

Date: October, 2001

Transit User's Perceptions of AVL Benefits

Draft

Zhong-Ren Peng
Department of Urban Planning
Email: zpeng@uwm.edu

Danlin Yu
Department of Geography
Email: danlinyu@uwm.edu

Edward Beimborn
Center for Urban Transportation Studies
Email: beimborn@uwm.edu

University of Wisconsin-Milwaukee
PO Box 413
Milwaukee, WI 53201-0413

Transit User's Perceptions of AVL Benefits

Zhong-Ren Peng
Department of Urban Planning

Danlin Yu
Department of Geography

Edward Beimborn
Center for Urban Transportation Studies

University of Wisconsin-Milwaukee
PO Box 413
Milwaukee, WI 53201-0413

Abstract

This paper reports on an attitudinal survey on transit rider's perception of the importance transit users place on features of an Automatic Vehicle Location (AVL) system. On board surveys and on-time field checks were conducted in the cities of Manitowoc and Racine, Wisconsin to determine how users in those cities perceive their transit system and how well it performs. The surveys indicate that transit riders put a great value on increased on-time performance and improved schedule reliability. Passengers value features that AVL technology could bring, such as improving on-time performance, knowing when the next bus will arrive, knowing how long the delay is in case of delay, knowing another bus could be dispatched in case of breakdown. The surveys indicate that AVL technology could improve transit services and add value to passengers. The survey also found the expected ridership increase resulting from the AVL technology is moderate.

On-time performance surveys conducted in each city indicate that transit services in these communities generally operate on time at the route level. Although there are bigger variations at the time-point level, transit services tend to be on time most of the time. The implementation of AVL could further improve on-time performance, but maybe only marginally.

Key Words: Public Transportation, Automatic Vehicle Location System (AVL), Transit Services, On-Time Performance, Intelligent Transportation Systems (ITS).

Transit User's Perceptions of AVL Benefits

Zhong-Ren Peng
Department of Urban Planning

Danlin Yu
Department of Geography

Edward Beimborn
Center for Urban Transportation Studies

University of Wisconsin-Milwaukee
PO Box 413
Milwaukee, WI 53201-0413

INTRODUCTION

Automatic Vehicle Location (AVL) systems for public transit systems may have many benefits to transit agencies and riders, including improving on-time performance, raising productivity, enhancing security, and increasing ridership (Casey, et al. 1996, 1998; Gomez, Zhao and Shen, 1998; Casey, 1999; Peng et al. 2000; Gillen et al. 2001). AVL can provide transit dispatchers, planners, and transit riders real-time information about bus locations, running speed, and other information such as incidents. Transit dispatchers can use this real-time information to adjust for bus schedules to avoid bus bunching, and conducting real-time dispatch and controls such as sending another bus in the case of a bus breakdown. The transit planner could use this information to more efficiently plan transit routes and stops, and adjust for schedules. Transit users could benefit from increased on-time performance and schedule reliability, as well as up-to-the-minute real-time information to reduce waiting anxiety and cushion time. Because transit riders are extremely sensitive to schedule reliability (Wachs 1981; Abkowitz and Tozzi 1987; Cervero 1990), the increased arrival-time reliability could potentially increase transit ridership and improve service satisfaction.

There are a few studies in the literature that measured the impacts of AVL technology on on-time performance, service reliability and operation productivity (Gomez, Zhao and Shen, 1998; Housell and McLeod 1998; Khattaak and Hickman 1998; Casey, 1999; Strathman et al. 1999, 2000; Peng et al. 2000, Ding and Chien 2001; Gillen et al. 2001; Lee et al. 2001). However, there is no study that examines the impact of AVL technology on transit riders, as well as the rider's perceptions of the benefits of the AVL technology.

This paper reports the results of several attitudinal surveys of transit riders about the importance of what AVL could bring. Specifically, this paper tries to answer the following questions:

- How important is real-time bus location and arrival information to transit users?
- What aspect of AVL technology does the transit riders value the most?
- Will the use of AVL technology increase transit ridership?
- What is the current status of on-time performance of small and medium sized transit systems, and how much room is left for the AVL system to improve on-time performance?

SURVEY METHODS

Two types of surveys were conducted; an on-board transit rider survey and an on-time performance survey. The purpose of the on-board rider survey was to find out how transit riders perceive the importance of features brought by the AVL technology. The purpose of the on-time performance survey was to establish a baseline of current status of on-time performance of some small and medium sized transit systems.

The on-board rider survey was designed to focus on how transit riders value the potential benefits of AVL technology, e.g., real time information, on-time performance, improved safety, timely transit dispatch. In addition, some other questions are also proposed to provide background and control information, such as the value of lower fares and seat availability. The survey form was limited to one double-side page in length and included 15 questions (Appendix 1).

Two cities in the state of Wisconsin, Manitowoc and Racine, were chosen for the survey. These two cities have been chosen as sites to implement the AVL technology on their transit systems by the Wisconsin Department of Transportation. The transit system in the City of Manitowoc operates five full-time dedicated buses and one van with flexible scheduling, with a daily ridership of 800-900; and the City of Racine has 26 buses and 12 fixed routes, with a daily ridership of 6500-7500. Based on the definition by the Federal Transit Administration, both of them are in the category of small and medium sized transit systems, i.e., transit agencies with fleet size less than 50 vehicles (Casey et al, 1996).

The survey was conducted in the City of Manitowoc at March 21 and 22, 2001 by three people. A similar survey was conducted in the City of Racine at May 23rd (Wednesday) and 24th (Thursday), 2001 by eight people. The surveyors started to ride the bus at 7:00 am and ended the survey at 6:00 pm each day. Survey forms were distributed to every rider and collected before the riders got off the bus. Surveyors were available to help the riders to answer any question if necessary. The majority of the riders were very cooperative with a survey return rate of over 90% in the Manitowoc and over 80% in Racine for the time period and routes covered.

Besides delivering the survey forms to riders, surveyors also collected bus on-time performance data. Each surveyor had a bus schedule and knew the scheduled arrival time at each time point. When the bus got to each time point, the surveyor recorded the actual arrival time. To increase the sample size of the on-time performance data, two additional days were used in Racine for time checks. In addition to the on-board observation by the on-board surveyors, two additional surveyors drove around different time points to check bus arrival time randomly.

To be statistically significant, the sample size of the on-time performance was determined by the following formula:

$$n = \left(\frac{t * s}{E} \right)^2$$

Where, n is the desired sample size, t is the t score with the desired confidence limits, s is the estimated standard deviation, and E is the amount of error that can be tolerated. For example, if we want the significant level at 5%, 30 seconds are the tolerated error, and the standard deviation of the difference of actual arrival time and scheduled arrival time from the first day's observation is 120 seconds. The required minimal sample size for this route is:

$$n = \left(\frac{t * s}{E} \right)^2 = \left(\frac{1.96 * 120}{30} \right)^2 = 62$$

That is, we have to have at least 62 observations from different time points on the same route. If the tolerated error of observed arrival time and schedule time is thirty seconds, and the significant level is at 5%, all routes in both cities satisfy the minimal sample size requirements.

The methods used in this study can be easily adapted to other transit agencies to determine customer satisfaction with the quality of transit service. As such they are consistent with the TCRP Web document 6, the Transit Capacity and quality of Service Manual.

MAJOR FINDINGS FROM THE ON-BOARD RIDER SURVEY

There were 608 survey forms returned for Racine and 194 for Manitowoc. The following are the major findings from the on-board rider survey at the two cities. The data for two cities have been analyzed separately, but the results are very similar. The differences between the two cities were not statistically significant. Therefore, the results from two cities are reported here together.

1. Overall Rankings of the Importance of Different Elements of the AVL Benefits.

The questionnaire asked passengers to rank the relative importance of the major factors that affect their decisions to ride a bus. The most important ranking is scored 5 and the least important ranking is scored 1. These scores were then weighted using the frequency of respondents who selected the factors. The importance of the factors is then ranked based on the weighted index as shown in Table 1.

As shown in Table 1, both “knowing when the bus will actually arrive at the bus stop” and “Bus arrives at the scheduled time” are consistently valued by the passengers to be the most important factors. Transit riders also place high value on “knowing how late the bus is in case of delay.” These results are consistent with those from a survey conducted in Manitowoc three years ago, which indicated that real-time information and bus operating on time were valued to be the most important by transit riders. This is also consistent with prior studies that transit riders are very sensitive to schedule reliability than almost any other service features (Sterman and Schofer 1976; Wachs 1981; Cervero 1990).

Table 1 Ranking of all factors in affecting passengers' decision of riding bus

Factor	Rank in Racine (2001)	Rank in Manitowoc (2001)	Rank in Manitowoc (1998)
Knowing when the bus will actually arrive at the bus stop	1	1	2
Bus arrives at the scheduled time	2	3	1
Knowing that another bus can be immediately dispatched if there is a breakdown	3	4	4
Low bus fares	4	2	3
Knowing how late the bus is in case of a delay	5	5	6
Knowing the bus is equipped with a 911 emergency system	6	6	5
Having a seat available at all times	7	8	7
Knowing the transit system uses the latest vehicle location technology	8	7	8
Displaying the name of the next stop inside the bus	9	9	9
Having the driver call out the stops	10	10	10

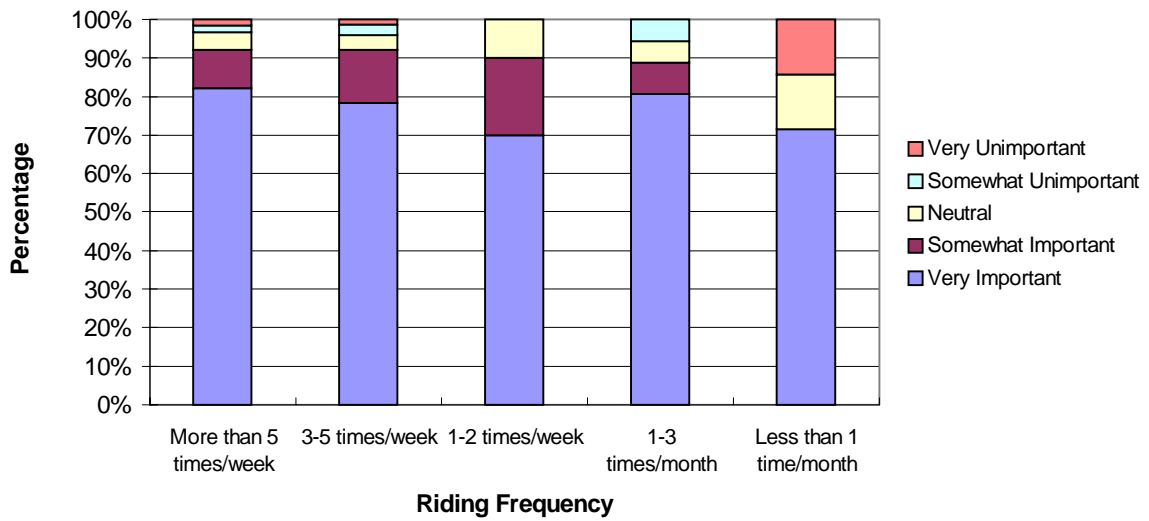
In addition, passengers also place a high degree of importance on “Knowing that another bus can be immediately dispatched if there is a breakdown” and “Knowing the bus is equipped with a 911 emergency system.” These are benefits that can result from deploying the AVL technologies.

Furthermore, “lowering bus fares” is also ranked as important by transit riders. On the other hand, since the bus users, especially those who use the bus service very often, knew the route they are riding very well, having the driver call out stops or having the name of the next stop displayed inside the bus are ranked as the two most unimportant factors in the surveys. Simply having a latest technology is not valued highly by the transit riders.

2. Real-Time Information

As shown in table 1, real-time information about the bus service actually will arrive is the most important factor in influencing bus riders’ perception on bus service’s performance. Overall, 79.4% of the respondents considered this factor as the most important one. When cross-tabulating with the frequency of using the transit service, it is found that generally the ones who ride more often tend to value this factor as the most important one in their decision to ride a bus (Figure 1).

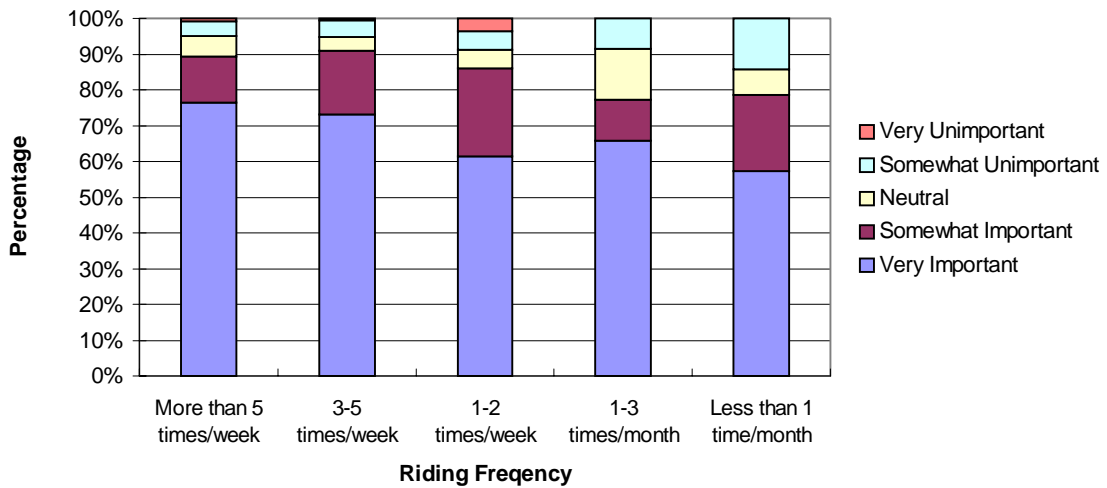
Figure 1 The Importance of Real-time information



3. On-time performance

The second most important factor that influences the rider’s satisfaction with the bus service is the bus on-time performance. 72.7% of all the respondents give this factor the most important rank.

Figure 2 On-time performance



In addition, from the percentage distribution (Figure 2), we found that as the same as the real time information, those who ride more often tend to give higher score to these factors.

4. Passenger Waiting Time

To further understand the bus on-time performance in influencing passenger’s decision of riding a bus, we made an observation on actual passenger waiting-time about two months later in the City of Racine. Three researchers stayed in selected

major bus stops and recorded the passengers' actual arrival time and the time getting into the bus. This two-day observation recorded in total of 974 cases, among them, 964 records are usable.

The recorded real waiting time was compared with the reported waiting time we obtained from the on-board survey. To our surprise, the average observed actual passenger waiting time (8.03 minutes) is very similar to the reported average waiting time (8.82 minutes). (Is this statistical significant?? Use T-test to test it.) However, the longest recorded actual waiting time was more than an hour (3900 seconds), which may obscured the average. (How about using the median waiting time for comparison??)

Based on the observation, 1.4% of all the passengers waited on the stop more than 30 minutes, which is about the same as the average headway. This is similar to the result obtained from the on-board survey (1.9%). Nearly one third of the passengers (30.5%) waited the bus for more than 10 minutes, while the corresponding percentage of passengers who reported waiting for 10 to 15 (please Check??) minutes during the on-board survey was only 22.1%. This may indicate that when passengers waited for the bus more than 10 minutes, they tended to underestimate their waiting time. Similarly, but to a less extend, 20.1% of observed passengers waited for more than 15 minutes while 14.0% of passengers reported that they waited more than 15 minutes. (Danlin, please make a table here showing the different waiting time between the observed and reported wait time??)

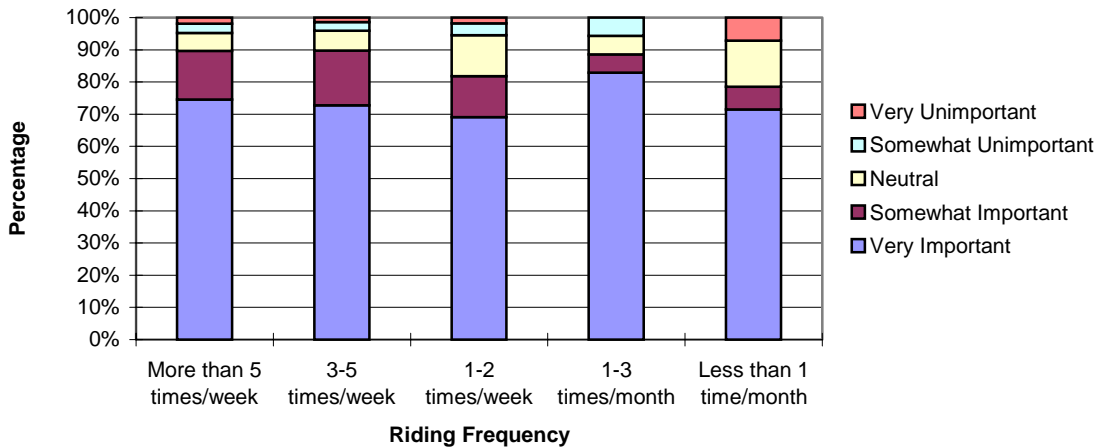
During the field observation, we observed that at least 80% of longer waiting time (more than 10 minutes) was due to bad bus on-time performance. In addition, we also recorded 94 passengers who left instead of boarding the bus. The average waiting time for those passengers who eventually left is nearly 10 minutes (597 seconds), but it varies greatly; the standard deviation is more than 8 minutes (493 seconds). This happens because some observed passengers just waited at the stop for several minutes (some times less than 2 minutes) and then left. Since the field observer can't directly contact the passengers and ask them why they left, it is unclear what would be the reasons. One may suspect that some of them may not be real passengers but only pedestrians. But it is not unreasonable to assume that many of them left because they thought they were waiting too long. In fact, the longest observed waiting time (3900 seconds) was recorded on one passenger who eventually left with angry. It is not unreasonable to assume that this person may not ride the bus again if he has any chance of getting an alternative travel mode. This is another indication that increasing on-time performance could reduce waiting time and increase ridership.

5. Replacement of Vehicle

Having a replacement of vehicle available for unexpected breakdowns emerged as the third most important factor in influencing passengers' decision of riding bus. This reflects the value of time as well as the sense of security. Actually, 73.9% of survey respondents ranks this factor as "very important,"* especially those who ride less than 3 times a month (figure 3).

* Because the numbers of respondents to different questions varied among questions, and the ranking of a factor's importance was calculated from all groups (not only the group who responded it as "most important") of respondents, the percentage of respondents who answer the factor as "most important" is not the absolute indicator in determining the factor's ranking. So, it is reasonably possible that though

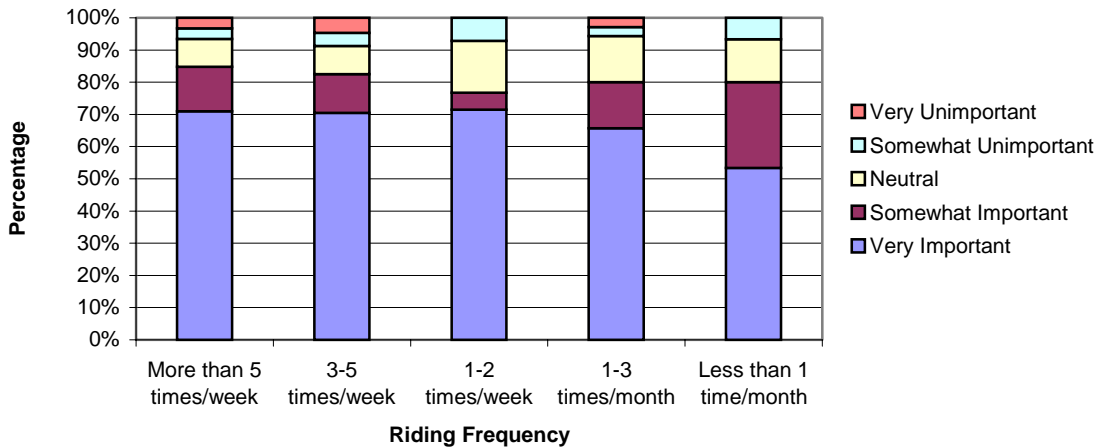
Figure 3 Replacement of Another Bus When Breakdowns



6. Low Fare

Low fare has ranked the fourth important factor for the passengers to decide to ride a bus. More than 70% of all the respondents (70.1%) give this factor a “very important” score. Interestingly, those who ride more frequently tends to favor lower fare than those who ride less frequently (Figure 4). Indicating the lower fare may not be a critical factor in attracting those who currently use less transit. This is consistent with prior research on transit price elasticity that transit service is not very price elastic (Cervero, 1990).

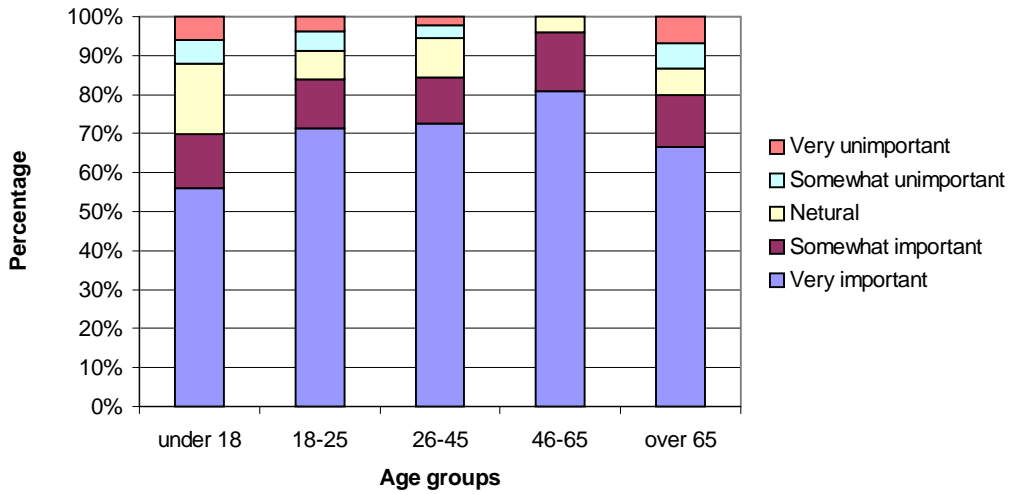
Figure 4 Importance of Low Fare



Not surprisingly, the percentage of those passengers who rank this factor as the most important factor is gradually increasing while the passengers getting older. However, passengers who are over 65 had a smaller percentage considering this factor as the most important one (Figure 5).

some factor has more percentage of respondents ranked it as “most important”, its rank will still be lower. It holds true through the later analysis.

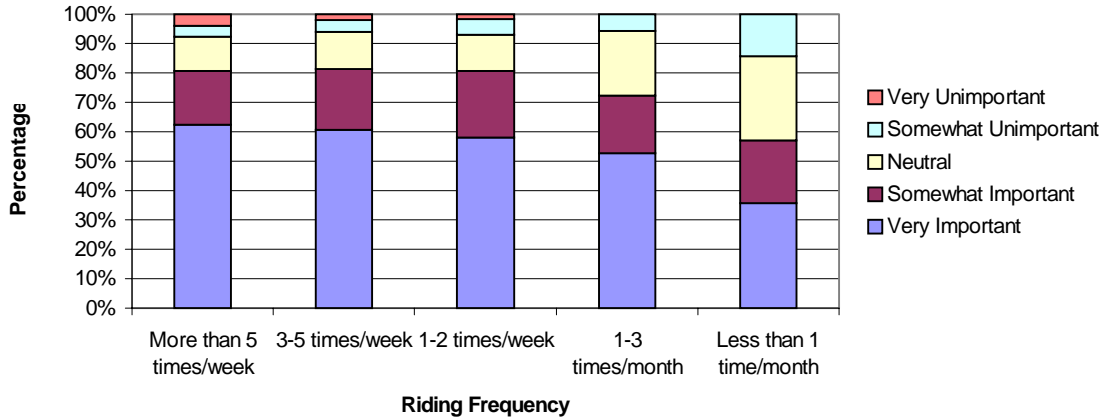
Figure 5 Distribution of low fare among different age groups



7. Knowing the exact delay time

Knowing the exact bus delay time ranks fifth in importance. Overall, the percentage of passengers who ranked this factor as the most important is 60.0% of the total. The noticeable difference is the group who ride less than one time a month (Figure 6).

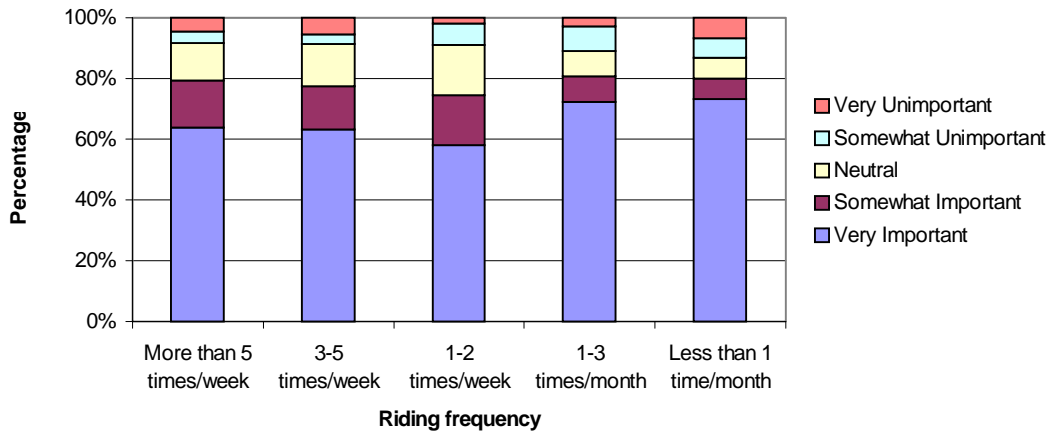
Figure 6. Importance of displaying delay time



8. Emergency Response

About two thirds of the respondents (63.9%) of all survey respondents rank this factor as very important. A noticeable difference is that passengers who ride less often tend to consider more of this factor as “most important” than those who ride more (figure 7). This may indicate the negative perceptions associated with the use of transit, especially for those non-riders and less frequent riders.

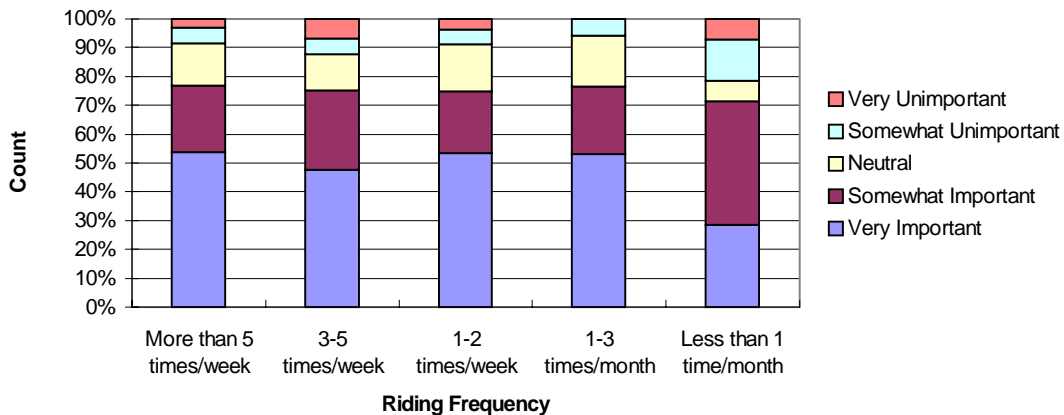
Figure 7 Importance of emergency response



9. Availability of seat

According to the observation of on-board surveyors, almost all bus riders could find a seat on the bus. So it is not surprising that this factor was not ranked as very important. Indeed, only 51.3% of all the respondents thought this factor as the most important one in affecting their decision of riding a bus or not. This observation holds true regardless of riding frequency (Figure 8).

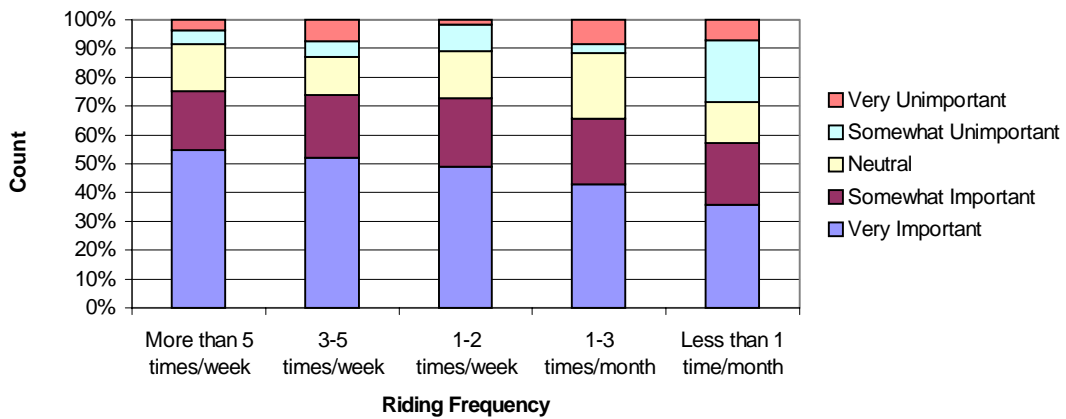
Figure 8 Importance of seat availability



10. Latest technology

From the survey, knowing that the bus was equipped with the latest technology seems to be less important than other factors. Overall there is 52% of the total respondents rank this factor as a “very important” factor in riding a bus. This holds true for riders with different use frequencies (figure 9).

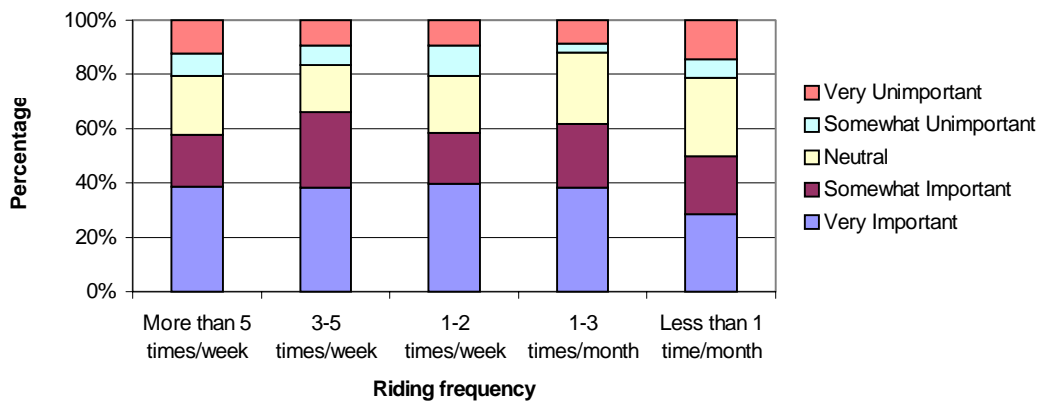
Figure 9 Importance of latest technology



11. Stop display and Calling Out Stops

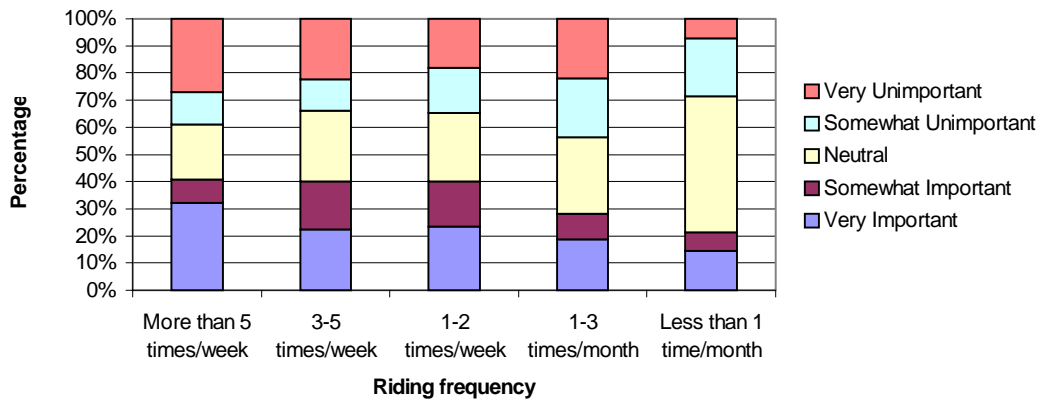
Since most people are local ones and who ride the bus quite often, they are very familiar with the stops they want to get of. Therefore, having the stops displayed inside the bus or having the driver calling out the stop names looks not that important to these passengers. Even people who didn't ride the bus very often tended to ignore this factor (figure 10).

Figure 10 Importance of displaying stops



Similarly, having the bus driver called out the stops is the least important factor in influencing people's decision of riding a bus. Overall there are only 27.3% of all respondents ranked this factor as "very important", while almost the same percentage of all respondents ranked this factor as "very unimportant" (24%). From the figure below (figure 11), it could be seen that people who ride the bus more often had less intention to have the driver called out the stops.

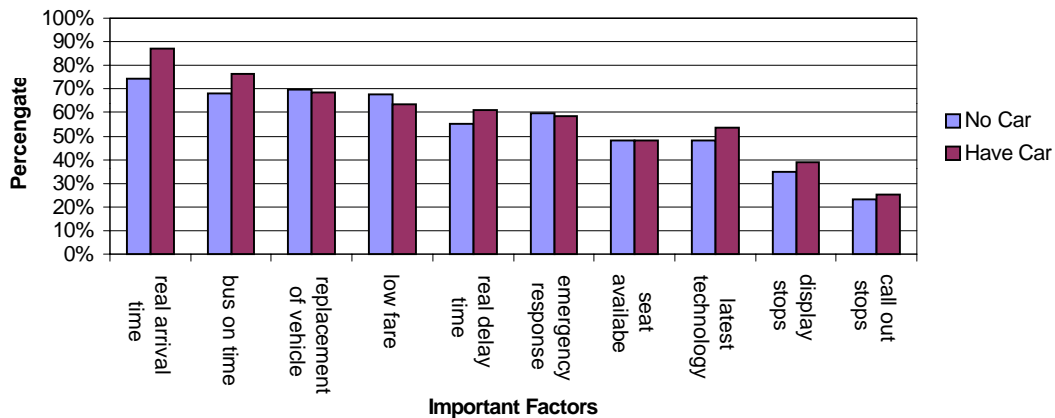
Figure 11 Importance of calling out stops



12. Captive Riders

Captive riders are those who didn't have an alternative way to go places but for taking the bus. It is not surprising that most of the respondents are those kind of captive riders. In fact, this survey indicated that 78.1% of all respondents didn't have a car as an alternative mode to travel. However, we found that the car availability doesn't have much effect on people's ranking of the importance of those factors, with a noticeable exception of the first two factors, for which people who has a car tends value more than those who don't have a car (Figure 12). Figure 12 charted all the respondents' ranking of the 10 factors as "very important" between passengers who have and who have no car.

Figure 12 Car availability in affecting people's ranking of decision factors

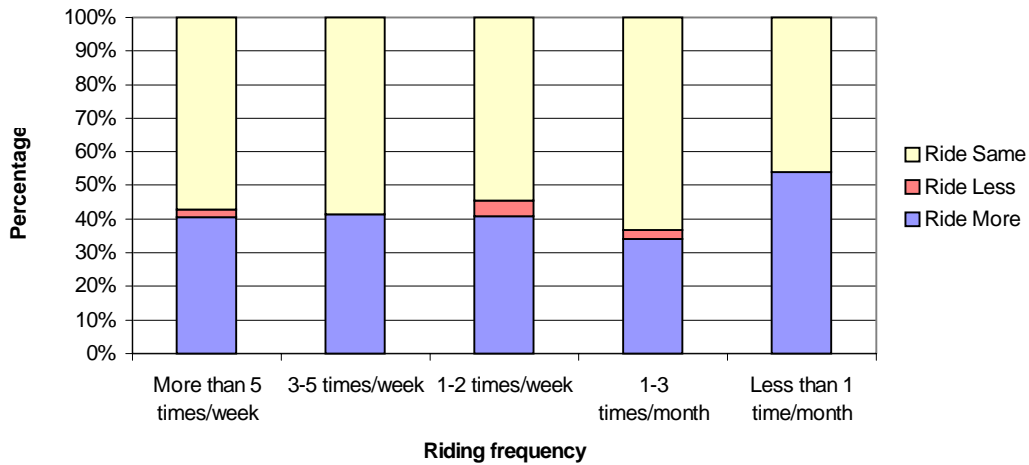


From the figure 12, it appears that people who own a car tend to be somewhat more sensitive to the time saving issues. In ranking the factor concerning "Knowing the exact arrival time", "Buses arrive as schedule" and "Knowing the exact delay time" as the "very important" factor, people who own a car have a higher percentage than those who haven't. This indicates that improve on-time performance and real-time information are more important factors for choice riders.

13. More Potential Riders?

One hope is that AVL technology might lead to more ridership. The results, however are somewhat mixed. A majority of respondents indicated it would not have any effect while 40.6% of all respondents answered that if better information were available, they would ride more often. Less frequent riders may have a higher tendency to ride more buses if better information were available (figure 13).

Figure 13 Better Information in influencing riding choice



We have performed a Logit analysis on the probability of using more transit services if better information is available. The logit analysis result is shown in Table 2.

Table 2. Logit analysis result

Dependent Variable: RideMore: 1=ride more often, 0=ride the same amount

	B	S.E.	Wald	df
WaitTooLong	0.791	0.256	9.536	1
OwnCar	0.382	0.206	3.447	1
RarelyOnTime	0.608	0.39	2.432	1
SomeOnTime	0.221	0.252	0.769	1
City	0.797	0.225	12.502	1
Constant	-1.503	0.209	51.739	1

-2 Log likelihood (0) =

-2 Log likelihood (B) = 807.207

WaitTooLong: 1=the waiting time is not reasonable, 0=reasonable

OwnCar: 1=car available, 0=not available

RarelyOnTime: 1=bus rarely on time, 0=otherwise

SomeOnTime: 1=bus bus on time sometimes, 0=otherwise

City: Racine=1, Manitowoc=0

This logit analysis shows that

- (1) When the passenger perceives the waiting time is too long, he/she would be more likely to use more transit than those who think the current waiting time is reasonable if better and more timely information is available.

- (2) When the passenger has a car available, he/she would be more likely to use more transit than those who do not have a car available if better and more timely information is available.
- (3) When the passenger thinks the current transit services rarely on time, or only on time sometimes, he/she would be more likely to ride more often than those who think the current transit services running on time at most of times or almost always, if better and more timely information is available.
- (4) Based on the coefficients, those who think the current transit services rarely on time is even more likely to ride more buses than those who think the current transit services running on time sometimes, if better and more timely information is available.
- (5) For some reason, people residing at the City of Racine is more likely to ride more buses than those who live in the City of Manitowoc, if better and more timely information is available.

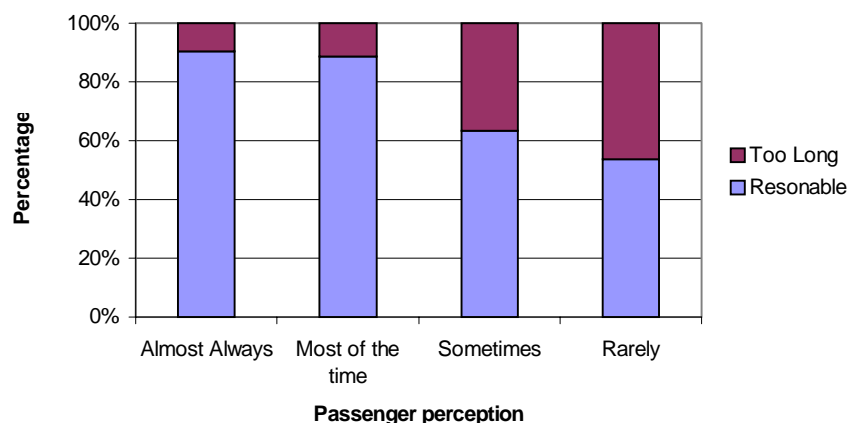
This Logit analysis shows better and more timely information could help improve customer services, raise the image of transit providers, and attract more riders, especially those who *think* the current services are not that great. One shortcoming of this survey is that it did not survey non-riders. So we don't know whether better information could attract non-rider to ride the bus.

14. Passenger's perception of bus on-time performance

Riders' perception to bus on-time performance is mostly positive. There are 29% of survey respondents reporting the bus was almost always on time, 49% reported bus on time most of times, only 5% reported the bus rarely on time. Regarding the amount of wait time, most of riders (83%) considered waiting time as reasonable.

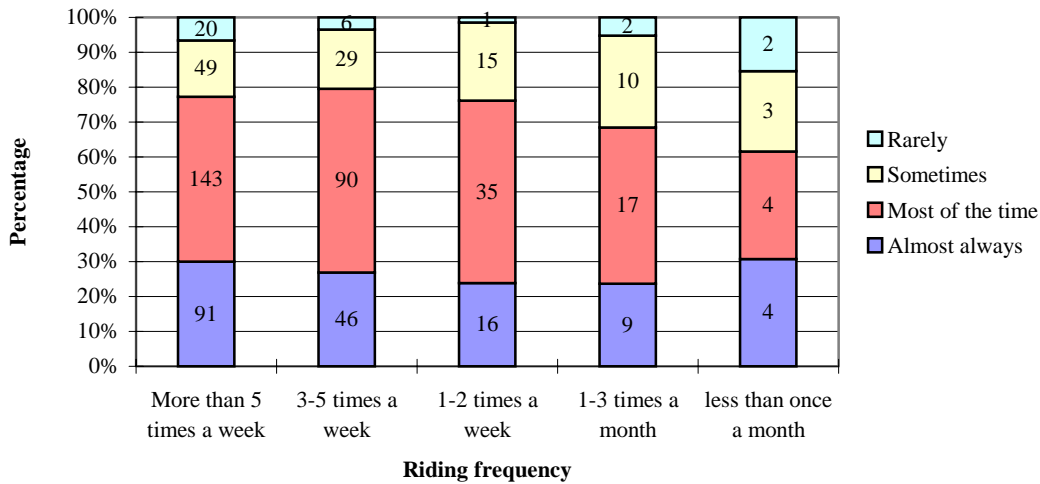
It is not surprising to find that those who regarded their waiting time as "reasonable" to comment the bus come on time "almost always" (figure 14).

Figure 14 Passenger perception of bus on-time performance



Furthermore, the passenger's perception of bus on-time performance is also related with how frequent the passenger ride the bus. It seems that the more often the passenger rides the bus, the more likely he/she consider the bus running on time (Figure 15). It implies that a few times' bad experience may leave a bad impression on the rider, who then don't ride it so often.

Figure 15. Riding frequency and its relation with passengers' waiting time perception



15. Information Access

Most riders got the bus schedule information from the hard-copy schedule. When asked how would they access to real-time information, most of them answered to access it from the standard telephone, some would access the information from the Internet. About 30 percent of respondents have Internet access and 26% has cellular phone. This indicates the many transit riders have access to the Internet and cellular phones, and transit agencies should consider using these media to make real-time information available.

16. Other factors in affecting people's decision of riding a bus

Through open question comments, we found some other factors that transit riders consider to be important in affecting their decisions of riding a bus.

The first one is the bus driver's attitude. Most of the bus drivers are nice and kind to their passengers. However, some passengers complained about some bus drivers having attitudinal problems towards passengers such as smoking on the bus, etc.

The second one is about extending the bus service's time period. Bus service in Racine City does provide limited Saturday and Sunday services. But some respondents regarded these kinds of Saturday and Sunday services inadequate.

MAJOR FINDINGS FROM THE ON-TIME PERFORMANCE SURVEY

The on-time performance of each transit system was measured using the time difference between observed actual bus arrival time and the scheduled time on

specific time-points. The difference of on-time performance among different routes has been analyzed via ANOVA (ANalysis Of VAriance).

1. The actual on-time performance

According to our on-time performance check, on average, all the routes were running relatively on time during the time of the surveys (Table 3). At the route level, the average time of the bus being later or early was about one minute. However, the standard deviation is large (over 100 seconds), indicating the on-time performance at the time-point level is not as good as the route level. The longest delay at a time point happened in this survey was 1285 seconds, on May 23rd, when a bus arrived at a time point 21 minutes late.

Table 3. The average on-time performance in Racine City's bus routes

Routes	Average time difference between scheduled and actual (seconds)	Standard Deviation
Route 1	-58.49*	251.67
Route 2	-55.78	204.19
Route 3	41.06	261.52
Route 4	-18.97	195.60
Route 5	-67.96	143.09
Route 68	34.96	106.76
Route 7	46.11	191.92
Route 86	31.69	191.17
Route 20	-19.71	39.19

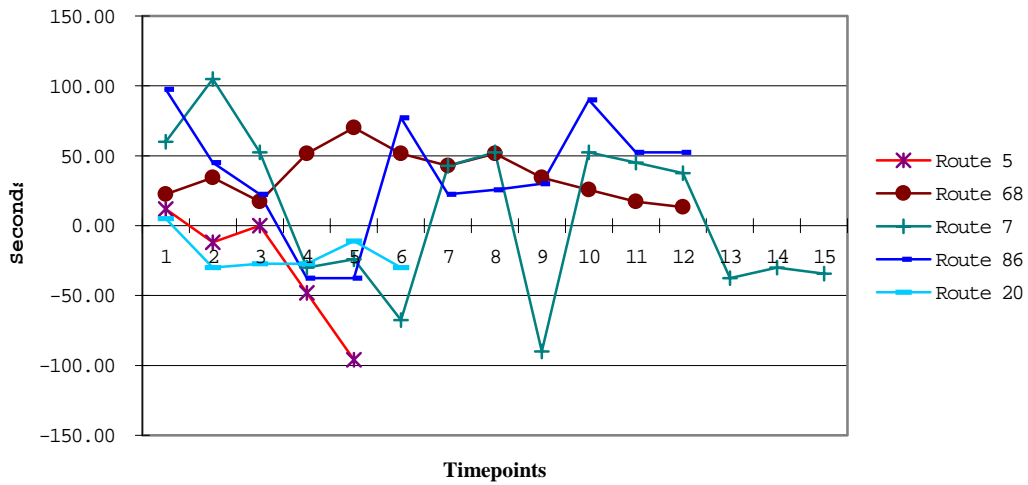
*: Positive numbers indicate that the bus arrived late, and negative numbers indicate the bus arrived early in average.

According to our observation, the routes that are busier, the standard deviation of the scheduled-actual time differences are larger. Route 3 in Racine City is the busiest route, which has the highest standard deviation. While Route 20 is the least busy route, which has the smallest standard deviation.

2. On-time performance variations between different time-points

As indicated above, there are differences in on-time performance at different time points in the same route. However, because of some technical observation problems, we only have 5 routes (route 5, 7, 20, 68 and 86) that have relatively complete on-time performance records on each time point.

Figure 17 On-time performance varies among different time points



The pattern in Figure 17 is apparent. Route 7 and 86 are the two busiest routes among the five routes, and their variances among different time-points are the highest. The least busy one, route 20, shows a relatively smooth on-time performance pattern among different time points; it is also the shortest route.

the ANOVA analysis among the nine routes. Table 4 shows the result.

Table 4. ANOVA analyses among different routes in Racine City

Total	50654443.92	1269			
--------------	-------------	------	--	--	--

The F statistics is 8.342 and statistical significance is above 99% level. According to this result, the null hypothesis that there is no on-time difference for different routes could be safely rejected at least at the 1% significant level. The on-time performance did vary from routes to routes.

Table 5. Correlation between bus's busy degree and its different on-time performance

	Standard Deviation	Busy Degree
Pearson Correlation		

standard deviation of on-time performance and the number of returned survey forms. Table 5 and Table 6 show the result:

Table 6 Regression between bus' busy degree and its different on-time performance

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		

REFERENCE

- Abkowitz, Mark and John Tozzi. 1987. Research contributions to managing transit service reliability. *Journal of Advanced Transportation*, 21: 47-65.
- Casey, RF., et al. 1996. *Advanced Public Transportation Systems. State of the Art Update '96*. United States Department of Transportation, Washington DC.
- Casey, RF., et al. 1998. *Advanced Public Transportation Systems. State of the Art Update '98*. United States Department of Transportation, Washington DC.
- Casey, R. 1999. Advanced Public Transportation Systems Deployment in the United States. Report No. DOT-VNTSC-FTA-99-1, Volpe National Transportation Systems Center, U.S. Department of Transportation, Cambridge, MA.
- Cervero, Robert. 1990. Transit pricing research A review and synthesis, *Transportation* 11: 117-139.
- Ding Y. and S. I. Chien, 2001 Improving Transit Service Quality And Headway Regularity With Real-Time Control. Paper presented the 80th annual meeting of the Transportation Research Board, Washington, D.C. January 7-11.
- Gillen, D., E. Chang and D. Johnson. 2001. Productivity Benefits and Cost Efficiencies from ITS Applications to Public Transit: The Evaluation of AVL. Paper presented the 80th annual meeting of the Transportation Research Board, Washington, D.C. January 7-11.
- Gomez, A, Zhao, F, and Shen LD. 1998. Benefits of Transit AVL and Transit AVL Implementation in the U.S. Paper presented at the 77th annual meeting of the Transportation Research Board, Washington, DC.
- Hounsell, N. and F. McLeod. 1998. AVL implementation application and benefits in the U.K. Paper presented the 77th annual meeting of the Transportation Research Board, Washington, D.C. January 11-15.
- Khattak, A. and M. Hickman. 1998. Automatic vehicle location and computer aided dispatch systems: Commercial availability and deployment in transit agencies. Paper presented the 77th annual meeting of the Transportation Research Board, Washington, D.C. January 11-15.
- Lee, Y.J., K.S. Chon, D.L. Hill, N. Desai. 2001. Impact Of AVL System On Schedule Adherence For MTA Bus System. Paper presented the 80th annual meeting of the Transportation Research Board, Washington, D.C. January 7-11.
- Peng, Z-R, Octania, S, Zygowicz, R.J. and Beimborn, E.A. 2000. Evaluation of the Benefits of Automated Vehicle Locator Systems for Small and Medium Sized Transit

Agencies. Paper presented at the 79th annual meeting of the Transportation Research Board, Washington, DC.

Sterman, B. and J. Schofer. 1976. Factors affecting reliability of urban bus services. *Transportation Engineering Journal*, 147-159.

Strathman, J., K. Dueker, T. Kimpel, R. Gerhart, K. Turner, P. Taylor, S. Callas, D. Griffin, and J. Hopper. 1999. Automated bus dispatching, operations control, and service reliability: Baseline analysis. Paper No. 990930, Transportation Research Board, 78th Annual Meeting, Washington, D.C.

Strathman, J., K. Dueker, T. Kimpel, 2000. Automated Bus Dispatching, Operations Control, and Service Reliability: The Initial Tri-Met Experience. Paper No. 00-0636, Transportation Research Board, 78th Annual Meeting, Washington, D.C.

Wachs M. (1981) "Pricing urban transportation A critique of current policy," *Journal of the American Planning Association* 47: 243-251.

Maritime Metro Transit Survey

Dear Maritime Metro Customer: In order to help us better serve you, won't you please take a few moments to fill out this short survey? All responses are strictly confidential, and you will not be identified in any way.

1. How did you know when this bus would leave the bus stop that you used?
 - I have a bus schedule
 - I use this stop often and have come to know the schedule
 - I called the transit system help line to get the time
 - I arrived when it was convenient for me with the hope that the bus would arrive soon
2. How long did you have to wait at the stop before the bus arrived? ____minutes
3. Do you consider the amount of time that you had to wait for the bus to be:
 - Reasonable Too longComments: _____
4. In your opinion, how often do the buses on this route run on time?
 - Almost always Most of the time Sometimes Rarely
5. How did you get to the bus stop today?
 - I walked, and it took me ____ minutes
 - I drove, and it took me ____ minutes
 - I was dropped off, and it took me ____ minutes
 - I transferred from another route
6. How often, on average, do you ride the bus?
 - More than 5 times a week
 - 3-5 times a week
 - 1-2 times a week
 - 1-3 times a month
 - Less than once a month
7. What is the primary purpose of your trip today? (Please check only one)
 - Work Shopping School Medical Other_____
8. How do you get information about the bus service? (Please check all that apply)
 - I have a copy of the bus schedule
 - I call the bus company
 - From other people
 - From information displayed at the bus stop
 - Other_____
9. If you knew exactly when the bus would arrive at a stop, how would it affect your use of the bus?
 - I would ride more often
 - I would ride less often
 - I would ride the same amount
10. Please rate how important the following are in your decision to ride the bus:

	Very Important	Somewhat Important	Neutral	Somewhat Unimportant	Very Unimportant
Knowing when the bus will actually arrive at the bus stop ----->	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bus arrives at the scheduled time ----->	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knowing how late the bus is in case of a delay ----->	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Displaying the name of the next stop inside the bus ----->	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Having the driver call out the stops ----->	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knowing the bus is equipped with a 911 emergency system ----->	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knowing that another bus can be immediately dispatched if there is a breakdown-->	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knowing the transit system uses the latest vehicle location technology ----->	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Having a seat available at all times ----->	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Low bus fares ----->	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

11. Which of the following do you currently own or have access to? (Please check all that apply)

- Internet Cellular telephone

12. If up-to-date bus information was available, how would you use it? (Please check all that apply)

- I would use the Internet to get the information
 I would use a cellular telephone to get the information
 I would use a standard telephone to get the information
 I would not use up-to-date bus information

13. Did you have a car available that you could have used for the trip you are making today?

- Yes No

14. Are you a:

- Male Female

15. What is your age group?

- Under 18 18-25 26-45 46-65 Over 65

Please list any other comments that you may have about this service below:

List of tables and figures

Table 1 Ranking of all factors in affecting passengers' decision of riding bus

Table 2. Logit analysis result

Table 3. The average on-time performance in Racine City's bus routes

Table 4. ANOVA analyses among different routes in Racine City

Table 5. Correlation between bus's busy degree and its different on-time performance

Table 6 Regression between bus' busy degree and its different on-time performance

Figure 1 The Importance of Real-time information

Figure 2 On-time performance

Figure 3 Replacement of Another Bus When Breakdowns

Figure 4 Importance of Low Fare

Figure 5 Distribution of low fare among different age groups

Figure 6. Importance of displaying delay time

Figure 7 Importance of emergency response

Figure 8 Importance of seat availability

Figure 9 Importance of latest technology

Figure 10 Importance of displaying stops

Figure 11 Importance of calling out stops

Figure 12 Car availability in affecting people's ranking of decision factors

Figure 13 Better Information in influencing riding choice

Figure 14 Passenger perception of bus on-time performance

Figure 15. Riding frequency and its relation with passengers' waiting time perception