Billing for Performance:
Determining Billing Methods that Encourage Performance in Community Transportation

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ABSTRACT
The purpose of this research is to determine whether different billing methods impact the performance of community transportation systems not using automated scheduling software. A scheduler aware of the dominant billing method on a run can create a schedule that positively affects the performance and income of their community transportation system by determining the assigned run, the miles each passenger rides, and the order of pickups and drop offs.

The hypothesis is that billing methods have an impact on productivity with the expectation that runs dominated by flat rate billing will have better performance statistics than revenue mile billing, which will outperform service mile billing. This analysis looked at run level data for 10 North Carolina community transportation systems to determine how runs with a majority of clients assigned to one billing method perform compared to the average performance of the transportation systems.

The analysis proves the hypothesis, with flat rate billing significantly outperforming the average performance of transportation systems using flat rate billing. Service mile billing has the weakest performance, with mixed billing methods and revenue mile billing in the middle, close to the average performance. This research proves that community transportation systems primarily concerned with performance should not use service mile billing.

INTRODUCTION

The purpose of this research is to determine whether different billing methods impact the performance of community transportation systems not using automated scheduling software. These billing methods are commonly based on time, miles traveled, passenger miles and/or passenger boardings. A scheduler aware of the dominant billing method on a run can create a schedule that positively affects the performance and income of their community transportation system by determining the assigned run, the miles each passenger rides, and the order of pickups and drop offs. Systems with automatic scheduling software were excluded from the analysis because optimization algorithms typically do not have the ability to consider characteristics of the dominant billing methods when creating the schedules.

When scheduling manually, a run consisting entirely of clients using revenue mile billing methods, for instance, should be designed to minimize deadhead miles because the transit system receives no income for deadhead miles. A run consisting entirely of service mile billing methods is not as concerned with minimizing deadhead miles or revenue miles since the transportation agency receives additional money for each mile traveled. Revenue and service mile runs will not be concerned with the number of passengers because the miles are shared and additional passengers do not result in additional income. However, a run consisting of clients using flat rate billing methods should be scheduled to minimize all miles traveled and maximize the number of passengers because the transit system receives extra income for passengers, but not for miles.

We hypothesize that billing methods have an impact on productivity at community transportation systems that do not have automated scheduling software with the expectation that runs dominated by flat rate billing will have better performance statistics than revenue mile billing, which will outperform service mile billing. The definition of each billing method and its expected effect on productivity are listed in Table 1.

TABLE 1 Definitions of Billing Methods with Expected Effects on Productivity

Billing Method	Definition	Expected Effects on Productivity
Flat rate	A set fee charged per passenger boarding regardless of the miles or hours the passenger travels.	Encourages the scheduler to be more efficient than revenue mile and service mile billing methods because the transit agency receives no monetary benefit for driving more miles or hours and adding passengers increases income.
Revenue mile	Total revenue miles (first pickup to last drop off) are divided equally among the passengers on the run and each passenger's share of miles are multiplied by the rate.	Encourages better passenger per service mile statistics than service mile billing because the agency is not receiving money for the non-revenue portion of the service miles. This billing type does not have a monetary reward for booking additional passengers on a run.
Service miles	Total revenue miles (depot pull out to pull in) divided equally among the passengers on the run and each passenger's share of miles are multiplied by the rate.	Should have the lowest performance of the billing methods because the transit system receives income for all miles traveled, regardless of number of passengers.

LITERATURE REVIEW

Many studies have covered factors that influence efficiency in community transportation. However, most of the variables examined are based on operating conditions, use of technology or management and do not discuss or study the impact of client billing methods on community transportation operations and performance. The authors found no research on community transportation that correlates billing methods and performance.

In *Analytic Model for Paratransit Capacity and Quality-of-Service,* fleet size and travel demand are used as the primary determining factors in describing performance of paratransit systems. Using simulation models, this paper attempts to explain the relationship between fleet size and efficiency, as well as the minimal fleet size for delivery of services at a certain level of performance *(1).*

In one of many papers written on the influence of technology in this area of transit, *Impacts of Management Practices and Advanced Technologies on Demand Responsive Transit Systems,* demand-response based transit systems were studied to quantify the effects of advanced technology on performance. The researchers found that “the use of paratransit computer aided dispatching (CAD) systems and agency service delivery provide a productivity benefit” *(2)* and use of such technologies could have a great impact on the number of passenger miles per vehicle. The research in this paper applies only to transportation systems that do not have automated scheduling software.

Factors Influencing Productivity and Operating Costs of Demand Response Transit discusses some financial factors that may affect productivity, the relationship between productivity and operating costs, the use of no-show charges and the relationship between productivity and other operational characteristics. In one analysis, this paper separated transit systems based on how whether they paid contractors by hour or by mile. The systems paying contractors by hour had higher mean operating expenses per trip, and the researchers conclude that this occurs because drivers are paid for idle time *(3).*

METHODOLOGY

Client reservation and run level data was available for 13 small North Carolina community transportation systems without automated scheduling software. Three of the datasets used one billing type for all passengers and had to be excluded because no internal differences in performance could be measured. The remaining 10 datasets with at least two billing methods were comprised of six months of data for each system during Fiscal Year 2007-2008.

Table 2 contains descriptive statistics for each transit system for the collection period and the passengers per service and passengers per revenue mile. These performance statistics were created by dividing the total number of service or revenue miles by the total number of passenger trips. Passengers per service and revenue hour were not used because the billing types were primarily mileage based and a direct 1:1 ratio between mile and hour efficiency is not a given. High passengers per revenue mile compared to low passengers per service mile indicate high deadhead miles. The transportations systems in this study have a large variation in passengers, service miles, revenue miles, and performance.

TABLE 2 Descriptive Statistics and Performance by System

System	Total Passenger Trips	Total Service Miles	Total Revenue Miles	Passengers Per Service Mile	Passengers Per Revenue Mile
A	11,102	89,475	70,226	0.39	0.50
B	24,603	239,164	135,247	0.29	0.50
C	34,434	301,716	226,539	0.36	0.49
D	29,255	228,957	212,336	0.23	0.25
E	3,788	45,399	32,737	0.32	0.46
F	9,248	90,286	72,562	0.40	0.51
G	28,648	245,214	211,009	0.29	0.33
H	25,978	157,632	117,258	0.26	0.35
I	35,697	196,380	152,365	0.62	0.78
J	17,469	105,676	80,094	0.49	0.66
Mean	22,022	169,990	131,037	0.37	0.48
Median	25,291	177,006	126,253	0.34	0.49
Maximum	35,697	301,716	226,539	0.62	0.78
Minimum	3,788	45,399	32,737	0.23	0.25

To compare performance for each billing type, run level statistics were calculated and the runs were coded as flat rate, revenue mile, service mile, or mixed. Other billing methods were not available for analysis because they did not regularly occur in the datasets. If 60% or more of the passengers on the run were one billing method, the run was coded for that billing method. If no billing method represented 60% of the passengers, runs were coded as mixed. Sixty percent was used as the cutoff because it was assumed that the run could be scheduled according to the efficiencies encouraged by the dominant billing type. If there was no dominant billing type, it was assumed that the scheduler could not create a schedule based on the characteristics of any single billing method. The calculations were also made with an 80% cut off for coding runs by billing type, but this more stringent requirement did not have a significant impact on the final results except for increasing the runs coded as mixed.

Because subscription trips are typically more efficient than demand response trips, it was verified that the percent subscription trips for each billing type was consistent with the overall percent subscription trips for the transportation system. In addition, it was verified that wheelchair trips were consistent for each billing type within a transportation system since wheelchair trips tend to reduce vehicle capacity.

The descriptive statistics for each billing method and calculated performance are shown in Table 3, ordered by passengers per service mile. Using this calculation method, the results generally prove the hypothesis that flat rate billing has the highest passenger per service mile, followed by revenue mile, mixed, and service mile billing. In this analysis, however, revenue mile billing has a slight advantage in passengers per revenue miles to flat rate.

However, the kind of analysis shown in Table 3 weighs systems with more passengers and miles greater than smaller systems because it aggregates passengers and miles.

TABLE 3 Descriptive Statistics and Overall Performance by Billing Type

Billing Type	Total Passengers	Total Service Miles	Total Revenue Miles	Passengers Per Service Mile	Passengers Per Revenue Mile
Flat Rate	123,975	872,355	722,238	0.14	0.17
Service Mile	29,232	284,117	204,415	0.10	0.14
Revenue Mile	49,606	393,730	267,706	0.13	0.19
Mixed	17,409	149,697	116,014	0.12	0.15

To ensure that large systems were not overrepresented, the performance calculations were also averaged by system, counting each billing type and each system equally. Table 4 is a preparatory table, displaying the performance of each billing type within each system, sorted from highest to lowest passengers per service mile. The figure shows that, in general, flat rate has a higher passenger per service mile rate than revenue mile, which is higher than mixed, and all tend to be higher than service mile billing.

TABLE 4 Statistics by System with Total Passengers and Efficiencies by Billing Type

System	Billing Type	Total Passengers	Passengers per Service Mile	Passengers per Revenue Mile
A	Flat Rate	4,907	0.19	0.24
	Mixed	1,811	0.11	0.14
	Revenue Mile	4,384	0.09	0.12
B	Revenue Mile	17,639	0.11	0.18
	Service Mile	6,597	0.10	0.19
	Mixed	367	0.09	0.12
C	Revenue Mile	22,694	0.17	0.23
	Flat Rate	7,253	0.08	0.10
	Mixed	3,647	0.06	0.08
	Service Mile	840	0.06	0.08
D	Flat Rate	28,953	0.13	0.14
	Mixed	232	0.06	0.07
	Revenue Mile	70	0.04	0.05
E	Revenue Mile	1,622	0.12	0.20
	Mixed	435	0.08	0.09
	Service Mile	1,306	0.07	0.09
	Flat Rate	425	0.05	0.07
F	Service Mile	4,713	0.08	0.09
	Flat Rate	2,872	0.17	0.21
	Mixed	1,663	0.16	0.21
G	Flat Rate	27,772	0.12	0.14
	Mixed	387	0.12	0.13
	Revenue Mile	489	0.05	0.06
H	Flat Rate	25,447	0.18	0.24
	Mixed	212	0.05	0.07
	Service Mile	319	0.04	0.05
I	Mixed	4,291	0.24	0.29
	Flat Rate	15,949	0.24	0.32
	Service Mile	15,457	0.14	0.18
J	Mixed	4,364	0.19	0.28
	Flat Rate	10,397	0.17	0.22
	Revenue Mile	2,708	0.13	0.17

The passengers per service and revenue mile statistics in Table 4 were averaged by billing method to create *billing method performance*. Figures 1 and 2 illustrate that, when using *billing method performance*, runs dominated by the flat rate billing method outperform the other billing methods in both passengers per service mile and passengers per revenue mile, proving the hypothesis. Revenue mile billing has the next highest passengers per service mile and passengers per revenue mile for runs with a dominant billing method, with service mile billing performing the worst. Mixed runs, as expected by their varied composition, have performance measures that fall between the other billing methods.

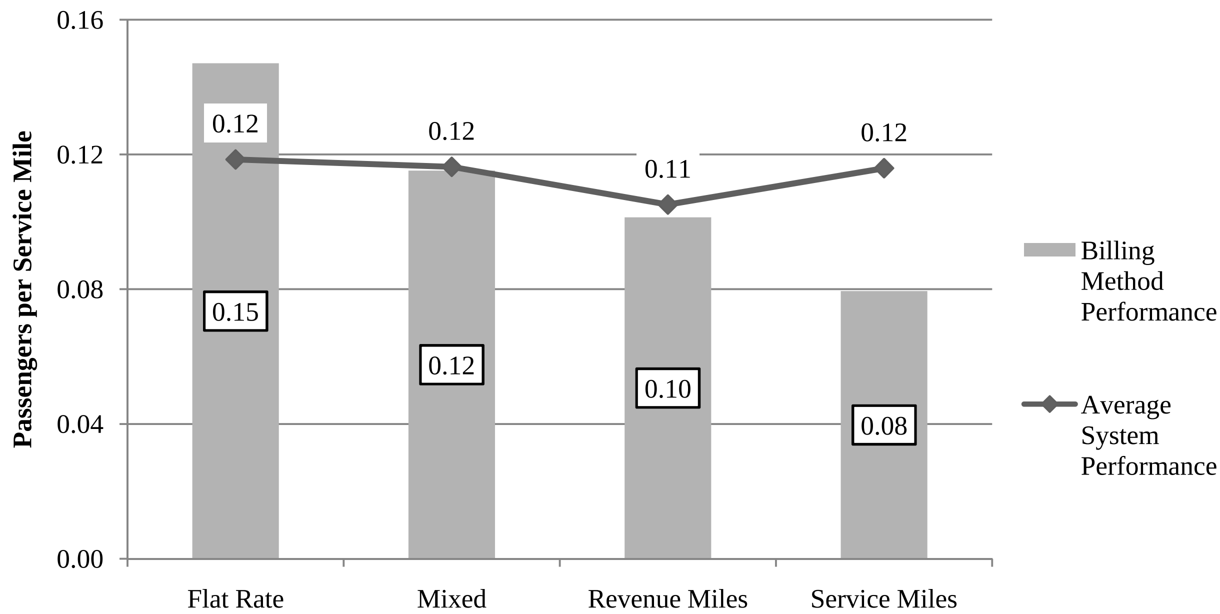

FIGURE 1 Billing Method and Average System Performance- Passengers per Service Mile

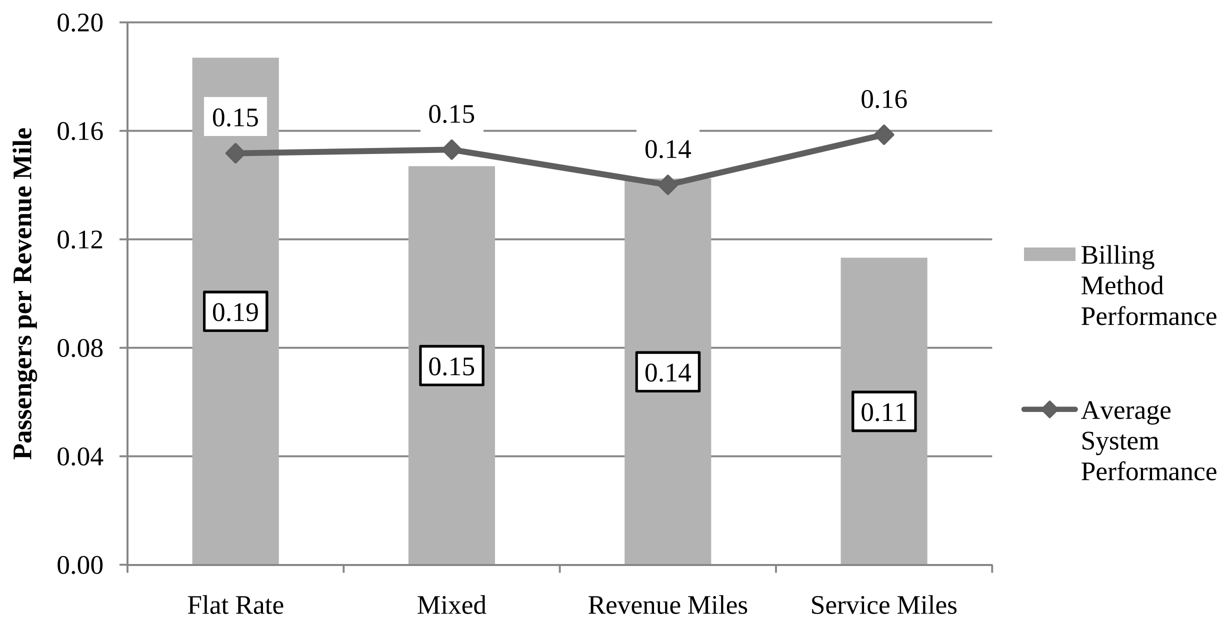

FIGURE 2 Billing Method and Average System Performance- Passengers per Revenue Mile

In Figures 1 and 2, the *billing method performances* are compared to the *average system performances* for systems using that billing method. The *average system performance* is calculated by averaging the passengers per service and revenue miles for the systems that utilize the particular billing method. The service mile billing method, for instance, averages the passengers per service and revenue mile statistics for all billing methods for only systems B, C, E, F, H, and I, because the other systems do not use service mile billing. The resulting statistic allows us to compare the performance of a billing method to the average overall performance of the systems utilizing that billing method.

The comparison between *billing method performance* and *average system performance* in Figures 1 and 2 definitively proves the hypothesis as true. Systems using flat rate billing have a *billing method performance* of 0.15 passengers per service mile, 25% higher than the *average system performance* of 0.12, demonstrating that using flat rate billing encourages higher performance. Service mile billing, meanwhile, is outperformed by the *average system performance* by 50% for passengers per service mile (Figure 1) and by 45% for passengers per revenue mile (Figure 2). Revenue mile and mixed billing tend to perform close to the *average system performance*, as expected.

CONCLUSIONS

This research proves that flat rate billing is more effective at encouraging higher performance than revenue or service mile billing in community transportation systems without automated scheduling software. Runs that were predominately billed by flat rate had significantly better performance, followed by mixed and revenue mile, with service mile performing the worst. Flat rate performs best, as hypothesized, because it has monetary incentives for a higher number of passengers on each run and less miles. Revenue mile billing does not have the incentive to maximize passengers nor does it have an incentive to minimize revenue miles. However, revenue mile billing does have better performance than service mile billing because the transit system is encouraged to minimize deadhead miles, increasing passengers per service mile. Service mile billing has no incentive to minimize miles or maximize passengers, resulting in the weakest performance of the billing types studied.

This research does not suggest that flat rate billing is the most efficient method to recover costs. Nor does this paper attempt to understand the impacts of different rates within billing methods. This paper does prove, however, that the use of service mile billing should be discouraged where community transportation system performance is paramount.

FUTURE RESEARCH

A clear connection between billing method and community transportation performance has been established in this research. Further exploration of this topic is encouraged so that the relationship can be better understood. In particular, additional billing methods, including passenger miles, hourly rates, and zoned-based fares, should be included in future research projects so that a better comparison of performance can be made.

Another question that this research elicits is whether billing types do not determine efficiency, but efficiency determines the billing type. Do transportation systems, for instance, tend to bill easy to provide, efficient trips as flat rate and hard to provide trips as service mile? Care has been taken to ensure that the billing types are as equivalent as possible in the analysis, but there could be factors that were not considered.

Identifying the occurrences of different billing methods among community transportation systems may also reveal interesting information. If a particular billing method is dominant but does not encourage efficiency, the reasons behind its continued use may illuminate other aspects of community transportation not considered in this paper. A survey of schedulers as to their work flow and the decision making process could yield a wealth of knowledge on this subject.

Transportation researchers and practitioners should work with automated scheduling software vendors to incorporate billing method considerations into the scheduling logic of these software packages. Many of these software packages are able to optimize one or two variables. Sometimes, these variables are not the most important ones to the transportation system. A transportation system billing by revenue mile, for instance, may need to minimize deadhead miles and the software package may not be able to optimize in this way. Transportation providers using automated scheduling software may want to consider changing their billing methods to match the variables that the software attempts to optimize.

Finally, further research could be also be performed via surveys to determine if community transportation systems that have automated scheduling software but do not use the schedule optimization feature refuse to do so because the most important variables to the transportation system are not being optimized.

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