidy) while states often employ scoring techniques except nine states who award subsidies according to formulas and the one used in South Carolina, with two categories, population (proportional to population) and patronage (proportional to their subsidy per passenger trip)—would be a practical way of allocating subsidies (Marshment, 1998). To derive performance driven transit funding model, a performance index, PI developed to allocate funding, is the weighted performance rating, PR, of the past 3 years, and the weights are set up to be 3, 2, and 1 where performance rating is a function of R/C ratio, annual trips per capita and new trips per capita (Sousa & Miller, 2005). Evaluating the effect of operating subsidies on the performance, one of the papers concludes subsidies from different sources (federal or state and local) have different effects on the performance of different types of paratransit systems (differentiated on the basis of whether they are publicly or privately operated), that used five measures to capture the efficiency and effectiveness: revenue vehicle miles per employee, revenue vehicle miles per vehicle, revenue vehicle miles per operating expense, passengers per service area population, and passengers per vehicle (Karlaftis & Sinha, 1997).

Comparing transit operation in various cities, the evaluation must consider the differences in urban form and land use, population, employment distribution, topography and climate, and structure variables accordingly to minimize these effects where variables must be disaggregated by areas of the metropolitan region that distinguish between transit service in the central city and in suburban areas. To identify variables for characterizing Level of service into three major components: quantity (the supply), quality (how good the service is) and cost/revenue (deals with economic factors though depends on quantity and quality), this paper concentrates on the checklist of all system attributes plus the corresponding performance measures selected by cooperative process that best reflect the mass transportation objectives and contribute to transit level of service (Allen & Cesare, 1976).

One of the earlier studies used z- scores of each system on each of the selected performance measures and a ranking scale developed by summing the selected indicator z-scores for each system called as ZSUM, that indicates the overall performance of a bus system (Fielding & Anderson, 1983). Data Envelopment Analysis (DEA) methodology was used in earlier and recent studies to estimate relative scores in efficiency and effectiveness of various transit systems and compare individual system to their peers in multiple performance measures (Arman, Labi, & Sinha, 2012)**,** (Ferronatto, Lindau, & Fogliatto, 2009), (Fu, Yang, & Casello, 2007), (Chu, Fielding, & Lamar, 1992). Principal Component Analysis (PCA) based indices take into account both efficiency and effectiveness leading to more reliable scores and performs better on data sets where variables are highly correlated (Ferronatto, Lindau, & Fogliatto, 2009).

Factors are used to determine which potential peer agencies are most similar to the target agency, and individual likeness scores (the percentage difference between a potential peer's value for the factor and the target agency's value) for each individual screening and peer-grouping factor can be used to calculate a total likeness score, where score of 0 indicates a perfect match between two agencies (and is unlikely to ever occur) and vice versa (Ryus, et al., 2011). The Florida peer

selection process attempts to identify comparable transit systems through a point scoring system where performance of each of the potential non-Florida peers is compared with the average of the Florida systems for each of defined variables (Gan, Ubaka, & Zhao, 2002).

Overall, there are many mechanisms to evaluate rural transit performance; however, they generally focus on a few main data elements and analysis trends. The purpose of this study was to develop a simplified methodology that should reflect and comply with the guidance of TCRP Report 136, and can be adapted easily by using readily available data.

Section 3
Data Collection

This section will discuss the data that were collected to perform the evaluation of the performance measures for Alabama's rural transit systems. The data included information about the transit systems currently operating in Alabama and the counties they serve. Then, the data each of these agencies is required to submit to the Alabama Department of Transportation on a quarterly basis and corresponding performance measures is used to track individual agency performance. Finally, the section will present other, non-controllable factors that might influence transit performance in the areas where the system operate. These non-controllable factors will be used later to equate the system operation between providers.

At the time of this report, there were twenty-nine transit systems operating in 50 of Alabama's 67 counties. The names of the transit systems and the counties in which they operate are shown in Table 3-1.

Table 3-1. Transit systems county coverage

Transit Systems	County Name
Alabama Tombigbee Regional Commission	Clarke County Conecuh County Monroe County Wilcox County
Area Referral and Information Service for the Elderly (ARISE)	Tallapoosa County
Autauga County Commission	Autauga County
Baldwin County Commission	Baldwin County
Birmingham Regional Paratransit	Jefferson County Shelby County
Blount County Commission	Blount County
Chilton County Commission	Chilton County
City of Eufaula County Commission	Barbour County
City of Guntersville	Marshall County
Covington County Commission	Covington County
Cullman County Commission	Cullman County

Transit Systems	County Name
Dekalb County Commission	DeKalb County
East Alabama Regional Planning & Development Commission	Calhoun County Cherokee County Clay County Cleburne County Coosa County Talladega County
Educational Center for Independence	Washington County
Escambia County Commission	Escambia County
Etowah County Commission	Etowah County
H.E.L.P. Inc.	Pickens County
Jackson County Commission	Jackson County
Lawrence County Commission	Lawrence County
Lee-Russell Council of Governments	Lee County Russell County
Macon-Russell Community Action Agency	Macon County Russell County
Madison County Commission	Madison County
Morgan County Commission	Morgan County
Northwest Council of AL Local Governments	Colbert County Franklin County Lauderdale County Marion County Winston County
Pike Area Transit System (PATS)	Pike County
Southeast AL Regional Planning & Development Commission	Houston County
St. Clair County Commission	St. Clair County
Walker County Commission	Walker County
West Alabama Health Services	Choctaw County Dallas County Greene County Hale County Lowndes County Marengo County Perry County Sumter County

Each of the transit system listed in Table 3-1 is required to provide operating data to the Alabama Department of Transportation on a quarterly basis. The data submitted to the department from the transit agencies is listed in Table 3-2.

Table 3-2. Available performance data submitted by agencies

Data/Performance Measures Variables
Vehicle miles
Passenger miles
Passenger trips
Passenger service hours
Vehicle Hours
Operating cost
Administrative cost
Revenue

Using the data submitted by the agencies, a preliminary list of performance measures was established using guidance from the Alabama Department of Transportation and reviewed literature. The performance measures are shown in Table 3-3.

Table 3-3. Performance measures

Measures/Key Ratios	Equations
Productivity	Passenger trips / vehicle hour
Operating cost per vehicle hour	(Operating plus Administrative cost) / vehicle hour
Operating cost per vehicle mile	(Operating plus Administrative cost) / vehicle mile
Operating cost per passenger trip	(Operating plus Administrative cost) / passenger trip
Average passenger trip length	Total passenger miles / total number of passenger trips
Average travel time	Total passengers' travel time / total number of passenger trips
Hourly Utilization	Passenger Hours / Vehicle hours
Mileage Utilization	Passenger miles / Vehicle miles
Operational Cost Recovery Ratio	Revenue / Operating cost

It must be noted that the data from the quarterly reports submitted to the department contained discrepancies that needed to be removed to obtain accurate performance measures. For example vehicle miles were sometimes recorded as very large in comparison to passenger miles, sometimes actually being reported as less than passenger miles. Additionally, there were discrepancies in the revenue and cost values as charges were incurred in one quarter and the revenues were recorded in another.

In reviewing the performance measures, there were some wide discrepancies across the transit agencies in the state. Table 3-4 shows the performance measure with average value, best, and worst performance for the 29 agencies in Alabama.

Table 3-4. Performance measures values (average, high and low)

Measures/Key Ratios	Average	Best	Worst
Productivity	2.81	7.14	0.90
Operating cost per vehicle hour	28.18	12.11	47.99
Operating cost per vehicle mile	1.93	0.97	3.85
Operating cost per passenger trip	12.40	3.19	26.96
Average passenger trip length	5.36	1.73	16.46
Average travel time	1.75	0.11	42.27
Hourly Utilization	2.16	42.47	0.10
Mileage Utilization	0.81	1.07	0.46
Operational Cost Recovery Ratio	0.63	1.58	0.15

These performance measures and results for the transit agencies in Alabama highlight the differences in operations throughout the state. For example, productivity (the measure of passenger trips per vehicle hour) which would indicate how often the vehicles is carrying multiple passengers to similar destinations ranges from 0.90 – 7.14. From an outsider's perspective, it would be concluded that agencies with higher than average productivity would be seen as superior operating agencies using scheduling and dispatching than agencies with lower productivity value. A similar statement could be made for all the performance measures; for example, the agencies with lower operating cost per passenger trip would be seen as superior to agencies with higher operating cost per passenger trips.

However, when attempting to compare across agencies, several factors must be examined that are outside the agencies' control. These variables were considered important as they represented a normalization or equalization of the performance measures. For example, an agency in a very sparsely populated area might have a lower productivity value simply due to the fact there are few people in the area to offer service. Similarly, an agency might have higher operating cost per passenger trip due to offering service in a larger county. These factors are outside the control of the operating agency, and if these values were taken into account, it might be possible to show that these agencies are actually operating more efficiently than others with higher values simply based on population and serving area size. These potential factors are listed in Table 3-5.

Table 3-5. Non-controllable data and sources

Non-Controllable Data	Source
Resident 2010 Census population	U.S. Census Bureau, Population Division
Elderly 65 and older	U.S. Census Bureau, Population Division
Land Area, Square Miles	U.S. Census Bureau
Road length, Miles	Census 2000 TIGER/Line® Shapefiles
%Road length miles >= 5% slope	AlabamaView- 10m DEM Data for Alabama Counties
%Road length miles >= 10% slope	AlabamaView- 10m DEM Data for Alabama Counties
%Road length miles >= 15% slope	AlabamaView- 10m DEM Data for Alabama Counties
Mean Slope%	AlabamaView- 10m DEM Data for Alabama Counties
Rail and road intersections	Census 2000 TIGER/Line® Shapefiles
Intersections	Census 2000 TIGER/Line® Shapefiles
Median household income, in dollars, 2010	U.S. Census Bureau
Shape Factor	Census 2000 County and County Equivalent Areas in ArcView Shapefile

The non-controllable data sources were further modified to become useful factors for comparison of performance measures. The modifications made to the measures are shown in Table 3-6.

Table 3-6. Data needed further processing

Name	Type of processing
Elderly 65 and older	Using access to determine the summation of 65 and older
Road length, Miles	Using ARCGIS Summation
%Road length miles >= 5% slope	Using ARCGIS Slope raster from DEM, Contour of slope raster, summation of road ways intersect with >= 5% slope
%Road length miles >= 10% slope	Using ARCGIS Slope raster from DEM, Contour of slope raster, summation of road ways intersect with >= 10% slope
%Road length miles >= 15% slope	Using ARCGIS Slope raster from DEM, Contour of slope raster, summation of road ways intersect with >= 15% slope
Mean Slope%	Using ARCGIS Slope raster from DEM, Mean of slope raster
Rail and road intersections	Using ARCGIS, find no of roadways intersect with railways
Intersections	Exporting dbf from ARCGIS and opening table in excel, count the instances where common FNODE, and TNODE appear without duplicating same occurrence
Shape Factor	Dissolving county boundaries by the boundary of transit systems, and calculate SF

Section 4
Data Analysis

Prior to using the data and adjustment factors for evaluating performance measures, a step was undertaken to determine the correlation between the performance factors and adjustment factors. The correlation values along with P-values among factors, performance measures (PM), and PM variables were determined by using Minitab software. The goal was to determine correlation factors and associated P-values for the 29 systems. However, when examining the systems, it was determined that while most systems operate over a single county service area, there are others that are operating in sub-county areas or multiple counties.

- City of Eufaula County Commission – Sub county
- City of Guntersville – Sub county
- Birmingham Regional Paratransit – Urbanized county
- Madison County Commission – Urbanized county
- East Alabama Regional Planning & Development Commission – Multiple counties
- Northwest AL Council of Local Governments – Multiple counties
- West Alabama Health Services – Multiple counties

In an effort to remove bias from the correlation results, a series of candidate systems were developed to test the effect of sub-county and multiple county results.

- 22 systems exclude sub, urbanized and multicounty systems
- 26 systems exclude multicounty systems
- 27 systems exclude sub-county systems
- 25 systems exclude sub-county and urbanized county systems

The correlation and its P values between factors and performance measures for the different sample sizes are shown in the Appendix. Based on the results and to eliminate the differences in the extent and type of area covered by transit systems, it was decided to keep the sample size of 25 systems. Furthermore, it has been investigated that the values of correlation between factors and the variables of PM improves when 25 systems were analyzed rather than considering 29 systems. The correlation and its P values between factors and the variables of performance measures for two different sample sizes are shown in the Appendix.

The cutoff values for considering the reasonable correlation between factors and PM variables or performance measures are more than or equal to 0.4 for positive correlation and less than or equal to -0.4 for negative correlation. In addition, 10% confidence interval was chosen that is

equivalent to p value <= 0.1. Based on these criteria, Tables 4-1 and 4-2 shows the factors which are highly correlated with PM variables and performance measures.

Table 4-1. Factors correlated with Performance Measures variables

Factors/PM variables	Vehicle miles	Passenger miles	Passenger trips	Passenger service hours	Vehicle Hours	Operating cost	Administrative cost	Revenue
resident 2010 Census population	Strongly Correlated	-	-	-	Strongly Correlated	-	-	Strongly Correlated
Land Area 110210D, Square Miles	Strongly Correlated	Strongly Correlated	Strongly Correlated	-	Strongly Correlated	Strongly Correlated	Strongly Correlated	Strongly Correlated
Road length miles	Strongly Correlated	Strongly Correlated	Strongly Correlated	-	Strongly Correlated	Strongly Correlated	Strongly Correlated	Strongly Correlated
%Road length miles >= 5% slope	-	-	-	-	-	Strongly Correlated	Strongly Correlated	-
Mean Slope%	-	-	-	-	-	-	Strongly Correlated	-
Rail and road intersections	-	Strongly Correlated	Strongly Correlated	-	Strongly Correlated	-	-	Strongly Correlated
Intersections	Strongly Correlated	Strongly Correlated	Strongly Correlated	-	Strongly Correlated	Strongly Correlated	-	Strongly Correlated
Shape Factor	Strongly Correlated	Strongly Correlated	Strongly Correlated	-	Strongly Correlated	Strongly Correlated	Strongly Correlated	Strongly Correlated

Table 4-2. Factors correlated with Performance Measures

Factors/PM	Productivity	Operating cost per vehicle hour	Operating cost per vehicle mile	Operating cost per passenger trip	Average passenger trip length	Average travel time	Hourly Utilization	Mileage Utilization	Operational Cost Recovery Ratio
%Elderly 65 and older	-	-	-	-	-	-	-	Strongly Correlated	-
Land Area 110210D, Square Miles	Strongly Correlated	-	-	Strongly Correlated	-	-	-	-	-
Road length miles	Strongly Correlated	-	-	Strongly Correlated	-	-	-	-	-
Rail and road intersections	Strongly Correlated	-	-	-	-	-	-	-	-
Intersections	Strongly Correlated	-	-	Strongly Correlated	-	-	-	-	-

Similarly, correlation within factors that are highly correlated with PM variables and performance measures are presented in Tables 4-3 and 4-4 respectively.

Table 4-3. Correlation within factors – Performance Measure Variables

Factors	resident 2010 Census population	Land Area 110210D, Square Miles	Road length miles	%Road length miles >= 5% slope	Mean Slope%	Rail and road intersections	Intersections	Shape Factor
resident 2010 Census population		-	Strongly Correlated	-	-	Strongly Correlated	Strongly Correlated	-
Land Area 110210D, Square Miles	-		Strongly Correlated	-	-	Strongly Correlated	Strongly Correlated	Strongly Correlated
Road length miles	Strongly Correlated	Strongly Correlated		-	-	Strongly Correlated	Strongly Correlated	Strongly Correlated
%Road length miles >= 5% slope	-	-	-		Strongly Correlated	-	-	-
Mean Slope%	-	-	-	Strongly Correlated		-	-	-
Rail and road intersections	Strongly Correlated	Strongly Correlated	Strongly Correlated	-	-		Strongly Correlated	-
Intersections	Strongly Correlated	Strongly Correlated	Strongly Correlated	-	-	Strongly Correlated		Strongly Correlated
Shape Factor	-	Strongly Correlated	Strongly Correlated	-	-	-	Strongly Correlated	

Table 4-4. Correlation within factors – Performance Measures

Factors	%Elderly 65 and older	Land Area 110210D, Square Miles	Road length miles	Rail and road intersections	Intersections	%User Number
%Elderly 65 and older		-	-	-	-	-
Land Area 110210D, Square Miles	-		Strongly Correlated	Strongly Correlated	Strongly Correlated	Strongly Correlated
Road length miles	-	Strongly Correlated		Strongly Correlated	Strongly Correlated	-
Rail and road intersections	-	Strongly Correlated	Strongly Correlated		Strongly Correlated	-
Intersections	-	Strongly Correlated	Strongly Correlated	Strongly Correlated		-

Looking at the results in the previous tables, the following factors were identified that are correlated with the variables of PM and describe most of other factors.

- Road length miles (RL miles) are correlated with all PM variables except Passenger service hours and correlated with most of other factors.
- %Road length miles >= 5% slope is correlated with Operating and Administrative costs, and not explained by other selected factors. However, Administrative cost does not include any maintenance cost and %Road length miles >= 5% slope is not considered as a correlated factor with Administrative cost.

Looking at the above results, the following factors were identified that are correlated with performance measures and describe most of other factors.

- %Elderly 65 and older is correlated with Mileage utilization and not explained by other selected factors.
- Road length miles (RL miles) are correlated with Productivity and Operating cost per passenger trip, and explains most of other factors. However, Land Area miles can explain

the same number of other correlated factors. RL miles was selected because it shows better correlation values with others.

At first, PM variables correlated with the selected factors are divided by the corresponding factors to eliminate their influence from PM variables, means PM. It can be seen that the most of the PM values were unchanged after incorporating the division because of the presence of the same factor in numerator and denominator (shown in Table 4-5). The division tool was applied for correlated factors with PM variables regardless of sign of correlation.

Table 4.5 Equations after incorporating correlated factors in PM variables

Measures/Key Ratios	Equations
Productivity	$\frac{\text{Passenger trips}}{\text{RL miles}} \Big/ \frac{\text{vehicle hour}}{\text{RL miles}}$
Operating cost per vehicle hour	$\left(\frac{\text{Operating cost}}{\text{RL miles} * \%\text{RL miles} >= 5\% \; slope} + \frac{\text{Administrative cost}}{\text{RL miles}}\right) \Big/ \frac{\text{vehicle hour}}{\text{RL miles}}$
Operating cost per vehicle mile	$\left(\frac{\text{Operating cost}}{\text{RL miles} * \%\text{RL miles} >= 5\% \; slope} + \frac{\text{Administrative cost}}{\text{RL miles}}\right) \Big/ \frac{\text{vehicle mile}}{\text{RL miles}}$
Operating cost per passenger trip	$\left(\frac{\text{Operating cost}}{\text{RL miles} * \%\text{RL miles} >= 5\% \; slope} + \frac{\text{Administrative cost}}{\text{RL miles}}\right) \Big/ \frac{\text{passenger trips}}{\text{RL miles}}$
Average passenger trip length	$\frac{\text{Total passenger miles}}{\text{RL miles}} \Big/ \frac{\text{total number of passenger trips}}{\text{RL miles}}$
Average travel time	$\text{Total passengers' travel time} \Big/ \frac{\text{total number of passenger trips}}{\text{RL miles}}$
Hourly Utilization	$\text{Passenger Hours} \Big/ \frac{\text{Vehicle hours}}{\text{RL miles}}$
Mileage Utilization	$\frac{\text{Passenger miles}}{\text{RL miles}} \Big/ \frac{\text{Vehicle miles}}{\text{RL miles}}$
Operational Cost Recovery Ratio	$\frac{\text{Revenue}}{\text{RL miles}} \Big/ \frac{\text{Operating cost}}{\text{RL miles} * \%\text{RL miles} >= 5\% \; slope}$

Secondly, three of the performance measures correlated with the selected factors are divided by the corresponding factors to eliminate their influence from PM. The new equations after incorporating division tools for the three PM are presented in Table 4-6.

Table 4-6. Equations after incorporating correlated factors for three performance measures

Measures/Key Ratios	Equations
Productivity	$\frac{\frac{\text{Passenger trips}}{\text{vehicle hour}}}{\text{RL miles}}$
Operating cost per vehicle hour	(Operating plus Administrative cost) / vehicle hour
Operating cost per vehicle mile	(Operating plus Administrative cost) / vehicle mile
Operating cost per passenger trip	$\frac{\frac{\text{(Operating plus Administrative cost)}}{\text{passenger trips}}}{\text{RL miles}}$
Average passenger trip length	Total passenger miles / total number of passenger trips
Average travel time	Total passengers' travel time / total number of passenger trips
Hourly Utilization	Passenger Hours / Vehicle hours
Mileage Utilization	$\frac{\frac{\text{Passenger miles}}{\text{Vehicle miles}}}{\text{RL miles}}$
Operational Cost Recovery Ratio	Revenue / Operating cost

Finally, other performance measures that are related to operating cost do not have any correlation with any factor while as a PM variable, operating cost is correlated with %Road length miles >= 5% slope. So, it is necessary to combine the findings of the two tables into Table 4-7, where the bold rows are from PM results and others are from PM variables results. The only exception is related to operating cost per passenger trips, which includes correlated factors both from PM variable and PM analyses.

Table 4-7. Equations after incorporating correlated factors in PM variables

Measures/Key Ratios	Equations
Productivity	$\frac{\text{Passenger trips}}{\text{vehicle hour}} \Big/ \text{RL miles}$
Operating cost per vehicle hour	$\frac{\text{Operating cost}}{\text{RL miles} * \%\text{RL miles} >= 5\% \; slope} + \frac{\text{Administrative cost}}{\text{RL miles}} \Big/ \frac{\text{vehicle hour}}{\text{RL miles}}$
Operating cost per vehicle mile	$\frac{\text{Operating cost}}{\text{RL miles} * \%\text{RL miles} >= 5\% \; slope} + \frac{\text{Administrative cost}}{\text{RL miles}} \Big/ \frac{\text{vehicle mile}}{\text{RL miles}}$
Operating cost per passenger trip	$\frac{\text{Operating cost}}{\text{RL miles} * \%\text{RL miles} >= 5\% \; slope} + \frac{\text{Administrative cost}}{\text{RL miles}} \Big/ \frac{\text{passenger trips}}{\text{RL miles}} \Big/ \text{RL miles}$
Average passenger trip length	Total passenger miles / total number of passenger trips
Average travel time	$\text{Total passengers' travel time} \Big/ \frac{\text{total number of passenger trips}}{\text{RL miles}}$
Hourly Utilization	$\text{Passenger Hours} \Big/ \frac{\text{Vehicle hours}}{\text{RL miles}}$
Mileage Utilization	$\frac{\text{Passenger miles}}{\text{Vehicle miles}} \Big/ \text{RL miles}$
Operational Cost Recovery Ratio	$\frac{\text{Revenue}}{\text{RL miles}} \Big/ \frac{\text{Operating cost}}{\text{RL miles} * \%\text{RL miles} >= 5\% \; slope}$

Original performance measures without incorporating any changes for correlation were given ranking throughout the state based on best value. For example, if productivity or hourly utilization or mileage utilization or operational cost recovery ratio of any system has the highest value, that system will be assigned as 1st rank, while performance measures related to operating cost or average time or average length, should be ranked as lower is better. After assigning the rank for each performance measure, the summation of ranks was again ranked to assess an overall performance of each system (see the Appendix for results).

Performance measures based on updated PM variables were ranked individually, and aggregated rankings was done similarly (see the Appendix for results). Likewise, aggregated ranking of performance measures based on combined update were calculated (see the Appendix for results).

The following tables show the changes in each measure ranking by using old equations, new equations based on updated PM variables, and the combined update for a collection of systems. It can be noted that the value of Average Passenger Trip Length is not included because no new equation was found from the analyses. Note that the agencies are identified by letter to retain anonymity, and the letters assigned to agencies are different for each analysis.

Table 4-8. Changes in Productivity Ranking

Transit systems	Old Equation		Updated PM Variables		Combined Update	
	PM Values	Rank	PM Values	Rank	PM Values	Rank
Agency A	2.33	19	2.33	19	0.0003	27
Agency B	2.32	20	2.32	20	0.0012	14
Agency C	2.70	16	2.70	16	0.0021	3

Table 4-9 Changes in Operating cost per vehicle hour Ranking

Transit systems	Old Equation		Updated PM Variables		Combined Update	
	PM Values	Rank	PM Values	Rank	PM Values	Rank
Agency A	17.04	3	23.04	3	23.04	3
Agency B	34.13	22	37.57	13	37.57	13
Agency C	20.86	9	29.67	9	29.67	9

Table 4-10 Changes in Operating cost per vehicle mile Ranking

Transit systems	Old Equation		Updated PM Variables		Combined Update	
	PM Values	Rank	PM Values	Rank	PM Values	Rank
Agency A	1.18	3	1.60	2	1.60	2
Agency B	2.93	27	3.22	20	3.22	20
Agency C	1.30	4	1.84	4	1.84	4

Table 4-11 Changes in Operating cost per passenger trip Ranking

Transit systems	Old Equation		Updated PM Variables		Combined Update	
	PM Values	Rank	PM Values	Rank	PM Values	Rank
Agency A	7.31	8	9.89	6	0.001	4
Agency B	14.72	21	16.20	16	0.009	17
Agency C	7.73	9	10.99	9	0.008	16

Table 4-12 Changes in Average travel time Ranking

Transit systems	Old Equation		Updated PM Variables		Combined Update	
	PM Values	Rank	PM Values	Rank	PM Values	Rank
Agency A	0.29	19	2010.60	27	2010.60	27
Agency B	0.34	23	643.72	16	643.72	16
Agency C	0.34	22	438.52	8	438.52	8

Table 4-13 Changes in Hourly Utilization Ranking

Transit systems	Old Equation		Updated PM Variables		Combined Update	
	PM Values	Rank	PM Values	Rank	PM Values	Rank
Agency A	0.68	19	4686.95	6	4686.95	6
Agency B	0.78	17	1492.46	17	1492.46	17
Agency C	0.91	9	1183.62	23	1183.62	23

Table 4-14 Changes in Mileage Utilization Ranking

Transit systems	Old Equation		Updated PM Variables		Combined Update	
	PM Values	Rank	PM Values	Rank	PM Values	Rank
Agency A	0.81	17	0.81	17	5.00	21
Agency B	0.80	19	0.80	19	4.63	22
Agency C	0.83	14	0.83	14	6.94	4

Table 4-15. Changes in Operational Cost Recovery Ratio Ranking

Transit systems	Old Equation		Updated PM Variables		Combined Update	
	PM Values	Rank	PM Values	Rank	PM Values	Rank
Agency A	0.74	10	0.49	9	0.49	9
Agency B	0.81	7	0.68	6	0.68	6
Agency C	0.49	17	0.32	14	0.32	14

Examining the values for all agencies, essentially adding the ranking for the nine performance measures, creates a total statewide ranking. The following table shows the rankings from the original performance measures and from the combined updated measure, along with a change.

Table 4-16. Statewide rank and change associated with difference performance measures

Agency	Original Rank	Modified Rank	Change
A	8	7	+1
B	24	14	+10
C	9	4	+5
D	6	23	-17
E	27	20	+7
F	7	3	+4
G	23	13	+10
H	19	11	+8
I	20	16	+4
J	29	28	+1
K	25	25	+0
L	11	12	-1
M	5	8	-3
N	16	21	-5
O	4	6	-2
P	12	17	-5
Q	10	10	+0
R	15	18	-3
S	28	29	-1
T	21	19	+2
U	22	22	+0
V	13	24	-11
W	2	2	+0
X	1	1	+0
Y	14	15	-1
Z	18	26	-8
AA	17	9	+8
BB	26	27	-1
CC	3	5	-2

Section 5
Conclusions

The main purpose of the study is to formulate a new methodology that eliminates the influences of uncontrollable factors, thus standardizing the performance measures to make a better comparison among different rural transit systems in Alabama based on the defined performance measures of TCRP. To do so, existing measures were modified to adjust the measure for comparison purposes in Alabama. After excluding correlated uncontrollable factors, it can be seen that the ranking of individual PM were changed (shown in Tables 4-8 through 4-15). Sometimes, the lower ranking turns out the best ranking after standardization. The aggregated ranking also shows significant difference for aggregated existing and updated ranking. It can be concluded that this methodology provides a useful effort to standardize the performance measures by eliminating the effects of uncontrollable factors such as different terrain, population, and road coverage conditions, etc., and rank those by maintaining a fair scale of judgment. The final recommendation is to use this tool to make a fair individual or aggregated ranking of performance measures among different rural transit systems.

Section 6
References

Allen, W. G., & Cesare, F. D. (1976). Transit Service Evaluation: Preliminary Identification of Variables Characterizing Level of Service. *Transportation Research Record* , 41-47.

Arman, M., Labi, S., & Sinha, K. C. (2012). An Assessment of the Operational Performance of Public Transit Agencies Using Data Envelopment Analysis (DEA) Technique. *Transportation Research Board* .

Bertini, R. L., & El-Geneidy, A. (2003). Generating Transit Performance Measures with Archived Data. *TRR* , 109-119.

Chu, X., Fielding, G. J., & Lamar, B. W. (1992). Measuring Transit Performance Using Data Envelopment Analysis. *Transportation Research Part A: Policy and Practice* , 223-229.

Cottrell, W. D., & James, B. (2009). Performance Measures for Personal Rapid Transit. *Transportation Research Board* .

Ellis, E., & McCollom, B. (2009). *TCRP Report 136.* Washington, D.C.: Transportation Research Board.

Ferronatto, L. G., Lindau, L. A., & Fogliatto, F. S. (2009). Comparison of Public Transportation Efficiency Indices Based on Data Envelopment Analysis and Principal Component Analysis. *Transportation Research Board* .

Fielding, G. J., & Anderson, S. C. (1983). Public Transit Performance Evaluation: Application to Section 15 Data. *Transportation Research Record* , 1-7.

Fu, L., Yang, J., & Casello, J. (2007). Quantifying the Technical Efficiency of Paratransit Systems Using the Data Envelopment Analysis Method. *Transportation Research Board* .

Gan, A. C., Ubaka, I., & Zhao, F. (2002). Integrated National Transit Database Analysis System. *TRR* , 78-88.

Institute, C. (2006). *Demographic Trends in Rural and Small Town America.* University of New Hampshire, Durham.

Karlaftis, M. G., & Sinha, K. C. (1997). Performance Impacts of Operating Subsidies in the Paratransit Sector. *TRR* , 75-80.

Kosky, S. (2007). *Performance Evaluation for Rural Transit Systems* . Columbia, Missouri.

Marshment, R. S. (1998). Assessment of State Procedures for Allocating Section 5311 Subsidies to Rural Public Transit Operators. *TRR* , 63-67.

Radow, L. J., & Winters, C. (n.d.). *Rural Transit Performance Measurement.* Retrieved November 21, 2011, from http://www.ctaa.org/webmodules/webarticles/articlefiles/Rural_Transit_Performance_Measurement.pdf

Reilly, J., Beimborn, E., & Schmitt, R. (1998). *Transit Performance Measurement.* Albany.

Ryus, P., Parks, J., Coffel, K., Perk, V., Cherrington, L., Arndt, J., et al. (2011). Development of the TCRP G-11 Transit Agency Peer-Grouping Methodology. *Transportation Research Board* .

Sousa, P., & Miller, E. J. (2005). Performance-Driven Transit Funding Model. *TRR* , 73-81.

Stephanedes, Y. (1979). *Performance Indicators and Policy Evaluation in Rural Transit.* Hanover, New Hampshire.

Section 7
Appendix

The appendix shows the data from Section 4.

For the following tables, the columns and rows are defined by:

1	resident 2010 Census population
2	Elderly Density
3	%Elderly 65 and older
4	Land Area 110210D, Square Miles
5	Pop Density
6	Road length miles
7	Road Density
8	%Road length miles >= 5% slope
9	%Road length miles >= 10% slope
10	%Road length miles >= 15% slope
11	Mean Slope%
12	Rail and road intersections
13	Intersections
14	Median household income, in dollars, 2010
15	Shape Factor
16	%User Number
a	**Productivity/passenger trips per vehicle hour**
b	**Operating cost per vehicle hour**
c	**Operating cost per vehicle mile**
d	**Operating cost per passenger trip**
e	**Average passenger trip length**
f	**Average travel time**
g	**Hourly Utilization**
h	**Mileage Utilization**
i	**Operational Cost Recovery Ratio**

	a	b	c	d	e	f	g	h	i
1	-0.016	0.16	-0.046	0.195	0.159	-0.046	-0.046	0.031	0.178
	0.934	0.408	0.813	0.311	0.409	0.811	0.812	0.873	0.357
2	-0.105	0.199	-0.056	0.206	0.233	0.04	0.039	0.107	0.061
	0.586	0.301	0.773	0.284	0.225	0.836	0.841	0.58	0.752
3	0.098	-0.261	-0.144	-0.123	-0.195	0.121	0.121	-0.386	-0.286
	0.613	0.172	0.457	0.524	0.31	0.531	0.532	0.039	0.132
4	0.492	-0.28	-0.283	-0.363	-0.258	-0.095	-0.088	-0.071	0.089
	0.007	0.141	0.136	0.053	0.176	0.626	0.65	0.713	0.645
5	-0.09	0.271	-0.019	0.223	0.238	0.008	0.007	0.135	0.099
	0.643	0.156	0.921	0.245	0.214	0.968	0.97	0.485	0.608
6	0.383	-0.238	-0.29	-0.26	-0.177	-0.066	-0.06	-0.085	0.118
	0.041	0.214	0.126	0.172	0.357	0.734	0.756	0.662	0.542
7	-0.211	0.101	-0.067	0.227	0.257	0.185	0.183	0.071	0.007
	0.273	0.601	0.729	0.236	0.179	0.336	0.343	0.714	0.971
8	-0.273	-0.063	0.262	0.229	0.057	0.155	0.149	-0.084	0.31
	0.151	0.747	0.17	0.233	0.769	0.423	0.439	0.665	0.101
9	-0.112	-0.102	0.053	0.079	0.011	0.151	0.15	-0.074	0.161
	0.563	0.6	0.787	0.685	0.953	0.433	0.437	0.702	0.403
10	-0.104	-0.045	-0.004	0.103	0.042	0.154	0.154	-0.092	0.115
	0.591	0.819	0.984	0.594	0.828	0.424	0.426	0.633	0.551
11	-0.207	-0.057	-0.012	0.164	0.11	0.18	0.178	-0.074	0.084
	0.281	0.77	0.95	0.394	0.569	0.349	0.354	0.703	0.667
12	0.144	-0.01	-0.096	0.054	0.013	-0.113	-0.112	-0.012	0.158
	0.455	0.96	0.622	0.781	0.946	0.56	0.564	0.949	0.413
13	0.186	-0.098	-0.193	-0.052	-0.032	-0.049	-0.046	-0.055	0.17
	0.334	0.612	0.315	0.789	0.87	0.802	0.814	0.778	0.378
14	-0.033	0.265	-0.2	0.058	0.115	-0.007	-0.005	-0.126	0.015
	0.866	0.165	0.299	0.764	0.552	0.97	0.979	0.516	0.937
15	0.122	-0.311	-0.31	-0.212	-0.036	0.016	0.013	-0.154	0.054
	0.527	0.101	0.101	0.27	0.854	0.932	0.945	0.424	0.782
16	0.706	-0.109	-0.133	-0.456	-0.37	-0.06	-0.05	-0.069	-0.134
	0	0.574	0.493	0.013	0.048	0.756	0.797	0.721	0.488

29 Systems Minitab Correlation and P-value

	a	b	c	d	e	f	g	h	i
1	0.027	0.001	0.14	-0.02	-0.048	0.041	0.041	0.176	0.172
	0.904	0.995	0.535	0.93	0.833	0.855	0.855	0.433	0.445
2	0.032	-0.197	-0.018	-0.079	-0.011	0.143	0.142	0.2	0.022
	0.886	0.38	0.937	0.726	0.961	0.525	0.53	0.372	0.924
3	0.02	-0.093	-0.153	0.031	-0.083	0.126	0.123	-0.542	-0.405
	0.929	0.681	0.495	0.891	0.715	0.576	0.584	0.009	0.062
4	-0.033	-0.159	-0.204	-0.142	-0.029	-0.082	-0.082	-0.09	0.036
	0.882	0.48	0.362	0.528	0.898	0.718	0.716	0.69	0.874
5	0.065	-0.102	0.069	-0.073	-0.029	0.096	0.096	0.298	0.122
	0.775	0.65	0.76	0.746	0.899	0.672	0.671	0.178	0.59
6	-0.042	-0.17	-0.218	-0.128	-0.017	0.01	0.009	-0.127	0.007
	0.853	0.448	0.329	0.569	0.939	0.965	0.969	0.572	0.975
7	-0.062	-0.104	-0.034	0.033	0.088	0.286	0.284	0.087	-0.045
	0.783	0.645	0.88	0.884	0.696	0.197	0.2	0.7	0.842
8	-0.325	0.082	0.247	0.321	0.169	0.184	0.179	-0.026	0.318
	0.139	0.716	0.269	0.145	0.452	0.412	0.425	0.908	0.149
9	-0.128	0.022	0.101	0.121	0.051	0.185	0.184	-0.083	0.101
	0.569	0.923	0.655	0.592	0.822	0.409	0.413	0.712	0.654
10	-0.107	0.083	0.07	0.152	0.067	0.195	0.194	-0.121	0.047
	0.635	0.712	0.758	0.499	0.767	0.385	0.388	0.591	0.834
11	-0.196	0.007	0.033	0.19	0.133	0.226	0.225	-0.051	0.03
	0.383	0.976	0.884	0.397	0.556	0.311	0.315	0.821	0.894
12	-0.187	0.02	0.248	0.149	-0.022	-0.215	-0.219	0.238	0.229
	0.405	0.928	0.266	0.508	0.923	0.336	0.327	0.286	0.306
13	-0.082	-0.094	-0.088	-0.032	0.009	0.082	0.08	-0.098	0.057
	0.717	0.677	0.697	0.889	0.968	0.717	0.724	0.666	0.799
14	0.247	0.023	-0.264	-0.277	-0.181	0.006	0.011	-0.255	-0.015
	0.268	0.92	0.234	0.212	0.42	0.979	0.961	0.251	0.946
15	-0.199	-0.224	-0.214	-0.028	0.161	0.063	0.056	-0.079	0.106
	0.374	0.316	0.338	0.903	0.475	0.779	0.805	0.728	0.639
16	0.595	0.021	-0.091	-0.491	-0.38	-0.081	-0.071	-0.176	-0.236
	0.003	0.924	0.686	0.02	0.081	0.719	0.752	0.432	0.29

22 Systems Minitab Correlation and P-value

Excluding subcounty, urbanized and multicounties systems

	a	b	c	d	e	f	g	h	i
1	0.263	-0.243	-0.106	-0.31	-0.262	-0.03	-0.025	0.016	0.175
	0.204	0.242	0.612	0.131	0.205	0.887	0.906	0.94	0.403
2	-0.122	-0.149	0.024	0.008	0.053	0.152	0.149	0.205	0.023
	0.56	0.477	0.909	0.971	0.8	0.469	0.478	0.327	0.912
3	0.1	-0.148	-0.174	-0.053	-0.139	0.108	0.108	-0.463	-0.293
	0.634	0.481	0.405	0.801	0.509	0.606	0.607	0.02	0.156
4	0.531	-0.285	-0.299	-0.429	-0.312	-0.105	-0.097	-0.126	0.064
	0.006	0.168	0.147	0.033	0.13	0.619	0.643	0.55	0.761
5	-0.11	-0.05	0.111	0.027	0.049	0.108	0.107	0.288	0.1
	0.601	0.814	0.596	0.897	0.817	0.607	0.612	0.162	0.635
6	0.488	-0.33	-0.323	-0.447	-0.328	-0.07	-0.063	-0.159	0.062
	0.013	0.108	0.115	0.025	0.11	0.74	0.766	0.447	0.767
7	-0.213	-0.083	-0.009	0.092	0.134	0.282	0.279	0.074	-0.047
	0.306	0.692	0.965	0.662	0.524	0.172	0.178	0.726	0.823
8	-0.237	0.009	0.187	0.219	0.108	0.166	0.162	-0.04	0.318
	0.255	0.965	0.37	0.293	0.606	0.428	0.438	0.85	0.122
9	-0.055	-0.079	0.022	0.002	-0.031	0.154	0.154	-0.103	0.128
	0.793	0.706	0.915	0.992	0.882	0.462	0.462	0.624	0.543
10	-0.051	-0.034	-0.012	0.023	-0.02	0.159	0.16	-0.14	0.08
	0.809	0.873	0.956	0.913	0.926	0.447	0.445	0.503	0.704
11	-0.162	-0.084	-0.03	0.086	0.062	0.194	0.194	-0.08	0.054
	0.44	0.691	0.886	0.684	0.767	0.352	0.354	0.703	0.798
12	0.408	-0.257	-0.175	-0.344	-0.316	-0.145	-0.14	-0.095	0.073
	0.043	0.215	0.402	0.093	0.124	0.489	0.504	0.651	0.73
13	0.4	-0.326	-0.278	-0.411	-0.314	-0.045	-0.039	-0.147	0.099
	0.048	0.112	0.178	0.041	0.126	0.83	0.853	0.484	0.638
14	-0.018	0.081	-0.181	-0.118	-0.064	0.026	0.029	-0.211	-0.032
	0.932	0.701	0.386	0.574	0.76	0.9	0.892	0.311	0.879
15	0.135	-0.312	-0.317	-0.231	-0.043	0.013	0.01	-0.18	0.051
	0.52	0.128	0.122	0.267	0.84	0.951	0.963	0.388	0.807
16	0.731	-0.033	-0.136	-0.454	-0.375	-0.08	-0.069	-0.126	-0.14
	0	0.875	0.515	0.023	0.065	0.704	0.741	0.547	0.504

25 Systems Minitab Correlation and P-value

Excluding subcounty, urbanized systems

	a	b	c	d	e	f	g	h	i
1	-0.097	0.255	0.009	0.313	0.24	-0.034	-0.035	0.054	0.173
	0.639	0.209	0.964	0.119	0.237	0.87	0.865	0.792	0.397
2	0.016	0.167	-0.104	0.149	0.188	0.029	0.029	0.102	0.074
	0.938	0.415	0.614	0.467	0.358	0.888	0.887	0.621	0.719
3	0.003	-0.207	-0.113	-0.041	-0.139	0.139	0.137	-0.454	-0.396
	0.989	0.31	0.581	0.844	0.499	0.497	0.506	0.02	0.045
4	-0.09	-0.112	-0.172	-0.02	0.053	-0.078	-0.08	-0.045	0.088
	0.661	0.586	0.4	0.923	0.799	0.704	0.699	0.829	0.669
5	0.034	0.239	-0.066	0.164	0.191	-0.005	-0.003	0.135	0.123
	0.871	0.24	0.748	0.423	0.35	0.982	0.987	0.509	0.548
6	-0.149	0.036	-0.141	0.189	0.195	-0.015	-0.017	-0.036	0.123
	0.468	0.86	0.492	0.355	0.341	0.941	0.933	0.862	0.548
7	-0.083	0.081	-0.104	0.183	0.22	0.181	0.18	0.081	0.02
	0.687	0.693	0.615	0.372	0.28	0.376	0.378	0.694	0.923
8	-0.371	0	0.321	0.323	0.106	0.169	0.163	-0.081	0.31
	0.062	0.999	0.11	0.107	0.605	0.408	0.427	0.695	0.123
9	-0.203	-0.004	0.13	0.203	0.092	0.178	0.175	-0.063	0.14
	0.32	0.983	0.527	0.32	0.656	0.385	0.393	0.762	0.495
10	-0.176	0.068	0.073	0.236	0.129	0.184	0.182	-0.079	0.09
	0.389	0.742	0.723	0.245	0.531	0.368	0.374	0.7	0.663
11	-0.246	0.029	0.045	0.267	0.174	0.205	0.202	-0.056	0.067
	0.226	0.889	0.828	0.187	0.395	0.315	0.322	0.788	0.746
12	-0.198	0.207	0.074	0.382	0.249	-0.092	-0.095	0.088	0.211
	0.331	0.31	0.719	0.054	0.221	0.657	0.645	0.669	0.302
13	-0.171	0.166	-0.03	0.322	0.251	-0.005	-0.008	-0.003	0.162
	0.404	0.417	0.885	0.109	0.216	0.98	0.97	0.987	0.43
14	0.193	0.218	-0.281	-0.061	0.029	-0.026	-0.021	-0.147	0.039
	0.345	0.284	0.164	0.768	0.888	0.9	0.919	0.474	0.849
15	-0.206	-0.211	-0.208	-0.01	0.158	0.061	0.053	-0.077	0.106
	0.313	0.301	0.309	0.96	0.442	0.768	0.796	0.707	0.606
16	0.539	-0.077	-0.076	-0.482	-0.366	-0.052	-0.043	-0.097	-0.228
	0.004	0.707	0.713	0.013	0.066	0.8	0.835	0.638	0.263

26 Systems Minitab Correlation and P-value

Excluding multicounties systems

	a	b	c	d	e	f	g	h	i
1	-0.018	0.173	-0.022	0.193	0.14	-0.053	-0.053	-0.01	0.172
	0.931	0.388	0.912	0.334	0.486	0.794	0.793	0.959	0.392
2	-0.106	0.217	-0.027	0.214	0.231	0.04	0.038	0.101	0.069
	0.6	0.277	0.896	0.284	0.247	0.843	0.849	0.617	0.731
3	0.098	-0.258	-0.136	-0.124	-0.207	0.12	0.12	-0.427	-0.289
	0.626	0.194	0.497	0.539	0.301	0.551	0.552	0.026	0.144
4	0.493	-0.275	-0.276	-0.373	-0.29	-0.103	-0.096	-0.126	0.077
	0.009	0.164	0.163	0.056	0.142	0.611	0.633	0.532	0.704
5	-0.09	0.288	0.009	0.229	0.234	0.006	0.005	0.127	0.105
	0.656	0.145	0.964	0.251	0.241	0.976	0.979	0.528	0.601
6	0.385	-0.228	-0.272	-0.27	-0.217	-0.076	-0.07	-0.155	0.106
	0.048	0.253	0.17	0.173	0.278	0.707	0.727	0.439	0.6
7	-0.221	0.132	-0.015	0.249	0.257	0.196	0.192	0.049	0.019
	0.267	0.512	0.941	0.211	0.195	0.328	0.337	0.809	0.926
8	-0.278	-0.082	0.232	0.235	0.089	0.165	0.16	-0.038	0.324
	0.161	0.685	0.244	0.238	0.658	0.412	0.427	0.852	0.1
9	-0.113	-0.097	0.067	0.078	0	0.149	0.148	-0.101	0.159
	0.575	0.632	0.741	0.701	1	0.458	0.462	0.615	0.429
10	-0.106	-0.032	0.027	0.104	0.022	0.152	0.151	-0.139	0.114
	0.6	0.874	0.895	0.607	0.913	0.45	0.453	0.491	0.571
11	-0.207	-0.052	0.002	0.168	0.111	0.182	0.18	-0.082	0.09
	0.301	0.796	0.993	0.401	0.583	0.363	0.369	0.686	0.656
12	0.143	0.003	-0.072	0.048	-0.019	-0.123	-0.122	-0.077	0.146
	0.476	0.986	0.723	0.811	0.925	0.54	0.543	0.704	0.468
13	0.186	-0.085	-0.168	-0.058	-0.066	-0.058	-0.055	-0.122	0.16
	0.353	0.674	0.402	0.774	0.744	0.774	0.784	0.544	0.425
14	-0.033	0.281	-0.177	0.058	0.097	-0.012	-0.01	-0.175	0.011
	0.868	0.155	0.377	0.776	0.631	0.952	0.959	0.382	0.955
15	0.123	-0.307	-0.304	-0.212	-0.045	0.015	0.012	-0.18	0.055
	0.54	0.12	0.124	0.288	0.824	0.94	0.954	0.369	0.787
16	0.709	-0.102	-0.121	-0.466	-0.404	-0.068	-0.057	-0.121	-0.149
	0	0.612	0.546	0.014	0.037	0.738	0.777	0.549	0.458

27 Systems Minitab Correlation and P-value

Excluding subcounty systems

For the following tables, the columns and rows are defined by:

1	resident 2010 Census population
2	Elderly Density
3	%Elderly 65 and older
4	Land Area 110210D, Square Miles
5	Pop Density
6	Road length miles
7	Road Density
8	%Road length miles >= 5% slope
9	%Road length miles >= 10% slope
10	%Road length miles >= 15% slope
11	Mean Slope%
12	Rail and road intersections
13	Intersections
14	Median household income, in dollars, 2010
15	Shape Factor
16	%User Number
j	**Vehicle miles**
k	**Passenger miles**
l	**Passenger trips**
m	**Passenger service hours**
n	**Vehicle Hours**
o	**Operating cost**
p	**Administrative cost**
q	**Revenue**

	j	k	l	m	n	o	p	q
1	0.079	0.06	0.053	-0.046	0.052	0.093	-0.048	0.155
	0.685	0.758	0.784	0.811	0.79	0.633	0.806	0.421
2	-0.057	-0.058	-0.144	0.029	-0.08	-0.006	-0.121	-0.046
	0.77	0.765	0.456	0.881	0.681	0.975	0.532	0.814
3	0.222	0.182	0.176	0.133	0.233	0.155	0.246	-0.013
	0.247	0.344	0.362	0.491	0.223	0.423	0.199	0.947
4	0.603	0.637	0.759	-0.05	0.612	0.517	0.526	0.653
	0.001	0	0	0.796	0	0.004	0.003	0
5	-0.091	-0.087	-0.156	-0.004	-0.122	-0.037	-0.153	-0.041
	0.638	0.652	0.419	0.983	0.527	0.849	0.427	0.832
6	0.52	0.53	0.614	-0.03	0.522	0.449	0.385	0.549
	0.004	0.003	0	0.876	0.004	0.015	0.039	0.002
7	-0.102	-0.097	-0.218	0.17	-0.107	-0.045	-0.16	-0.16
	0.6	0.618	0.256	0.379	0.58	0.816	0.408	0.408
8	-0.357	-0.338	-0.254	0.133	-0.335	-0.393	-0.406	-0.23
	0.057	0.073	0.184	0.493	0.076	0.035	0.029	0.229
9	-0.229	-0.218	-0.162	0.136	-0.223	-0.271	-0.323	-0.225
	0.232	0.255	0.401	0.483	0.244	0.155	0.087	0.241
10	-0.216	-0.212	-0.171	0.138	-0.22	-0.252	-0.317	-0.251
	0.261	0.269	0.374	0.475	0.251	0.187	0.094	0.189
11	-0.321	-0.312	-0.282	0.157	-0.331	-0.365	-0.427	-0.346
	0.089	0.1	0.139	0.416	0.08	0.051	0.021	0.066
12	0.189	0.209	0.306	-0.1	0.194	0.184	0.093	0.299
	0.326	0.276	0.107	0.607	0.314	0.34	0.632	0.115
13	0.321	0.31	0.354	-0.029	0.317	0.284	0.17	0.36
	0.09	0.102	0.059	0.88	0.094	0.135	0.377	0.055
14	-0.011	-0.076	-0.165	-0.016	-0.088	-0.013	-0.175	-0.086
	0.957	0.696	0.393	0.934	0.649	0.947	0.365	0.656
15	0.647	0.595	0.537	0.052	0.654	0.573	0.442	0.559
	0	0.001	0.003	0.791	0	0.001	0.016	0.002
16	0.681	0.721	0.845	-0.011	0.685	0.682	0.741	0.705
	0	0	0	0.956	0	0	0	0

29 Systems Minitab Correlation and P-value

	j	k	l	m	n	o	p	q
1	0.424	0.386	0.365	-0.004	0.451	0.396	0.299	0.419
	0.035	0.057	0.073	0.986	0.024	0.05	0.147	0.037
2	0.042	0.047	-0.103	0.147	0.095	0.114	0.077	-0.027
	0.841	0.823	0.624	0.482	0.65	0.588	0.716	0.9
3	0.199	0.154	0.145	0.117	0.187	0.129	0.192	-0.039
	0.34	0.462	0.489	0.577	0.37	0.539	0.358	0.852
4	0.606	0.642	0.766	-0.06	0.615	0.512	0.533	0.647
	0.001	0.001	0	0.776	0.001	0.009	0.006	0
5	-0.02	-0.005	-0.135	0.102	0.029	0.068	0.032	-0.019
	0.923	0.982	0.52	0.627	0.891	0.748	0.879	0.927
6	0.579	0.592	0.683	-0.028	0.591	0.487	0.463	0.573
	0.002	0.002	0	0.893	0.002	0.014	0.02	0.003
7	-0.07	-0.06	-0.217	0.27	-0.037	-0.01	-0.068	-0.204
	0.74	0.777	0.297	0.192	0.859	0.961	0.748	0.329
8	-0.383	-0.358	-0.283	0.142	-0.387	-0.429	-0.473	-0.255
	0.059	0.079	0.17	0.497	0.056	0.032	0.017	0.219
9	-0.244	-0.233	-0.175	0.139	-0.253	-0.299	-0.348	-0.264
	0.24	0.262	0.404	0.508	0.223	0.147	0.088	0.203
10	-0.231	-0.229	-0.182	0.144	-0.246	-0.281	-0.333	-0.295
	0.266	0.271	0.383	0.493	0.236	0.174	0.104	0.153
11	-0.32	-0.309	-0.28	0.173	-0.335	-0.377	-0.425	-0.372
	0.119	0.133	0.175	0.409	0.102	0.063	0.034	0.067
12	0.369	0.405	0.551	-0.114	0.406	0.325	0.307	0.431
	0.069	0.045	0.004	0.587	0.044	0.113	0.136	0.031
13	0.496	0.485	0.543	-0.011	0.515	0.417	0.36	0.464
	0.012	0.014	0.005	0.959	0.008	0.038	0.077	0.019
14	0.047	-0.038	-0.139	0.023	-0.004	0.032	-0.085	-0.098
	0.824	0.856	0.507	0.914	0.987	0.879	0.686	0.643
15	0.656	0.606	0.54	0.048	0.666	0.579	0.449	0.563
	0	0.001	0.005	0.82	0	0.002	0.024	0.003
16	0.673	0.714	0.844	-0.032	0.669	0.675	0.726	0.707
	0	0	0	0.879	0	0	0	0

25 Systems Minitab Correlation and P-value

The following table shows the results using the original performance measures.

Productivity	R1	Operating cost per vehicle hour	R2	Operating cost per vehicle mile	R3	Operating cost per passenger trip	R4	Average passenger trip length	R5	Average travel time	R6	Hourly Utilization	R7	Mileage Utilization	R8	Operational Cost Recovery Ratio	R9	Sum of Ranks	Final Rank
2.33	19	17.04	3	1.18	3	7.31	8	4.99	17	0.29	19	0.68	19	0.81	17	0.74	10	115	8
2.32	20	34.13	22	2.93	27	14.72	21	4.03	12	0.34	23	0.78	17	0.80	19	0.81	7	168	24
2.70	16	20.86	9	1.30	4	7.73	9	4.97	16	0.34	22	0.91	9	0.83	14	0.49	17	116	9
3.18	8	21.43	10	1.31	5	6.75	6	2.92	5	0.15	4	0.48	25	0.57	28	0.45	19	110	6
1.55	23	37.99	24	2.14	20	24.57	28	9.36	26	0.52	25	0.80	15	0.82	16	0.88	6	183	27
2.87	11	23.97	12	1.65	14	8.36	10	3.17	7	0.14	3	0.39	27	0.63	26	0.89	5	115	7
1.84	21	18.74	7	1.36	7	10.19	13	5.60	20	0.29	18	0.53	23	0.75	21	0.15	29	159	23
2.77	15	33.02	21	2.68	24	11.92	17	2.66	4	0.18	7	0.50	24	0.60	27	0.56	15	154	19
2.65	17	28.91	17	1.96	19	10.93	14	3.65	10	0.25	15	0.67	21	0.65	24	0.46	18	155	20
1.43	25	32.18	19	2.34	22	22.49	26	4.44	14	0.19	9	0.28	28	0.46	29	0.36	23	195	29
1.00	27	27.08	16	1.61	11	26.96	29	16.46	29	42.27	29	42.47	1	0.98	3	0.18	28	173	25
2.85	12	26.21	13	1.43	9	9.18	11	5.98	21	0.33	20	0.93	6	0.93	8	0.33	26	126	11
3.17	9	17.81	5	1.17	2	5.62	4	3.01	6	0.19	10	0.62	22	0.63	25	0.36	21	104	5
3.00	10	43.53	27	1.36	6	14.49	20	9.45	27	0.29	17	0.87	12	0.88	11	0.72	11	141	16
4.19	5	26.38	14	1.85	17	6.30	5	3.22	8	0.22	13	0.93	7	0.95	7	0.72	12	88	4
0.96	28	12.11	1	1.63	13	12.60	18	7.17	25	0.97	28	0.93	4	0.93	9	0.79	9	135	12
5.32	2	38.56	25	2.39	23	7.25	7	2.32	3	0.16	5	0.86	13	0.76	20	0.35	24	122	10
2.77	14	26.98	15	1.75	15	9.73	12	4.70	15	0.33	21	0.91	8	0.85	12	0.24	27	139	15
1.83	22	29.14	18	1.92	18	15.95	23	6.16	22	0.23	14	0.43	26	0.74	22	0.37	20	185	28
2.41	18	47.99	29	3.85	29	19.92	24	5.53	19	0.36	24	0.87	11	1.07	1	1.31	2	157	21
0.90	29	18.35	6	1.78	16	20.47	25	11.44	28	0.12	2	0.10	29	1.00	2	0.36	22	159	22
3.75	6	43.41	26	1.38	8	11.58	15	6.93	24	0.21	11	0.79	16	0.83	15	0.55	16	137	13
5.04	3	17.28	4	0.97	1	3.43	2	3.23	9	0.18	6	0.90	10	0.91	10	0.60	14	59	2
4.32	4	15.94	2	1.62	12	3.69	3	2.17	2	0.22	12	0.95	2	0.95	5	1.21	3	45	1
1.27	26	19.57	8	2.79	25	15.40	22	5.24	18	0.73	27	0.93	5	0.95	6	1.58	1	138	14
2.81	13	32.66	20	2.91	26	11.62	16	3.88	11	0.26	16	0.74	18	0.97	4	0.34	25	149	18
3.59	7	46.37	28	2.26	21	12.92	19	4.22	13	0.19	8	0.68	20	0.74	23	1.05	4	143	17
1.52	24	36.71	23	2.99	28	24.21	27	6.82	23	0.62	26	0.94	3	0.84	13	0.79	8	175	26
7.14	1	22.76	11	1.47	10	3.19	1	1.73	1	0.11	1	0.80	14	0.80	18	0.64	13	70	3

The following table shows the results using the modified performance measures.

Productivity	R1	Operating cost per vehicle hour	R2	Operating cost per vehicle mile	R3	Operating cost per passenger trip	R4	Average passenger trip length	R5	Average travel time	R6	Hourly Utilization	R7	Mileage Utilization	R8	Operational Cost Recovery Ratio	R9	Sum of Ranks	Final Rank
2.33	19	23.04	3	1.60	2	9.89	6	4.99	17	2010.60	27	4686.95	6	0.81	17	0.49	9	106	7
2.32	20	37.57	13	3.22	20	16.20	16	4.03	12	643.72	16	1492.46	17	0.80	19	0.68	6	139	14
2.70	16	29.67	9	1.84	4	10.99	9	4.97	16	438.52	8	1183.62	23	0.83	14	0.32	14	113	8
3.18	8	57.16	25	3.50	24	18.00	17	2.92	5	664.35	17	2109.80	12	0.57	28	0.15	25	161	22
1.55	23	53.35	23	3.01	17	34.50	28	9.36	26	4360.52	28	6742.69	4	0.82	16	0.61	7	172	26
2.87	11	28.19	8	1.94	5	9.83	5	3.17	7	263.22	1	755.09	25	0.63	26	0.72	4	92	4
1.84	21	23.79	4	1.73	3	12.94	10	5.60	20	504.48	12	927.69	24	0.75	21	0.11	28	143	16
2.77	15	38.36	14	3.11	18	13.85	11	2.66	4	265.91	2	736.40	26	0.60	27	0.42	11	128	10
2.65	17	42.23	17	2.86	16	15.96	15	3.65	10	501.89	10	1327.75	21	0.65	24	0.27	16	146	19
1.43	25	44.79	18	3.26	21	31.31	26	4.44	14	473.17	9	676.96	27	0.46	29	0.21	21	190	28
1.00	27	35.38	10	2.10	8	35.21	29	16.46	29	102706.30	29	103192.68	1	0.98	3	0.13	27	163	23
2.85	12	40.60	16	2.21	9	14.23	13	5.98	21	848.43	19	2421.67	8	0.93	8	0.20	22	128	11
3.17	9	23.92	5	1.57	1	7.55	4	3.01	6	1994.48	25	6321.07	5	0.63	25	0.26	17	97	5
3.00	10	80.88	27	2.52	12	26.93	20	9.45	27	611.93	14	1837.61	15	0.88	11	0.35	13	149	20
4.19	5	45.35	19	3.18	19	10.82	8	3.22	8	514.65	13	2156.37	10	0.95	7	0.31	15	104	6
0.96	28	17.46	1	2.35	11	18.16	18	7.17	25	2003.98	26	1926.32	14	0.93	9	0.47	10	142	15
5.32	2	53.32	22	3.30	22	10.02	7	2.32	3	274.20	4	1458.66	18	0.76	20	0.23	19	117	9
2.77	14	39.25	15	2.55	13	14.16	12	4.70	15	712.13	18	1974.38	13	0.85	12	0.14	26	138	13
1.83	22	51.02	21	3.35	23	27.93	22	6.16	22	341.61	6	623.97	28	0.74	22	0.17	24	190	29
2.41	18	65.73	26	5.28	28	27.28	21	5.53	19	1039.64	21	2505.17	7	1.07	1	0.87	3	144	18
0.90	29	28.14	7	2.74	14	31.39	27	11.44	28	273.95	3	245.59	29	1.00	2	0.21	20	159	21
3.75	6	115.27	29	3.66	26	30.74	23	6.93	24	612.18	15	2295.68	9	0.83	15	0.18	23	170	25
5.04	3	35.99	11	2.01	7	7.15	3	3.23	9	316.43	5	1593.48	16	0.91	10	0.26	18	82	3
4.32	4	19.34	2	1.96	6	4.48	1	2.17	2	1865.45	24	8058.35	3	0.95	5	0.88	2	49	1
1.27	26	25.10	6	3.58	25	19.75	19	5.24	18	1007.89	20	1280.84	22	0.95	6	1.16	1	143	17
2.81	13	86.54	28	7.72	29	30.79	24	3.88	11	503.60	11	1415.41	19	0.97	4	0.11	29	168	24
3.59	7	56.69	24	2.76	15	15.80	14	4.22	13	371.49	7	1333.10	20	0.74	23	0.72	5	128	12
1.52	24	47.16	20	3.84	27	31.11	25	6.82	23	1392.84	23	2111.46	11	0.84	13	0.60	8	174	27
7.14	1	36.33	12	2.35	10	5.09	2	1.73	1	1273.68	22	9097.67	2	0.80	18	0.36	12	80	2

The following table shows the results using the combined performance measures.

Productivity	R1	Operating cost per vehicle hour	R2	Operating cost per vehicle mile	R3	Operating cost per passenger	R4	Average passenger trip length	R5	Average travel time	R6	Hourly Utilization	R7	Mileage Utilization	R8	Operational Cost Recovery	R9	Sum of Ranks	Final Rank
0.0003	27	23.04	3	1.60	2	0.001	4	4.99	17	2010.60	27	4686.95	6	5.00	21	0.49	9	116	7
0.0012	14	37.57	13	3.22	20	0.009	17	4.03	12	643.72	16	1492.46	17	4.63	22	0.68	6	137	14
0.0021	3	29.67	9	1.84	4	0.008	16	4.97	16	438.52	8	1183.62	23	6.94	4	0.32	14	97	4
0.0007	19	57.16	25	3.50	24	0.004	7	2.92	5	664.35	17	2109.80	12	3.39	28	0.15	25	162	23
0.0002	29	53.35	23	3.01	17	0.004	6	9.36	26	4360.52	28	6742.69	4	6.50	8	0.61	7	148	20
0.0015	7	28.19	8	1.94	5	0.005	9	3.17	7	263.22	1	755.09	25	4.25	25	0.72	4	91	3
0.0011	16	23.79	4	1.73	3	0.007	13	5.60	20	504.48	12	927.69	24	5.52	16	0.11	28	136	13
0.0019	4	38.36	14	3.11	18	0.009	19	2.66	4	265.91	2	736.40	26	4.20	26	0.42	11	124	11
0.0013	10	42.23	17	2.86	16	0.008	15	3.65	10	501.89	10	1327.75	21	4.38	24	0.27	16	139	16
0.0006	22	44.79	18	3.26	21	0.013	23	4.44	14	473.17	9	676.96	27	2.52	29	0.21	21	184	28
0.0004	25	35.38	10	2.10	8	0.014	27	16.46	29	102706.30	29	103192.68	1	6.17	11	0.13	27	167	25
0.0011	15	40.60	16	2.21	9	0.005	10	5.98	21	848.43	19	2421.67	8	6.70	7	0.20	22	127	12
0.0003	28	23.92	5	1.57	1	0.001	3	3.01	6	1994.48	25	6321.07	5	4.19	27	0.26	17	117	8
0.0014	9	80.88	27	2.52	12	0.013	22	9.45	27	611.93	14	1837.61	15	6.00	12	0.35	13	151	21
0.0018	6	45.35	19	3.18	19	0.005	8	3.22	8	514.65	13	2156.37	10	6.24	10	0.31	15	108	6
0.0005	24	17.46	1	2.35	11	0.009	18	7.17	25	2003.98	26	1926.32	14	5.88	13	0.47	10	142	17
0.0031	1	53.32	22	3.30	22	0.006	11	2.32	3	274.20	4	1458.66	18	4.53	23	0.23	19	123	10
0.0013	12	39.25	15	2.55	13	0.007	12	4.70	15	712.13	18	1974.38	13	5.14	19	0.14	26	143	18
0.0012	13	51.02	21	3.35	23	0.019	29	6.16	22	341.61	6	623.97	28	5.09	20	0.17	24	186	29
0.0008	18	65.73	26	5.28	28	0.009	20	5.53	19	1039.64	21	2505.17	7	10.63	1	0.87	3	143	19
0.0004	26	28.14	7	2.74	14	0.013	24	11.44	28	273.95	3	245.59	29	7.61	2	0.21	20	153	22
0.0013	11	115.27	29	3.66	26	0.011	21	6.93	24	612.18	15	2295.68	9	6.77	5	0.18	23	163	24
0.0029	2	35.99	11	2.01	7	0.004	5	3.23	9	316.43	5	1593.48	16	6.43	9	0.26	18	82	2
0.0005	23	19.34	2	1.96	6	0.001	2	2.17	2	1865.45	24	8058.35	3	5.59	15	0.88	2	79	1
0.0009	17	25.10	6	3.58	25	0.014	26	5.24	18	1007.89	20	1280.84	22	7.43	3	1.16	1	138	15
0.0015	8	86.54	28	7.72	29	0.016	28	3.88	11	503.60	11	1415.41	19	6.72	6	0.11	29	169	26
0.0018	5	56.69	24	2.76	15	0.008	14	4.22	13	371.49	7	1333.10	20	5.64	14	0.72	5	117	9
0.0007	20	47.16	20	3.84	27	0.014	25	6.82	23	1392.84	23	2111.46	11	5.18	18	0.60	8	175	27
0.0006	21	36.33	12	2.35	10	0.000	1	1.73	1	1273.68	22	9097.67	2	5.20	17	0.36	12	98	5

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