IMPROVING THE EFFECTIVENESS OF RIDE ON

An Interactive Qualifying Project Report
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1.0 Abstract

Through the administration and analysis of a customer survey, our team was able to garner valuable information for use in new marketing and planning strategies for the Ride On bus system in Montgomery County. The development, implementation, and large sample frame of our survey were intrinsic to reconciling differences between previous studies. Additionally, our findings include the distribution of riders by zip code, refusals rates by ethnicity, and information relating demographics to user trip patterns.

2.0 Executive Summary

Montgomery County's Ride On bus system is one of the most well run systems in the United States. Yet with the County's burgeoning population, the system must be monitored regularly to ensure that the rider is always receiving high quality service. In order to accomplish this, the system must constantly develop new marketing and route planning strategies. Effective programs for marketing and planning hinge on careful observation of route level problems and successes.

Our team has successfully administered a concise thirteen-question survey, exploring many critical concerns on the route and trip level. The survey includes queries vis-à-vis the following categories: trip origin and destination, number and types of other public transit services utilized, fare type data, frequency of use, and the demographics of riders. A study was also conducted on arbitrary routes of those who refused the survey with respect to their ethnicity.

In order to administer the survey, our team rode buses on 63 routes for two weeks, collecting both morning and evening data. Administration of the survey was done face to face by administrators riding the bus. One thousand six hundred and forty-five individuals participated, yielding an exceptional response rate of 92.5%.

Interpretation of collected data was facilitated by a database developed with SPSS, a statistical analysis software package. From these data, our team has validated previous studies and established important conclusions that are critical

to improving the Ride On system.

In evaluating the effectiveness of a transit system, it is necessary to tabulate the number of linked and unlinked trips. An unlinked trip is defined as an individual trip solely on the bus of interest. A linked trip refers to the use of more than a single transit vehicle to reach one's destination. A successful transit system is one in which, for a majority of trips, two or fewer services are used (i.e. one linked trip at most) to get from origin to destination. We found that 60.7% of Ride On riders have one linked trip, 27.6% do not transfer at all (or have only one unlinked trip), and 11.7% use more than one transfer (more than one linked trip).

Another purpose of our research was to compile important data dealing with ethnicity. First, observations were made regarding frequency of Ride On use amongst four major ethnic groups: African Americans, Asians, Caucasians, and Hispanics. Of these four ethnicities, 86% of Hispanics and 78% of African Americans using the Ride On system, use it five or more times per week. Our second study demonstrated the relationship between frequency of use and the most common fare type used. From this study, it was noted that although Hispanics and African Americans use the bus the most per week, they, unlike other ethnicities surveyed, do not take full advantage of Ride On's many discounted fares. Finally, as previously mentioned, refusal data was recorded for each ethnicity. The resulting refusal rates showed that 43% of all Hispanic riders in an arbitrary subsample, a significant portion of the Hispanic ridership on those routes, refused to complete the survey, whereas the refusal rate was 17% or less

for all other ethnicities.

In conclusion, our analyses of linked and unlinked trips proved to be of the utmost importance to the Montgomery County Department of Public Works and Transportation (DPWT). For the past four years, the County has been debating the vast differences between a Washington Metropolitan Area Transit Authority (WMATA) survey conducted in 2000 and a County specific study developed by the architect of the Ride On system. Through intensive research, our team has been able to substantiate the conclusions made by the County executive. Also, relationships between fare data and ethnicity data will help the County target markets where prospective riders may not be currently reached. These and a multitude of other data collected and assimilated by our team will aide in bringing the Ride On system to optimal efficiency.

3.0 Introduction

Intracity transit services are an integral part of city life that is often taken for granted by many city residents. They are, however, beneficial and effective services that provide inexpensive and efficient transportation for large numbers of people. The extensive network of intracity bus systems in the United States provides service to a diverse range of citizens and operates under many different financial constraints. While some bus systems operate services only within the city limits, others operate to link rural and city areas, and even to integrate many different systems within a city or county. For example, Washington D.C.'s Metrobus system integrates city-specific transit with cross-county services.

Urban transit systems provide a variety of benefits to the population. For example, the systems provide an inexpensive means of transportation to persons who cannot afford to own their own vehicle, while at the same time helping to reduce congestion and pollution. For more information regarding urban mass transit, please refer to Appendix B.

One of the largest suburban systems in the United States is the Ride On system. Ride On is part of the Montgomery County, Maryland transit division, and operates in cooperation with the Washington Metropolitan Area Transit Authority (WMATA). The Ride On system services nearly 900,000 county residents by operating over eighty routes with three hundred and fifty buses. It provides many benefits to the County, including facilitating easy travel for a multi-ethnic population. This extremely complex system cooperates with a

variety of different transit services, such as the Metrorail, Metrobus, and the MARC commuter rail system.

In comparison with other transit systems, Montgomery County's Ride On system is rated as one of the most efficient systems throughout the Washington metro area. Although the system has garnered excellent results, its formidable size has discouraged the collection of adequate county-specific information. Many surveys conducted of the transportation system in Montgomery County have been done as part of a regional study. The County, however, would like to obtain information about its own riders. This information would provide the County with a basis to more effectively target its marketing and planning strategies. Since surveying the rider requires an in-depth knowledge of the system itself, one of our team's objectives is to gain familiarity with this complex system. For further information regarding case studies in transportation surveys, please refer to Appendix C.

Due to Ride On's complexity, there are many problems that negatively affect the system. Thus, it is very important to gather specific data that can be used to improve its effectiveness. Collection of this information is best facilitated through a comprehensive, concise, ridership survey. The survey provides a foundation for answering route level and marketing based questions. The sampling frame for this study was larger than those used in previous surveys since a complete sampling of ridership was needed. Additionally, in order to avoid obtaining invalid data, the survey must not be confusing to specific persons or

ethnic groups. All aspects of the survey's development involved careful consideration and planning since the county consists of such a wide range of individuals dispersed over a variety of locations.

One purpose of our survey is to help the transit department develop an idea of its riders' demographics, such as their age, race, primary language, the fare media that they use, and the origin and destination points of their travel. Since our concise survey serves to answer all of these questions, we were able to gather a plentiful amount of data to analyze. Once these data were analyzed, our team made comparisons based on previous studies. In doing this, we were able to settle discrepancies between a county model and a conflicting study. We were also able to glean information on linked and unlinked transit trips from the information that we collected. Through these observations, we will be able to offer recommendations that will increase the efficiency of the system.

4.0 Objectives

There are many complex issues associated with running an effective bus system in Montgomery County. Ridership is influenced by two critical factors, marketing and route planning. In order to make recommendations that will increase the ridership (see Appendix D), and thus the success of the system, it is necessary to target a survey toward these key factors.

It is important to note that many successes and failures discovered on the route level are major effects of marketing and planning strategies. From our survey, we made associations between demographic information and trip patterns that are useful for the implementation of new marketing and route planning strategies. For example, problems with travel patterns can be more easily targeted based on the zip code information we obtained. It may also be possible to develop or eliminate routes based on these data.

We also found out which fare types are used most frequently by certain ethnicities. With fare data, a marketing strategy can be developed to familiarize the public with media such as the 20 Trip Ticket, which is easier and more economical for the rider. If this were the case, then advertisement of these media at malls, supermarkets, and places frequented by other riders would increase the overall attractiveness of the system, and thus increase ridership.

Another main objective was to reconcile the differences of two previous models that analyzed trip patterns of Montgomery County riders. Since the two models reveal very different conclusions, we felt it necessary to establish which

was more accurate. One model came from a survey conducted of an arbitrary sample by the WMATA in 2000. The other model was created by County Executive, David Bone. Mr. Bone analyzed trip patterns based on his extensive knowledge and experience with the creation of the current Ride On bus system. Based on the results we obtained, we are able to decide which model was more accurate.

We have also noticed a relationship between race and survey refusal. Generally people refuse to complete surveys or participate in interviews because these methods are commonly seen as merely another means of solicitation. Another reason for a low response rate is that many surveys are thrown together quickly, thus not providing sufficient coverage by leaving out large amounts of detail that should be included, such as location, length and time in which trips are taken, and other important information (Pisarski, 03). Thus, we recorded the number of people by race refusing to participate in the survey on arbitrarily selected routes. These data will help our team to develop an idea of which groups may not be properly represented. Also, we were able to develop a general idea of what types of people frequently refuse surveys.

5.0 Methodology

Our team conducted a survey in cooperation with the Montgomery County transit department. All aspects of this survey's development involved careful consideration and planning. There are many factors we had to consider, for example, a sampling frame, time of sampling, and the Transit Department's goals and information needs. Furthermore, each question in our survey was specifically designed to answer our objective questions, as revealed in Table 1.

Table 1. Relationships Between Objectives, Survey Questions, and Their Purposes

Objectives	Questions or Associations of Questions That Will Answer Objectives	Purpose
Distribution of ridership by zip code	Zip code, age, ethnicity, gender	Route Planning
To reconcile WMATA survey and the County Model	Coming from or going to a public a transit vehicle	To obtain a more accurate model of County ridership
Associations between ridership and fare type	Fare type, age, ethnicity, gender	To target particular audiences for marketing
Refusal rates (to fill out survey) based on ethnicity	Number of refusals by ethnicity	To show what ethnic groups might not be represented in typical surveying techniques
Encourage current riders to increase system use by profiling frequent and weekend riders	Frequency of use, fare type, weekend ridership, linked trips, origin and destination, gender, age, ethnicity	To add ridership without adding extra cost

Definition of terms: ridership – total riders, age, ethnicity, gender
Fare type – examples: adult cash fare, Ride On 20 trip ticket, bus transfer, etc…
WMATA survey and County Model – predictions on the number of linked trips between transit services
Linked trip – a trip in which a rider uses two or more transit vehicles to reach their destination

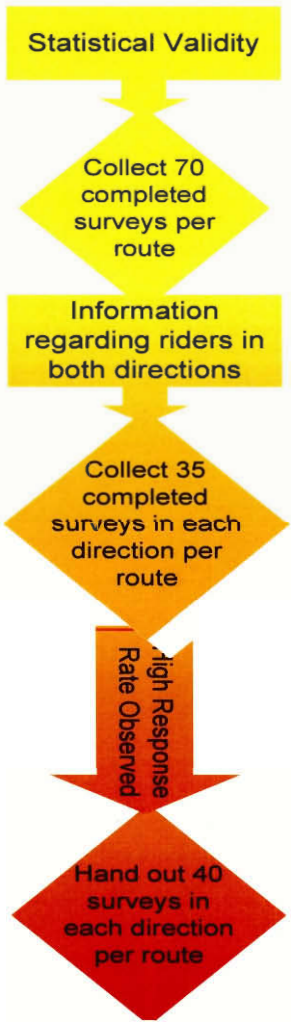
5.1 Pilot Testing

Before implementing our survey, we had to make sure that it could be easily understood by the general public. We accomplished this by conducting a pilot test of our survey. The objectives of our pilot survey were to find any errors in the questions and to make sure that the diction and syntax of our questions were at an acceptable level. As a result of our survey and collaboration with our marketing liaisons, we found that the survey also needed to be designed so that it could be read at a fourth-grade level (van der Reis, 02). We conducted our pilot survey during the afternoon hours of a weekday; it was handed out to twenty customers at two Rockville Ride On stops. We were then able to collect feedback on the readability and overall comprehensibility of our survey and were able to resolve problems with its distribution. Since these completed pilot surveys were handed directly back to us, respondents could also provide us with immediate feedback concerning improvements and suggestions to the survey. From the collected pilot survey responses we were better able to formulate our actual survey. The pilot testing also revealed an extremely high response rate, indicating that we only needed to hand out about 13% more surveys than were needed in order to have an effective sample frame.

5.2 Sampling

To properly represent the Montgomery County area, it was necessary to have a fairly large sampling frame. To determine an effective sample size, we calculated that seventy completed surveys per route would be roughly 10% of the

total ridership. In order to receive a total of seventy surveys, we handed out 40 surveys in each direction per route, totaling 80 surveys (see diagram to the right for further detail).



We surveyed Ride On buses for two weeks, in two shifts. The first shift was from 2 p.m. to 8 p.m. and the second was from 6 a.m. to 12 p.m. These times were chosen because we could easily obtain the most information from the majority of customers. The midday hours, 12p.m. to 2 p.m., were not surveyed due to a lack of customers. This information was adopted from the 1995 MBTA Systemwide Passenger Survey as well as from information provided to us by our liaisons. Additionally, it was decided that we should not survey routes that have fewer than 100 riders per day, as well as routes slated for elimination in the near future. Thus, instead of surveying all 81 Ride On routes, we surveyed a total of 63 routes. A summary of surveyed routes and total ridership per route can be found in Appendix E.

5.3 Survey Distribution and Collection

Our survey distribution strategy involved riding the buses and offering surveys (in accordance with the number determined in the sampling section) to all persons boarding the bus. We were able to divide the Ride On routes in groups

of three per survey administrator (which equaled a day of surveying for one surveyor). Surveys were distributed on buses departing from Metrorail stations. In dividing the bus routes by Metrorail stations, our four team members, as well as two County traffic checkers, were able to survey 63 routes per week.

An example of our survey distribution procedure is shown below for route 14 from Silver Spring to Takoma. As depicted, we distributed twenty surveys on our assigned route on a bus leaving the starting Metro station.

Route 14

Silver Spring
Metro Station
2:05 pm

Takoma
2:28 pm

20 surveys

Silver Spring
Metro Station
2:54 pm

Takoma
2:32 pm

20 surveys

After the survey distribution, we found it most efficient to have the customers return the completed surveys directly to us. In case the surveyors had to leave the bus, we left collection envelopes on the bus along with extra surveys

and pencils. Drivers then turned in the collection envelopes to their supervisors. The desk coordinators then placed the envelopes in a drop box at their respective garages; the envelopes were picked up by our team during that same week. Please refer to Appendix F for a more detailed description of our survey distribution and collection procedures.

6.0 Results and Analysis

In the transit business, universal terms for bus transfer patterns are used. These are classified as linked or unlinked trips. An *unlinked* trip is when one public transit vehicle is used to reach your destination. An example of this would be getting on a public bus, like Ride On, and reaching your destination with that one bus. A *linked* trip involves using more than one public transit vehicle to reach one's destination. A linked trip is also defined as two or more unlinked trips. For example, if you board a public bus, get off that bus, board another bus, and then reach your destination, the sequence is classified as a linked trip, or two unlinked trips.

In order to reconcile the differences between the 2000 WMATA model and the County model, we cross-tabulated the origin and destination points of our riders. Both of the aforementioned studies, as well as ours, were based on 100 Ride On passengers and what types of transfers they made both before and after the trip on which they were surveyed. According to our data (tabulated in Figure 1), 27.6 % of Ride On patrons use only one Ride On bus, or complete just one unlinked trip, to arrive at their destination. The number of people completing one unlinked trip only was found to be 32 % by the County study. The WMATA study, however, states that 53% of riders complete a single unlinked trip. The County model also predicts that for linked trips, either prior to or after the Ride On bus on which they are surveyed, 25% of riders will use a Ride On bus, 15% will use a Metrobus, and 28% will use the Metrorail.

Our results are similar to those of the County study, showing that 23.1% use a Ride On bus, 17% will use a Metrobus, and 31.4% will use the Metrorail to supplement their trip. Additionally, 0.1% will use an MTA bus, 0.1% will use a CTC bus, and 0.2% will use another type of public transit vehicle, in unity with a Ride On bus to reach their destination. A summary of the aforementioned using weighted-arrow graphs can be found in Appendix G.

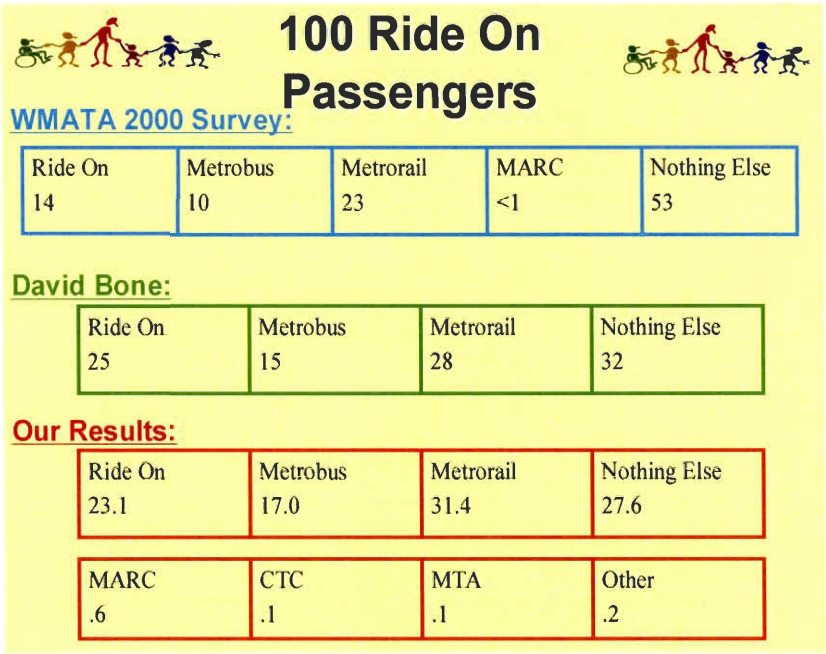


Figure 2

In summary, our results closely match those of the model by County executive David Bone, as shown in Figure 2. It should be noted that Mr. Bone did not factor in the MARC, MTA, CTC or other transit categories. Even so, the numbers we obtained for these categories are so small that they do not skew the results of the main categories. It was relatively unexpected that, rather than confirming or supporting the results of WMATA's two million dollar survey, our survey validated the results of a man who based his model solely on expert judgment and his knowledge of the Ride On system.

One of the important analyses we conducted was of the transfer patterns of the riders surveyed. This analysis was conducted in order to calculate the number of linked and unlinked trips.

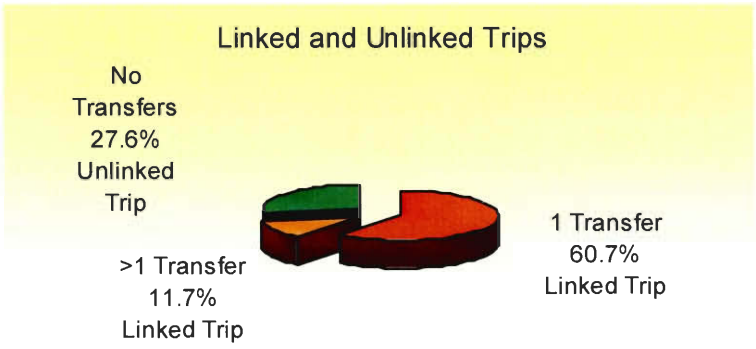


Figure 3

A main reason for wanting this information is that, in order to have an effective bus system, a rider should use two or fewer public transit vehicles to reach their destination. In other words, a successful bus system is one in which there is only a small percentage of customers that have to transfer more than once. Our analysis of the Ride On system found that percentage to be 11.7% (See figure 3). Compared to the 27.6% of no transfers and 60.7% of one transfer, this number is relatively small; thus demonstrating the system's effectiveness.

Of those 11.7% who transfer more than once, 49% use MARC, Metrorail, Metrobus, or another public transit system, while 51% use Ride On exclusively. Consequently, 6% of customers use three Ride On buses to reach their destination. This is significant because this small percentage points towards the success of Ride On route planning. It was also found that for people making only one transfer, the percentage using Ride On (28%) is much lower than those using any other public transit vehicle (72%). This is important information because it shows that most Ride On customers are commuters, which explains the large

number of other transit vehicles being used to transfer.

In a subsequent route-related analysis, we also made another important discovery. We cross-tabulated zip codes between Washington, D.C. and three main transit hubs in the County, Rockville, Bethesda, and Silver Spring. Specifically, these zip codes were cross-tabulated with regard to destination and point of origin. We noticed that in the morning hours, the number of persons traveling into Washington D.C. from Rockville, Silver Spring, and Bethesda was 20, 15, and 35 respectively. When the evening trips were analyzed, we discovered a large discrepancy in the number of those returning. The anomalous data was due to the wording of the survey question, which asked "where will you start *this* bus ride?" The destination question asked "where will you end *this* bus ride." Check boxes under each question gave the respondent the choice of home, work, and a few other options. When patrons were traveling from Rockville, for example, to D.C. in the morning, they checked off "home" and filled in their home zip code in the space below with regard to their origin. On the return trip, the wording of the origin question ("where will you start *this* bus ride?") indicated that the survey only pertained to the bus that they were on. For example, to get to Rockville a person may take the red line to Friendship Heights, transfer to the 42 Ride On bus to Medical Center, and then subsequently transfer to the 46 at Medical center. If the rider was surveyed on the 46 on his way to Rockville, he or she would mark their destination as Rockville but the origin on *this bus* as Bethesda, when the rider really came from DC. The importance of this data may

not be evident at first, but it proves highly important to route planners. Its importance lies in the revelation that these bus riders are scattered throughout a number of routes due to the lack of a direct DC shuttle bus, which subjects riders to wasted time.

As previously stated, one of our objectives was to find associations among our survey questions in order to form the foundation for new marketing and planning strategies. One such association we sought to make was a relationship between the frequency that riders used the buses and the fare type by which they paid. A summary of fare types in Montgomery County can be found in Appendix H. We also wanted to see if particular demographic groups were not taking advantage of discounted and bulk fares, so that new marketing strategies could be focused towards these specific groups. It is in the best interest of both the County and riders if bulk fare methods are used. The reasons for this are twofold; first, riders would save money, and second, bulk fares provide an incentive to ride the buses more frequently, which would consequently increase ridership. In order to find those riders who do not sufficiently utilize the system, our team first made a cross-tabulation between ethnicity and high frequency use. For our purposes, we defined high-frequency use as a rider who utilizes the system five to seven days a week. As shown in Figure 4A, one can see that ridership, measured here by high-frequency use, is highest among Hispanics and Latinos, followed by African Americans, Asians, and Caucasians respectively. As previously noted, we then wanted to explore if the high-frequency riders were taking advantage of the

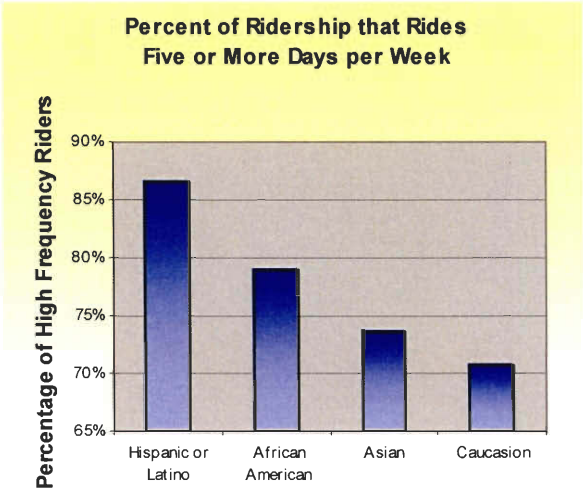


Figure 4A

discounted and bulk fares such as the Ride On 20-Trip Ticket, rather than paying the full adult cash fare price. As shown in Figure 4B, this is not the case; Hispanics and Latinos have the highest frequency of use, yet they pay using the adult cash fare more than any other ethnic group. Moreover, Hispanics and Latinos, along with African Americans, use the Ride On 20-Trip Ticket the least out of all the ethnicities, albeit having the highest frequency of ridership. Caucasians and Asians on the other hand, have the lowest high-frequency use, yet they take advantage of the Ride On 20-Trip Ticket the most out of the other ethnicities.

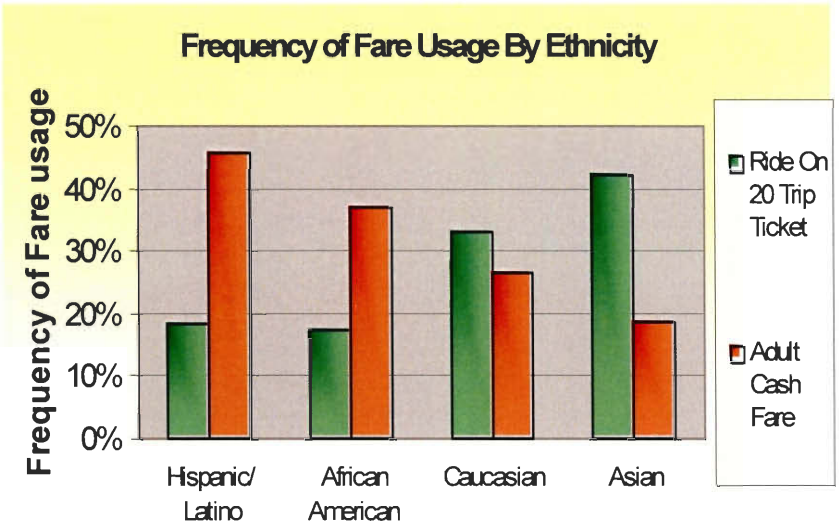


Figure 4B

In summary, this is notable because even though Hispanics and Latinos use Ride On most frequently, they fail to utilize bulk fare incentives as much as

other ethnicities, such as Caucasians and Asians. This shows that there is a significant marketing issue concerning fare media in the Hispanic and Latino community.

Another objective of our team was to develop a relationship between the number of people who refused to take our survey, and their ethnicity. The observation of refusals by ethnicity, however, did not involve the entire sample. Instead, only a sub-sample of riders was observed on arbitrarily chosen routes at the convenience of the surveyor. These collected data were compared against the total number of refusals, as well as the total number of riders in the sub-sample. We found that among the customers who refused to take our survey, 38 % were Hispanic, 29% were African American, 23 % were Caucasian, and 10% were

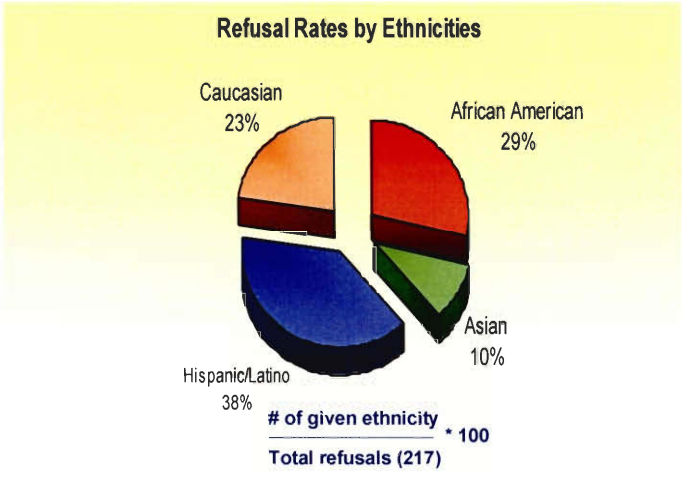


Figure 5A

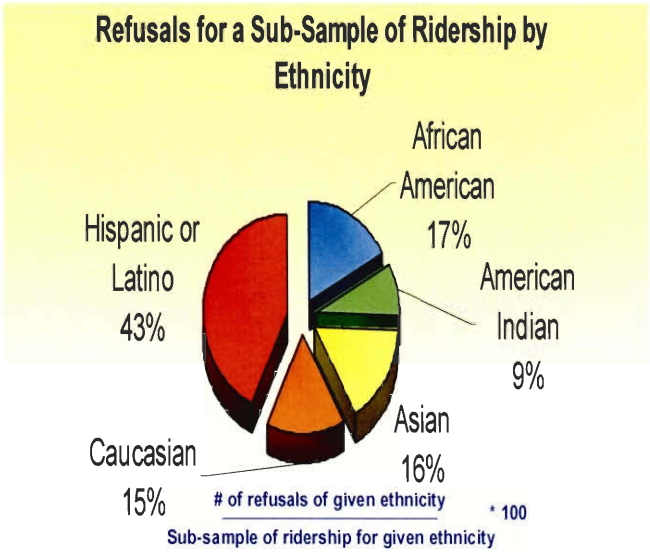


Figure 5B

Asian (see Figure 5A). In comparing the refusals by ethnicity to the overall sub-sample ridership in Figure 5B, we found that 43 % of Hispanics refused to take the survey. This number is significant, because it is almost triple the percentage of other ethnicities that refused to take the survey, such as African Americans, Asians, and Caucasians. Based upon these refusal rates, it is evident that Hispanic riders may not be properly represented in this study.

Additionally, a major purpose of our study was to glean important marketing related data. One major task for marketing is to encourage weekday riders to ride not only during the week, but also on the weekend. This will not cost the County any extra money because it will not have to plan or provide for any new routes. There will only be an increase in usage of existing weekend routes, which would consequently increase revenue.

In order to properly market to existing riders, and those who are demographically similar to them, the Montgomery County DPWT needed to assess the demographics of its riders. From the analysis of our data, it is evident that the majority of people using the Ride On system do not take advantage of it on the weekend. Analysis of weekend riders' profiles (See Figures 6A and 6B) showed that most people who use the buses on the weekends, whether regularly or occasionally, are of the ages 24 and younger, or 65 and older. By cross-tabulating weekend ridership with ethnicity, as shown in Figures 7A and 7B, we have noticed that of the Hispanics who use the buses on weekdays, 63 % also use it on Saturdays, and 48% on Sundays. Of African Americans, 52% utilize Ride On on

Saturdays and 38.15% on Sundays. Caucasians represent the major ethnic group that uses Ride On the least during weekends; 33% use the service on Saturdays, and 23.43% on Sundays. Additionally, the ridership from Saturday to Sunday shows only a 10-15% decrease.

Additionally, it was noted that 65% of Ride On users are commuters as shown in Figure 8A. Also, the final destination of riders coming from work is shown in Figure 8B. We also discovered an overall relationship between age and fare type used. It was noted that patrons ages 18 or less tend to use student ID's, those persons between 19 and 44 use an adult cash fare, those between 45 and 64 use mostly the Ride On 20-Trip Ticket.

7.0 Recommendations

After careful study of our data, we have developed several recommendations for the Montgomery County DPWT. First, results concerning associations between fare type and demographics lend to the conclusion that specialized and incentive fares are not being appropriately utilized. Based upon relationships between ethnicity and fare type, it is obvious that certain ethnicities are not being properly marketed to. The greatest disparity between frequency and fare type exists within the Hispanic population. In order to better reach this population, marketing strategies should be further developed in Spanish that not only encourage bus use but also encourage the use of bulk fares. It has been duly noted that senior citizens do not utilize the discounted senior fare. Therefore, marketing strategies should involve informing senior citizens of the benefits available to them.

In the realm of route planning, we have also developed a few important conclusions. Based upon data regarding transit from Washington, D.C. to various hubs in the County, we have observed that, except for the red line, there is no direct way to reach Washington. Our recommendations are twofold. First, we propose that a shuttle be created between Rockville and Friendship Heights. This shuttle would service only Metro stations along the red line, serving strictly as a rapid feeder system for D.C. bound commuters. In order to ensure the success of this shuttle service, a high occupancy vehicle lane for the shuttle and other high occupancy vehicles would be beneficial. Additionally, a less time expedient but

easier solution would be to extend the service of route 46, starting from Shady Grove, to include the red line Metro stations of Friendship Heights and Bethesda.

Though the Ride on system is already extremely effective, it will always benefit from careful observation of marketing and planning information. In submitting these recommendations, we hope that we can play a part in improving this already successful service. To supplement our data and conclusions, and based on customer feedback, we also highly recommend a customer satisfaction survey. This, along with our data, would help system administrators to develop a more complete idea of their system's effectiveness and make the Ride On system the transit market standard.

Appendix A

Mission and Organization of Montgomery County Division of Transit

The Division of Transit Services coordinates transportation services in Montgomery County. Transit accomplishes an essential mobility mission of the County, connecting people and communities to workplaces, educational institutions, recreational opportunities and many other essential destinations. Montgomery County operates the "Ride On" bus system. The system is designed to complement services provided by the other transit providers in the County and is supplemented by the WMATA's regional bus and rail carrier. It is one of the largest suburban bus systems in the nation, operating 350 buses over more than 80 routes. Most routes connect with one or more of the County's 13 Metrorail stations, which also serve as hubs for the regional Metrobus service. Ride On's ridership is approximately 22 million trips a year or 77,000 trips per weekday. Transit plays a key role in the viability of the local economy and in the accessibility of neighborhoods.

The Department of Public Works and Transportation (DPWT) is responsible for planning and implementing a transportation capital program to support a comprehensive, coordinated, and effective approach to transportation in Montgomery County. The basic objectives are to develop and implement a multi-modal transportation program to safely and efficiently move people throughout the county. This consists of the planning, design, construction, and maintenance of roads, bridges, bikeways, pedestrian facilities, parking facilities, and mass

transit facilities. Finally the Department supports mass transportation through its own Ride On bus service. The following, Table 2, is the budget for the fiscal years 01-06. It consists of eight programs, which contain a total of 78 projects for $428 million in the six-year period. (Montgomery County Department of Public Works and Transportation, 2003)

Table 2. DPWT Budget for Fiscal Years 2001-2006

Bridges	$12,554,000
Highway Services	$70,622,000
Mass Transit.	$42,467,000
Parking Facilities	$52,731,000
Pedestrian Facilities, Bikeways, and Trails	$40,465,000
Roads	$100,808,000
Traffic Improvements	$67,688,000
WMATA	$40,204,000
TOTAL	**$427,539,000**

While working closely with our liaisons, planning manager Phil McLaughlin and transit marketing specialist Beverly LeMasters, we were able to gain familiarity the operation of the Ride On system. Consequently, our objectives were aimed at improving planning and marketing strategies. The following organizational table (Table 3) shows which results will affect these components of the organization.

Table 3. Impact on Components of DPWT

Component of DPWT	Affecting Results
Marketing	- Evaluate current fare media - Target Hispanics & Seniors to use discounted fare media - Conduct a customer satisfaction survey
Planning	- Propose a shuttle service between Rockville and Washington DC - Analyze current routes for improvement based on trip data - Extend route 46 from Bethesda to Friendship Heights

We feel that our contributions to improving the effectiveness of the Ride On system will help the County in their mission to better serve their customers. In order to increase overall ridership, we have recommended evaluating current fare media for improvements. We suggest targeting not previously reached riders to use discounted fare media. Also, we recommend an analysis of current routes, which will prove beneficial to improving service throughout the system. Through the database that we have compiled, the County can supplement studies conducted in the past as well as the future.

Appendix B

Urban Mass Transit

Urban mass transit is an effective system for a few specific reasons. First, the system provides a means by which a large number of people can travel inexpensively and quickly. An effective transportation system ensures customer's satisfaction as well as safety. An increase in efficiency, affordability, and convenience, will result in an increase in ridership. Integration of different branches of the transit services, such as train to bus, or bus to car/van, also increases the system's overall attractiveness
(Smerk, 1974).

Of course, there are some benefits and drawbacks to such a system. Customer access to transit services plays a major role in the operation of a successful system. For instance, studies have shown that the maximum distance a customer is willing to walk to a bus station is about one-eighth of a mile. Anything exceeding this distance greatly decreases the chance that a customer will utilize the system. Besides distance, there is a schedule-associated quandary that tends to compound the issue of efficient access to bus services. One must consider that a transit authority is not only planning the bus route and schedule but also connecting these services to trains and other modes of transportation. Providing a large number of citizens with punctual bus service in a complex and interrelated transportation system poses a great challenge to a transit authority (Proceedings of the Society of Automotive Engineers, 299). It is challenging,

however, to monitor all of the intricacies of route operations within the bus system. One of the purposes of our survey is to expose route planning problems by collecting information on linked and unlinked transit usage. These data, in collaboration with zip code information will help our team make recommendations to improve bus service in the County.

Factors Affecting the Success of Urban Mass Transit

Maintaining an effective transit system is often a large financial responsibility to the service provider. There are many factors that influence the success of public bus transportation; thus, it is necessary to pay close attention to both internal and external factors regarding the system's operation so that it runs effectively and efficiently. In order to maintain satisfactory service, the following factors have been implicated: "...schedules, reliability of service, equipment characteristics, fare structure, convenience and comfort, cleanliness, availability of parking (especially for long distance services linking suburbs with the intercity), and advertising and public relations" (Smerk, 203).

Additionally, it is important for bus services and city governments to thoroughly study local demographics, population densities, and their relationship to bus routes. Comparison of these data through statistical analysis has proven to be an effective tool for the optimization of bus services at the route level, weeding out underused routes and reinforcing successful ones. By keeping an attentive eye on the aforementioned statistics, it is possible to mend a large service problem by adjusting small details in routes and scheduling. In conducting our survey, we

aim to target these small problems and develop recommendations the County may use to improve service and increase ridership.

Internal Factors and External Factors

Development of successful transit solutions greatly depends on the integration of external and internal factors. Internal factors include fare structure and collection methods. Studies have shown that reducing transit fares is a very effective method to increase ridership. On average, research shows that a five percent decrease in fares results in a 23.2% increase in ridership. Adjustment of fares toward different customer groups is also another way to increase ridership without affecting major budget changes. For example, offering fare discounts to students in cooperation with a university, or employees of a company has demonstrated a high success rate (Taylor, 57). For example, in Montgomery County, it may be beneficial to the bus system and its ridership to market specialized fare media to certain peoples or regions. If, for example, the twenty trip ticket was marketed to previously neglected groups, it may greatly increase ridership as an effect of its ease of use.

Another major fare-related issue is the time delay involved in fare collection. Collection of fares can further compromise the system's efficiency if only exact change is accepted. It is also now a widespread practice throughout the United States to enforce a strict exact change policy to protect the operator from robbery.

It has been demonstrated, through various studies, that external and more

complex factors play an even greater role in determining ridership statistics. Some external issues such as demographic statistics, gas prices, and parking fees can profoundly affect ridership (Taylor, 73). In an independent report conducted in cooperation with the Puget Sound Transportation Panel, data was obtained linking external factors to the use of mass transit services. This research specifically demonstrated the positive correlation between increased bus usage and increased population and employment density (Frank, 1).

Manipulating Fares to Increase Ridership

To combat the significant delay of fare collection, many transit systems have implemented pre-paid cards that can be swiped at a console in the bus. Much like a credit card, this fare medium allows for rapid boarding and greatly expedites trip time. Studies have shown that in order to entice customers to purchase these pre-paid fare cards, incentives such as discounts must be offered to the rider.

In the Washington D.C. area, a pre-paid fare card has been tested on a small scale. The card is known as "SmarTrip," and its main purpose is to decrease boarding time. The fare system in the area is quite complicated and the implementation of this card has shown promise in even a small sampling of riders. In March, 2000, the SmarTrip system was added to the METRO rail system, resulting in 130,000 cards being distributed out to customers. In order to expand SmarTrip use to the Ride On system, a fare box with SmarTrip capability would need to be introduced. The WMATA has recently introduced 1600 fare boxes

into their buses. In order to reduce capital and operating costs, the fare boxes were not equipped with magnetic swipe capabilities. These fare boxes are an updated version of the previous fare boxes that were installed in the 1980's. With the implementation of these new fare boxes, a support system will be needed to handle the customer service and electronics issues associated with the new system. The Lockheed Martin Corporation will perform the services discussed above under a contract. This effort will contribute to simplification of the fare system in the Washington D.C. area (Levinson, 285).

Along with pre-paid fare cards, the entire process of payment could be moved off of the bus completely. This would only be efficient in a large-scale setting where transfer from one mode of transit to another could take place. Payment terminals could be set up with turnstiles, much like those used in a subway system. These turnstiles would require only a swipe of the electronic fare card and a subway attendant to avoid fare evasion (Montgomery County Department of Public Works, 2002).

The Future of Urban Transit

With a rapidly growing population, and the immigration of people to the area, it is essential to make commuting as easy as possible. With proper planning, bus transit can be made extremely attractive to potential customers if it is faster, cheaper, and more efficient than cars. Creation of bus friendly roadways allowing for bus-only travel will greatly increase ridership. The most significant advance

in bus systems will come from technology. New technology has the ability to create more user-friendly systems and amenities that increase the appeal of public transportation. Technologies such as automatic vehicle location (AVL) and global positioning system (GPS) allow many advantages for both riders and transit authorities. The benefits of a GPS system are found in tracking of daily bus routes, which can be compared using a computer-based system. From these results, planners can develop better routes and schedules. The AVL system can eventually be placed inside bus stops and upon request of the waiting passenger, the bus's position would be announced (Levinson, 42). With the inclusion of these advances in technology and customer service, mass transit systems will play an integral role in the future of urban society.

Appendix C

Transportation Surveys and Case Studies

Transportation surveys, such as the ones listed below, are important to evaluate in order to provide a better understanding of their components (questions, collection techniques, etc…) In order to compile a survey to fit our needs, it is beneficial to look at previous surveys done in other cities. These present us with information on how a survey was conducted, questions it asked to obtain certain information, and how the results were analyzed.

National Transportation Survey

The National Transportation Survey (NTS) is a survey that is administered in ten countries around the world. It is sponsored in the United States, Switzerland, Great Britain, Denmark, Germany, Austria, Norway, Belgium, France and the Netherlands. In some countries it has been running since 1959 and the survey is given more frequently in some countries than others. The goal of the travel survey, and travel surveys in general, is to obtain information regarding "demographic, socioeconomic, and trip making characteristics of individuals and households." (Kunert, 00). This goal is accomplished by administering surveys by mail, telephone, interviews, the web, survey diaries, etc. The length of this national survey fully depends on which country is conducting it. It could last from one day to a week to as long as several years. The response rate to this survey tends to be relatively high, but it of course depends on the population in question, as well as location and design of the survey. The data acquired from

this survey is analyzed to determine such things as travel frequency, mode of transportation, how gender, race, income, etc… affects mobility. Demographic information is important for a transportation system to know because it allows for better marketing strategies in their service areas. It will also provide information on areas that are most heavily concentrated with riders, and also the ethnicity, age, perhaps income, etc… of their customers. Improvements are constantly being made to the NTS in order to get a better understanding of the transportation in these countries. These improvements include broadening the survey to include a larger sample, administering the survey more frequently in order to keep the rate of information about the transportation systems constant and current, and also looking into the reasons for non-response rates (Kunert, 00).

On the other hand, a current design for travel surveys that has worked reasonably well is a computer program called TFlow Fuzzy. It is a program designed to lower the cost and time of administering and analyzing travel surveys. The underlying idea is to interview passengers on transportation vehicles, and count the number of passengers boarding at each stop. By doing this, one develops a sample by using projection. Once this data is entered into the system, a method called "matrix correction technique" is used. The matrix correction technique relies heavily on the amount of people at each stop, which varies greatly from stop to stop. The system is designed to ease the surveying process, and was first used in Germany in 1998 (Friedrich, 01).

Another aspect of transportation survey analysis is the relationship

between the variables being studied. In our project we are evaluating the relationships between fare types, means of transportation, and the community to determine efficiency. An example of this is a survey done in Maryland between the relationship of African American, single mothers, their modes of transportation, and their occupations. From a survey conducted, it was found that their choice of jobs heavily depended on whether or not the job was accessible by public transportation (Bethea, 96).

Massachusetts Bay Transportation Authority

A survey conducted by the Massachusetts Bay Transportation Authority in 1995 acquired information of its passengers that is desired by the Montgomery County government in respect to its own riders. This study obtained information about the travel patterns, demographics, and satisfaction of its passengers. It has been the most extensive survey done in the area since 1970. While Montgomery County does not intend to focus on the satisfaction of its customers, the travel patterns and demographics of its riders is of major concern.

In order to collect this data, surveys were handed out between the hours of 6:30 a.m. and 3:30 p.m. on all routes. The completed survey forms could be collected in boxes, at stations, or mailed. The information retrieved from the completed surveys was entered into a database where a single response could be analyzed or combinations of responses could be examined (Chow, 97). Based on this survey we decided it would be most beneficial to survey the peak hours, rush

hour, in order to obtain the most information in the shortest span of time.

The Quincy garage was divided into three sections: East, North, and South. The Eastern and Northern districts contained six bus routes, while the Southern district contained four. There are nine groups under which the responses to the surveys were categorized. These are origin locations and activities, access to bus, trip purpose, reasons for using transit and alternate means, usage rates by fare type, automobile availability data, socioeconomic data, customer service data, egress time from bus, and destination locations and activities.

From these groups, specific information about the Quincy passengers was obtained. It was discovered that most trips originated from home, and went in either direction. The most favored way to get to the bus was to walk, and the second was from transfers. The four most common reasons for riding the bus were to get to and from work, school, personal business, or a shopping trip. Fare passes and cash were the two most common means of fare media used throughout the three districts, but it was established that people using passes ride the bus more frequently than those paying cash. Most of the bus riders in Quincy have a driver's license, and only a small percentage of riders are under seventeen years old. People using the transit regularly have been reported to have a household income of less than $20,000 (Chow, 97). In concerns to customer service, the system received an above average rating from the respondents. From this survey

we took questions and further developed them to fit our needs. The questions concerning travel patterns, demographics, and transit usage were the main focus points. As for the analysis, all of the data was entered into tables by route number and time of day, which is very comprehensive, but also very unclear.

Case Studies

Case studies provide a good background for us to see what has been found and done in the past concerning this topic. We can use the information from previous studies to familiarize ourselves with previous problems and successes. The following three studies were done specifically on Montgomery County. These were used to identify problems with transportation and overall efficiency. Recommendations based on these studies' conclusions will be used to improve the overall system. Based on the objectives if these studies, we can relate them to our objectives of marketing and planning.

One of the studies is the Veirs Mill Bus Priority Project. This was conducted in order to define factors affecting time economy in the bus system. There are eight routes along Veirs Mill Road, a six-mile, multi-lane state highway running from Rockville to Wheaton. Any bus running a route on Veirs Mill may lose up to 15 minutes per trip due to traffic congestion. Since this route is heavily congested, the project addressed three problems: bus speeds, schedule adherence, and improved rider convenience. The proposed project will aide in speeding buses through congestion and will decrease travel time. Increased service

reliability will result from this speed increase. Planning of this route needs to be revised. The route schedules will change based on the new bus stop times and appropriate measures for the new changes must be made. The estimated cost of six-million dollars will be small compared to the ridership increases and service benefits affected by this change. (Montgomery County Department of Public Works, 2002).

Since Montgomery County is so large there are many convolutions in the transportation system and as a result, another regional study was done. First, freeways are heavily congested during peak periods. Second, local roads are increasingly unable to cope with traffic demands specifically seen in east-west travel. This in turn generates major problems in the whole transportation system. Thirdly, a limitation in transit service to a number of major activity centers detracts from the benefits of the bus system. Consequently, a revision of congested routes needs to be thought out in order to fix these problems.

Currently, the Montgomery County Planning Board is evaluating a 20-year future with different transportation projects as well as near-term improvements. New ideas on route planning and distribution are to be made. As an indicator for the performance of each transportation scenario, the planning board chose to use an accessibility measure. The county's accessibility measures indicate how many jobsites the average household can reach within a given travel time, as well as how many households can be reached in a given travel time from employment centers. Three measures have been developed to determine

accessibility to transit systems. The first is called destination accessibility, which represents the number of destinations that can be reached in a certain travel time. The second is called fixed-guideway transit accessibility, which measures the percentage of businesses and residences that are located within one-half mile of fixed guideway transit stations. Accessibility to fixed-guideway systems also helps residents to view alternative housing options in case they either cannot afford or do not own a vehicle. Thirdly, travel times are measured for both autos and transit systems in the evening peak hours. In order to make the system attractive, transit services should provide a quicker alternative to auto usage (Hawthorne, 1999).

The county is rapidly growing in travel and development; as a result of this there must be changes in transportation. Montgomery County displays a diverse range of development patterns. Bases on the results from the accesibilty measures, route patterns and stop times are to be changed. As an example, if routes were changed, the number of homes that you can reach from your job site in 45 minutes would increase by 67,000 homes. (Hawthorne, 1999).

A third study was done to look at many alternatives to improve bus service in the National Capital Area. This study involved nine counties and was conducted by the WMATA from March 2000 through February 2002. The study analyzed the system from 2000-2002 and its needs for the future. The specific study marketing and planning objectives were:

- Identify changing travel patterns and new growth areas in the metropolitan region
- Determine where there are unserved and under-served markets
- Identify service changes and new services that respond to these opportunities
- Develop a comprehensive bus service and facility plan for the short term (5-year horizon) and the long term (20-year horizon).

The specific objectives for Montgomery County are to improve the total transit network of Metrobuses, Metrorail, and local buses. This will be accomplished by doubling ridership by 2025, improving system quality and image, and identifying funds, facilities, and services needed.

In the summer of 2000, an onboard survey was administered to 40,000 riders on the Metrobuses in all counties. Riders were asked what aspects they would like improved; the most requested being arrival time. This means that routes and times have to be changed so that buses are making it to their stops on time. One thousand non-riders were also surveyed by telephone to see what they would like to improve. The general opinion of these people was that they needed better information on the system. In this case it's not planning that needs to be rethought, it's marketing. Targeting this group with more information on the systems will increase overall ridership.

Many conclusions came out of this survey; the general consensus was that Montgomery County already had an efficient and well-run system. Slight improvements such as speeding up service and the use of ITS technology were recommended. The needs of the county were found to be longer service hours on

existing routes, more weekend service, improved cross county service, better connection to Prince George's County, more efficient service in the US 29 corridor, and expanding service in new growth areas. Based on our survey results, we can help with the weekend service improvements and seeing if service needs to be expanded to areas that heavily populated (i.e. new growth areas).

With the entire proposal in place, ridership is projected to improve by 7.9 million by 2010, a 21% increase from 2000. It is also anticipated that by the year 2010, there will be many service enhancements. Planning and marketing play a major role in making this improvement possible. (Washington Metropolitan Area Transit Authority, 2002).

Our analysis answers may help with some of the objectives of the aforementioned studies. With our main objectives in mind, marketing and planning, studying these cases will provide a background for our report.

Related Case Studies

The analysis of travel behavior has always been an integral part of transit studies. Virtually every major city has conducted one of these studies, in some form or another, to evaluate and improve its public transportation system. Consequently, there is an extensive amount of literature on this topic. A few cases are particularly relevant. The following section provides some examples of transportation studies and study methods that have worked for other county and city governments. They differ from the proposed Montgomery County transportation studies in that they elucidate different ways in which transit

information may be collected.

Los Angeles Metro Rapid Demonstration Program

The Los Angeles County Metropolitan Transportation Authority (MTA) and the City of Los Angeles Department of Transportation performed one such study in the San Fernando Valley region. On June 24, 2000, they implemented the Metro Rapid Bus Demonstration Program. One of the critical aspects of the demonstration process was to evaluate the components of the new Metro Rapid system in order to provide faster travel choices for current bus riders (City of Los Angeles Department of Transportation, 2000).

To accomplish this, employees distributed on-board questionnaires to bus riders before and after the implementation of Metro Rapid. The purpose was to evaluate the changes in the riders' behaviors and perceptions of the bus service before and after the introduction of Metro Rapid. This survey, and its implementation, proves to be a close parallel to our survey in that it contains specific questions that focus on riders' behavior, such as trip origins, destinations, and frequency of bus use. The survey also asks optional demographic questions to provide a basis for evaluating changes in the profiles of Metro Rapid and local riders.

The Continuous Survey Process

Melbourne and Sydney, Australia conducted similar Household Travel Surveys in 1997, which focused exclusively on personal travel of residents. Data from the Household Travel Survey and the subsequent continuous survey process was used to provide a detailed picture of personal travel for the city, and provided insight into the type of riders that the city transportation system carried. Consequently, the data is used for descriptive analysis of travel patterns and in the development of the State Government Transport Strategy for Melbourne, the development of a Transport Strategy for the city of Melbourne, and an assortment of studies that will eventually lead to the privatization of their public transport system. (Richardson, Battellino 2002)

Innovations in Surveys

A 1994 study in Switzerland involved a number of innovations that were not present in previous studies, such as the concept that "trips" are divided into several "stages," and the computer-assisted telephone interviewing method was applied. The latter allowed for more precise data on the combinations of different purposes in multipurpose trips, the chronological order of the modes chosen, the distances traveled, and the time spent on the way. Furthermore, short trips, especially those made by foot, were able to be included. An additional benefit is the possibility to asses the precise amount of time needed to change from one transport mode to another, such as the waiting time involved when utilizing several public transport modes in one trip.

The microcensus revealed that there is a difference between the travel behaviors of men and women. For instance, the women who were interviewed reported that they prefer traveling by private car during the evenings for safety reasons. However, in Switzerland, men earn a significantly higher income than women, therefore reducing the number of women who could afford a car. Hence, because of these two conditions: lower access of private cars to women and the lack of safety on public transport facilities at night, there is a discriminate factor against women, since their freedom of movement is reduced. This information served as a basis of recommendations to improve the transit system (Seether 2002).

Surveying Among Semiliterate Commuters

When conducting surveys among illiterate and semiliterate commuters the problem of finding the questionnaire to be too difficult is a common occurrence. Transportation surveys in South Africa chiefly focus on ascertaining information in regards to travel patterns, public transport usage, and the attitudes of low-income, semiliterate commuters who are essentially dependent on public transport for their journey to work. These transportation surveys, illustrated in the paper, "Transportation Surveys Among Illiterate and Semiliterate Households in South Africa" are not solely applicable to surveys in developing countries, but also, as van der Reis suggests, applicable to surveys of marginal populations in developed cities and even to societies with a relatively high degree of literacy. This case study hopes to elucidate some of these multi-cultural barriers and provides

suggestions on how they may be surmounted (van der Reis 2002).

Several of the most serious problems encountered by surveyors are a lack of sampling framework, unfamiliar terminology due to language barriers, respondent suspicion of the survey's objectives, lack of familiarity with rating-scale techniques, negative attitudes toward omitted or unfair choices, and fear of making mistakes and giving wrong answers.

A lack of sampling framework is sometimes caused by the fact that there is no listing in the directories for a majority of households because of low telephone ownership, or that the households do not pay taxes. Additionally, houses are often unnumbered and streets unnamed, which makes sampling points difficult to locate in the field. To overcome this, sampling involves the use of aerial photographs combined with the latest census figures in order to come up with a good idea of the distribution of people and housing in an area. Probability methods for selecting substitute respondents (because the primary respondents were not available) need to be supplemented by quota controls. By establishing quota controls based on gender and age bias in the sample toward the less mobile is avoided. The inclusion of the correct proportions of men and women of all age groups is also ensured using quota controls (van der Reis 2002).

Lack of familiarity with transportation terminology is also a barrier while surveying the semiliterate. It is obviously necessary to use practical, everyday terms in the survey questions instead of using transport jargon. Defining the meanings of terms that may appear unclear to less-literate respondents is therefore

necessary. Language barriers also create problems when conducting surveys. The reason for this is because certain terms have a definite, concrete meaning in one language, yet in another language, the same term might be interpreted in different ways. At other times it is necessary for the interviewer to simply complete the answer sheet according to the respondent's answers (van der Reis 2002).

Van der Reis also found that short, verbal rating scales are the most valid and reliable measures to use when surveying the semiliterate. For example, a scale such as "satisfies-unsure-dissatisfied" is a superior measure than any of the nonverbal rating scales (such as pictorial, graphic line, or numerical), which all cause confusion and require considerable explanation before the respondents will attempt to use them.

Problems concerning the rapport between the interviewer and the less-literate respondents have been identified in South Africa as well. Some of these problems include feelings of inadequacy and nervousness. They also have a tendency to provide what they think to be the expected response instead of supplying responses that echo their true feelings.

Empathetic interviewers boost the rapport with the interviewees. In conclusion, the design of questionnaires and procedures that take into account the respondents' familiarities, sensitivities, and limitations are of utmost importance in avoiding many of the difficulties involved in conducting travel surveys among illiterate and semiliterate populations (van der Reis 2002).

Appendix D

Case Studies in Increasing Ridership

As noted in earlier appendices, various factors have a positive influence over increasing the ridership of urban transit systems. The following case studies present the results of changes in transportation strategy in different transportation systems. They prove useful in that Montgomery County also seeks to better serve its ridership by implementing different marketing strategies and services. Thus, there are many parallels that perhaps provide insight into the future of Montgomery County transit.

One of the major factors that contribute to increased customer satisfaction and ridership is the implementation of a fare system that is easy to use and afford. One transit system that has benefited from this is the Green Bus Line in Brooklyn, New York, which services the southern and central of Queens County in the metropolitan area of New York City (Taylor, 2002).

According to officials, the thirty percent increase in ridership since 1997 can be simply explained by the implementation of a "one city, one fare" system. Riders along the Green Line, for instance, use prepaid swipe cards (known as MetroCards) that work throughout New York City and essentially lessens the system's fare by half.

New York City Transit benefited as well by changes in its fare structure and fare media. Fare awareness also was a large factor in the increase of ridership. The new MetroCard, for example, resulted in a bus-to-bus transfer policy that was

less restrictive than the use of paper transfers and allowed the possibility of several new travel patterns. The organization also administers a survey that tracks 1500 transit riders and nonriders through travel journals and diaries. The agency then uses the data to further improve their transit system (Taylor, 2002).

Prepayment fare options also benefited the Milwaukee County Transit System, which supplies bus service in the dense urban environment surrounding the University of Milwaukee-Wisconsin. One of its most valuable initiatives during the past few years is to focus on an assortment of prepayment fare options (Taylor, 2002). For example, students at the University are able to buy low-cost university passes that allow them to use the transit system for a fixed price. According to the agency's findings, passengers who purchased discounted bulk tickets are motivated to consume them more quickly, consequently increasing ridership. By offering such incentives and improving fare awareness, the transit system makes a continuous effort to increase its ridership and to provide good quality service (Taylor, 2002).

As noted in these previous case studies, surveys provide a basis for recommendations to transit services, and are often the cause of many changes within the transportation system. Montgomery County aspires to achieve some of the aforesaid changes based on the analysis of a ridership survey. As in the aforementioned studies, some of these changes will likely include improving fare awareness, and implementing different marketing and planning strategies.

Appendix E
Surveyed Routes (November 3-14, 2003)

Route #	Total surveyed/rt	November, 2002 riders/day	% of November riders	Average (whole year,2002)	% of Average
1	29	1501	2	1441	
2	26	894	3	878	
3	4	50	8	40	
4	25	350	7	346	
5	25	1908	1	1920	
6	9	475	2	462	
8	12	601	2	612	
9	35	1239	3	1161	
10	29	1831	2	1847	
11	27	869	3	856	
12		1840	0	1863	
13		365	0	336	
14	19	773	2	749	
15	32	4518	1	4588	
16	17	3842	0	3934	
17	30	1476	2	3934	
18	4	1007	0	1516	
19	6	140	4	176	
20	13	3270	0	3247	
22	11	139	8	119	
23	69	871	8	768	
24	22	278	8	275	
25	4	743	1	698	
26	105	2662	4	2669	
28	14	862	2	759	
29	4	826	0	779	
30	69	628	11	610	
31	4	149	3	127	
32	15	255	6	250	
33		257	0	242	
34	5	1558	0	1529	
36	12	481	2	430	
37	13	183	7	209	
38	35	1255	3	1278	
39	11	154	7	151	
41		750	0	693	
42	38	679	6	681	
43		713	0	761	
44	18	197	9	190	

45	43	772	6	828
46	58	3045	2	3087
47	29	1082	3	1128
48	117	1486	8	1502
49	75	1256	6	1525
51		218	0	204
52	6	106	6	102
53		253	0	236
54	31	1856	2	1873
55	38	3597	1	3713
56	63	1732	4	1811
57	33	1538	2	1617
58	23	1125	2	1169
59	39	3281	1	3402
60		232	0	217
61	47	2053	2	2163
62	1	2441	0	2485
63	55	569	10	642
64		1204	0	1271
65	5	134	4	134
66		121	0	102
67	15	115	13	120
70	22	238	9	355
71	13	170	8	226
72		280	0	257
74	13	215	6	215
75	26	111	23	167
76	24	482	5	426
77		163	0	218
78	6	241	2	176
79		116	0	124
81	15	150	10	163
90	1	663	0	758
92		1152	0	1023
93	30	231	13	233
96	26	506	5	503
124		1041	0	752
TOTAL	1645	74564	2	78051

Appendix F

Survey Distribution

In order to survey all 63 routes per week, we each surveyed three routes per day, totaling 18 routes per day. On Friday, three of the surveyors only had to survey two routes each, which left them time to survey another route that might have been missed during that week. Since our sampling frame was so large, our liaisons provided us with two County employees to help us with the distribution of the surveys.

The routes that each person surveyed were based on an analysis of a route map of the Ride On system. We found that it was most efficient to work out of Metro stations on the red line that had numerous Ride On stops. The reason for this was that we were able to organize the Ride On routes in groups of three (which equaled a day of surveying for one surveyor) at each Metro station. Therefore, the surveyor could work out of one station, without having to do excessive travel to get to their assigned routes.

In order to accomplish our goal of obtaining 35 completed surveys per route per direction, during each shift a surveyor would ride a bus and hand out 20 surveys in one direction, proceed to get off the bus, and hand out 20 more surveys on that same route on the way back to his or her station. This, coupled with the evening shift for this route, facilitated a total of about 35 completed surveys in each direction.

An example of this seemingly complex survey distribution scheme is as

follows: One day during the evening shift, a surveyor would have routes 2, 3, and 4 out of Silver Springs, which is a metrorail stop on the red line. To accomplish his or her assigned task, the surveyor would first ride bus 2 (or whichever bus arrived first) and hand out 20 surveys going away from the station. Once he handed out 20 surveys, he would then get off at the next stop, and proceed to ride bus 2 on the way back to Silver Springs and hand out 20 more surveys along the way. In the case that he did not hand out his assigned number of surveys, he would ride bus 2 again following the above pattern until he satisfied his quota. Once he returned to Silver Springs, having collected his goal of 35 completed surveys, he would then get on bus 3 or 4 (depending which arrived first) and repeat the aforementioned procedure. Finally he would get on the last bus and repeat the procedure one more time. Sometimes, this proved easier said than done, and quite often the goal for the number of surveys was not reached due to the fact that some of the bus routes did not have ample riders to survey during our allotted time frame. We deemed the lower number of collected surveys on these routes was still a representative sample of the ridership for these routes because these routes had a lower overall ridership.

For the passing out of our surveys, we wanted to convey to the customers that their participation in the survey was important, while at the same time recognizing that their time was valuable. Consequently we passed them out on a personal basis when time and space allowed, however, we did not follow an exact script. A personal basis means we showed the customers our Montgomery

County Badge, and proceeded to tell them it would be much appreciated if they could take just one minute to fill out our survey. From previous case studies in transit surveys, we found that handing surveys out face to face, on a personal level such as the aforementioned, provided the best response rate, which came to fruition in our survey as well. The face to face method also allowed for an explanation of the survey questions and their purposes in the case that anyone was perplexed. We also provided an explanation to the customer if they asked what the survey was for, so as to further reinforce the importance of their participation. In the case that the bus was crowded, we simply made an announcement at the front of the bus, and then proceeded to hand them out to riders as we walked towards the back of the bus.

Survey Collection

After the personal distribution of our surveys, we wanted to provide the easiest way possible for them to return their completed surveys to us. Therefore, we found it most efficient to have the customers return the completed surveys directly to us. This way eliminated the need for mail-in forms, which would have cost the County money. Occasionally, the surveyors would have to leave the bus in order to make the transfer to another bus to keep with their schedule. In this case, we left collection envelops on the bus along with uncompleted surveys and pencils. The customers could then take a survey, fill it out, and put it in the envelope. This also facilitated the easy collection of the surveys since drivers turned in the collection envelopes to their supervisors. Supervisors then put them

all in a drop box at their respective garage and the surveys were then be picked up by us later.

Appendix G

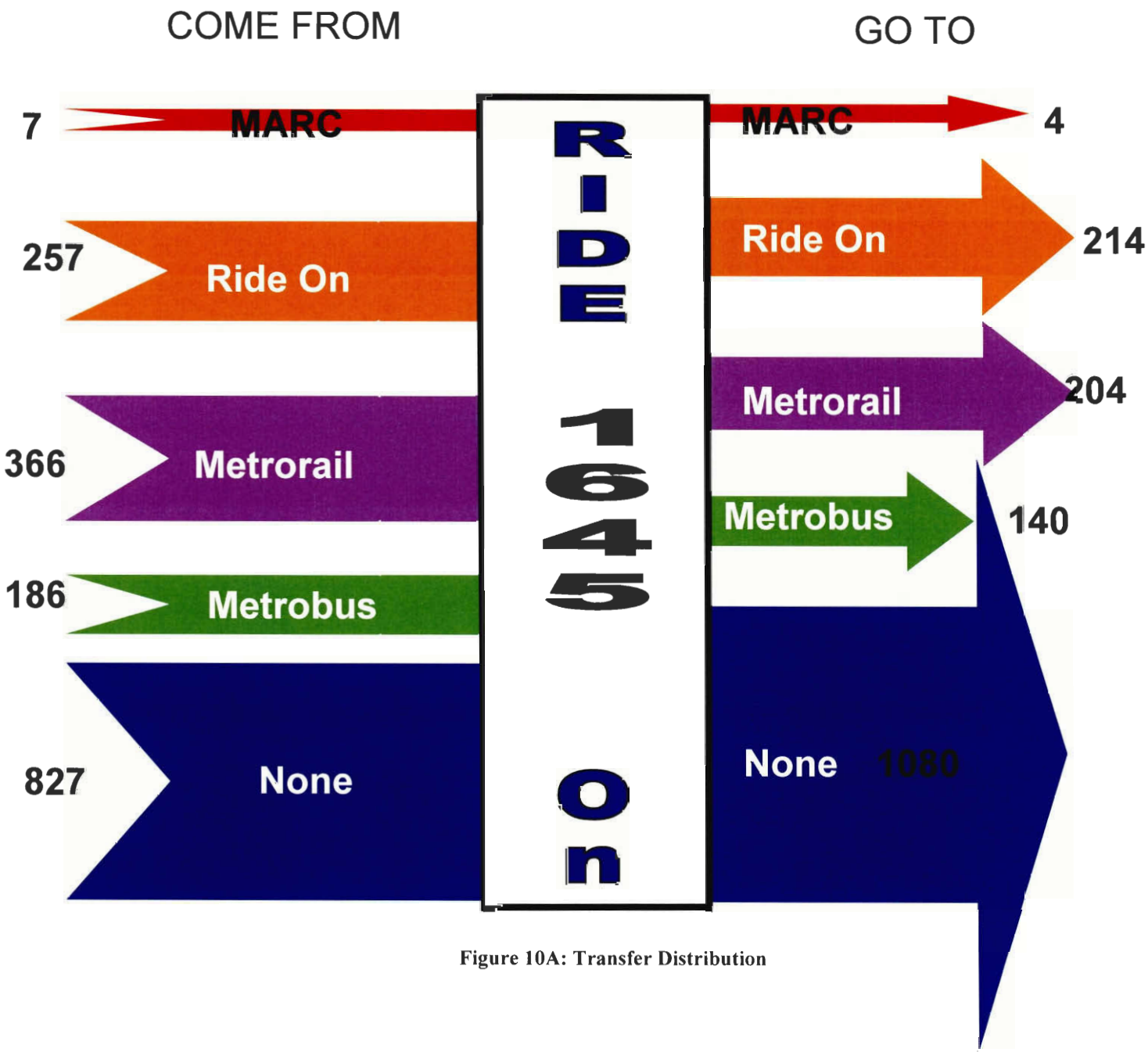


Figure 10A: Transfer Distribution

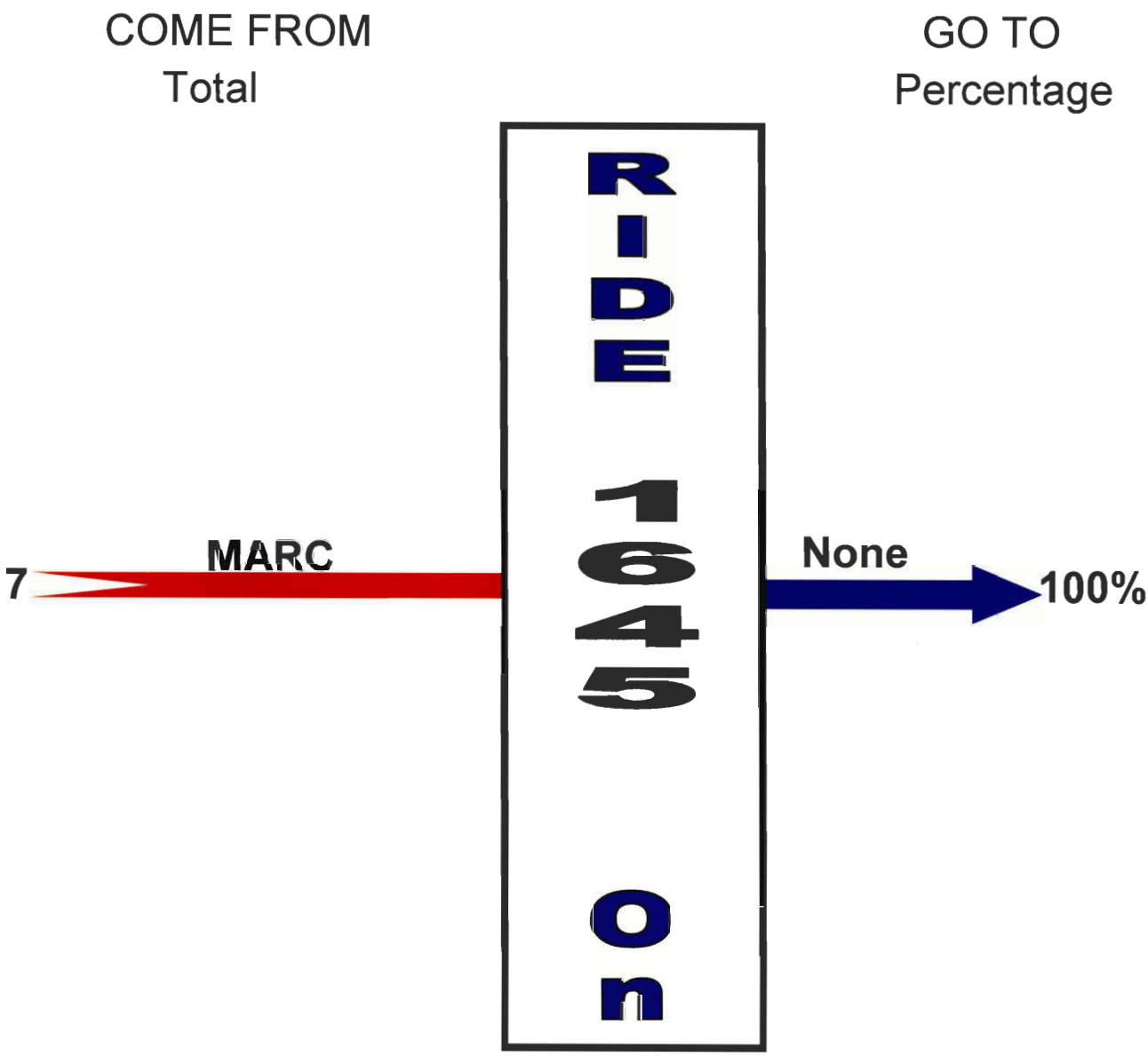


Figure 10B: Transfer Distribution From MARC

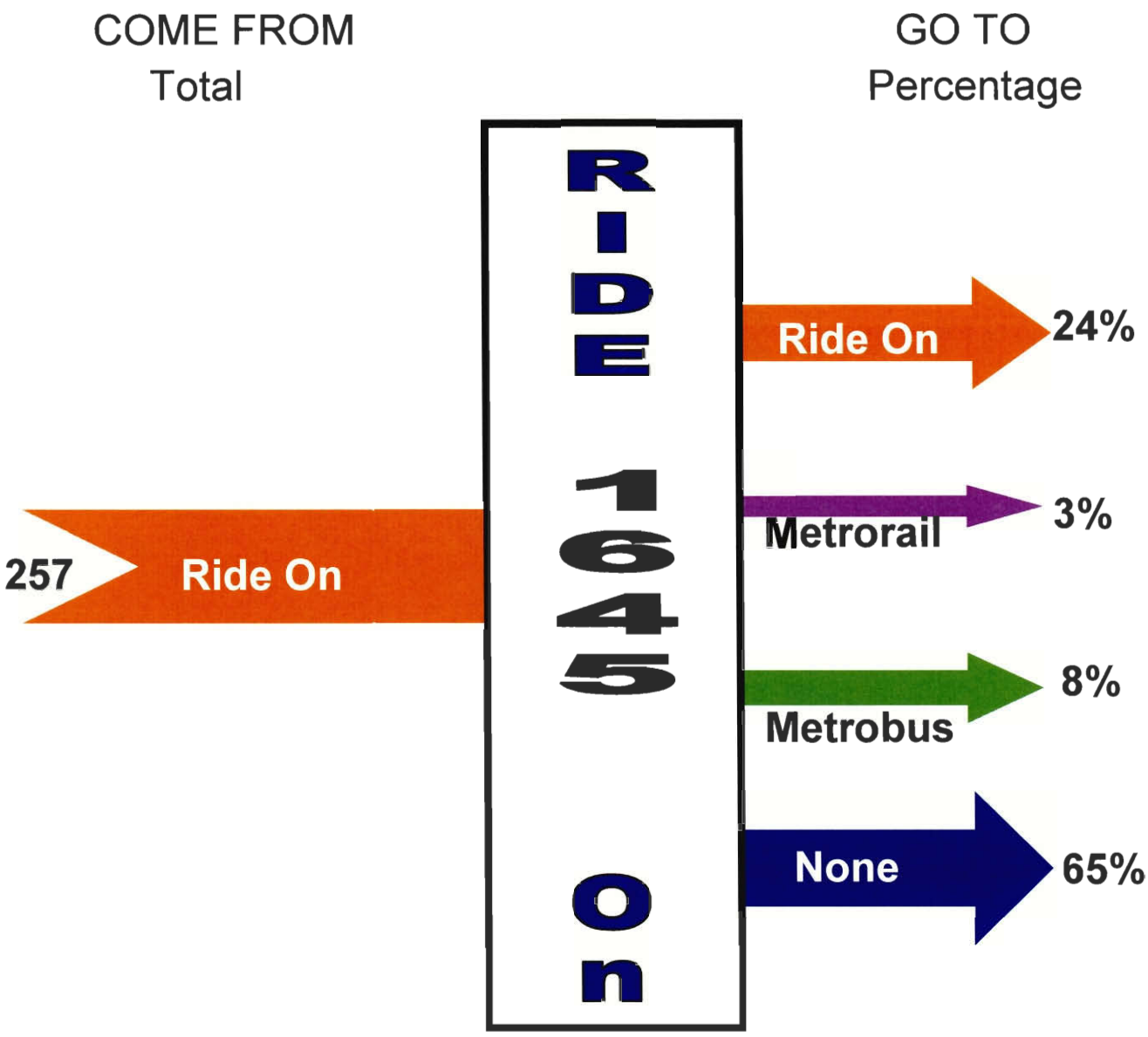


Figure 10C: Transfer Distribution From Ride On

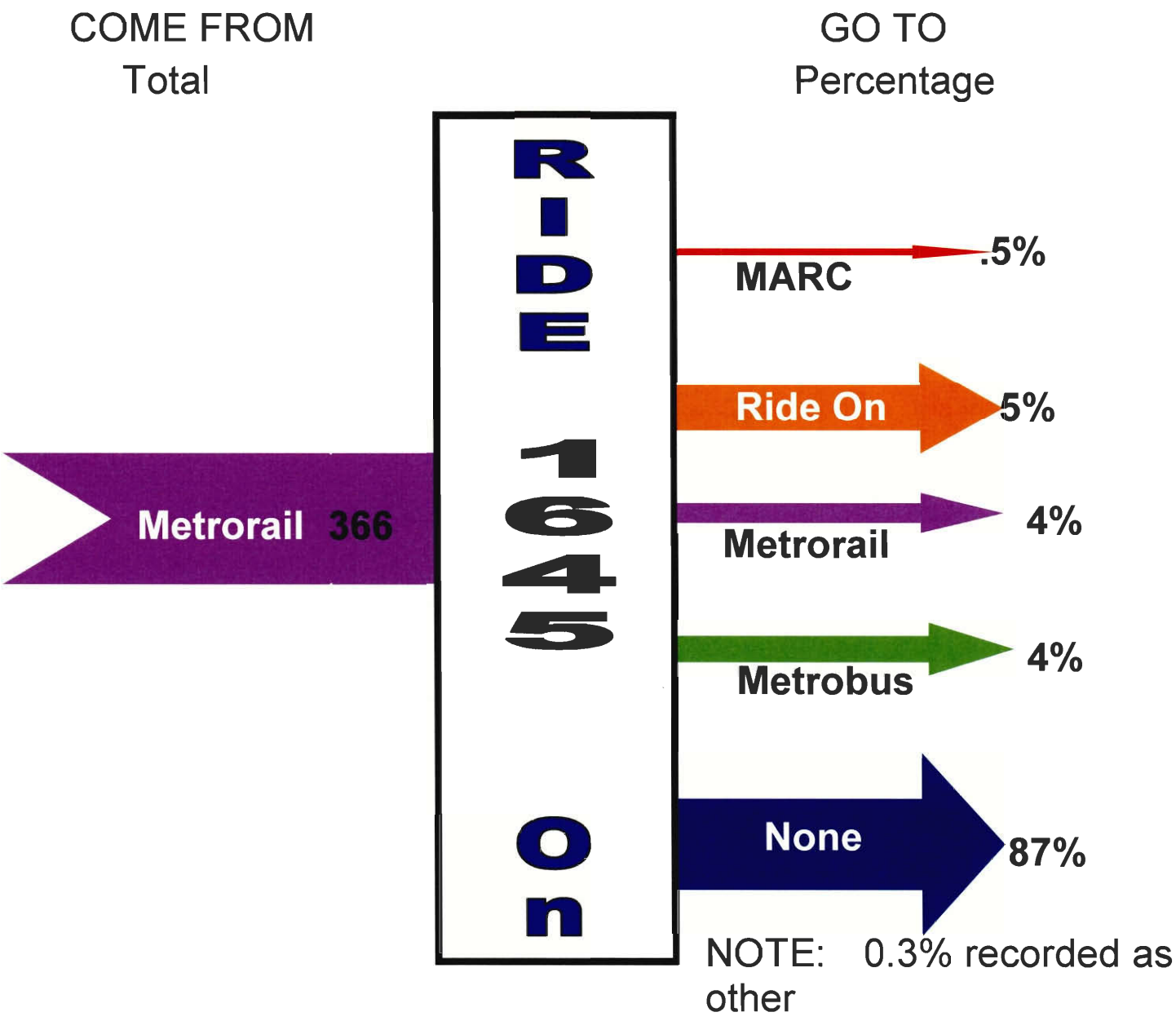


Figure 10D: Transfer Distribution From Metrorail

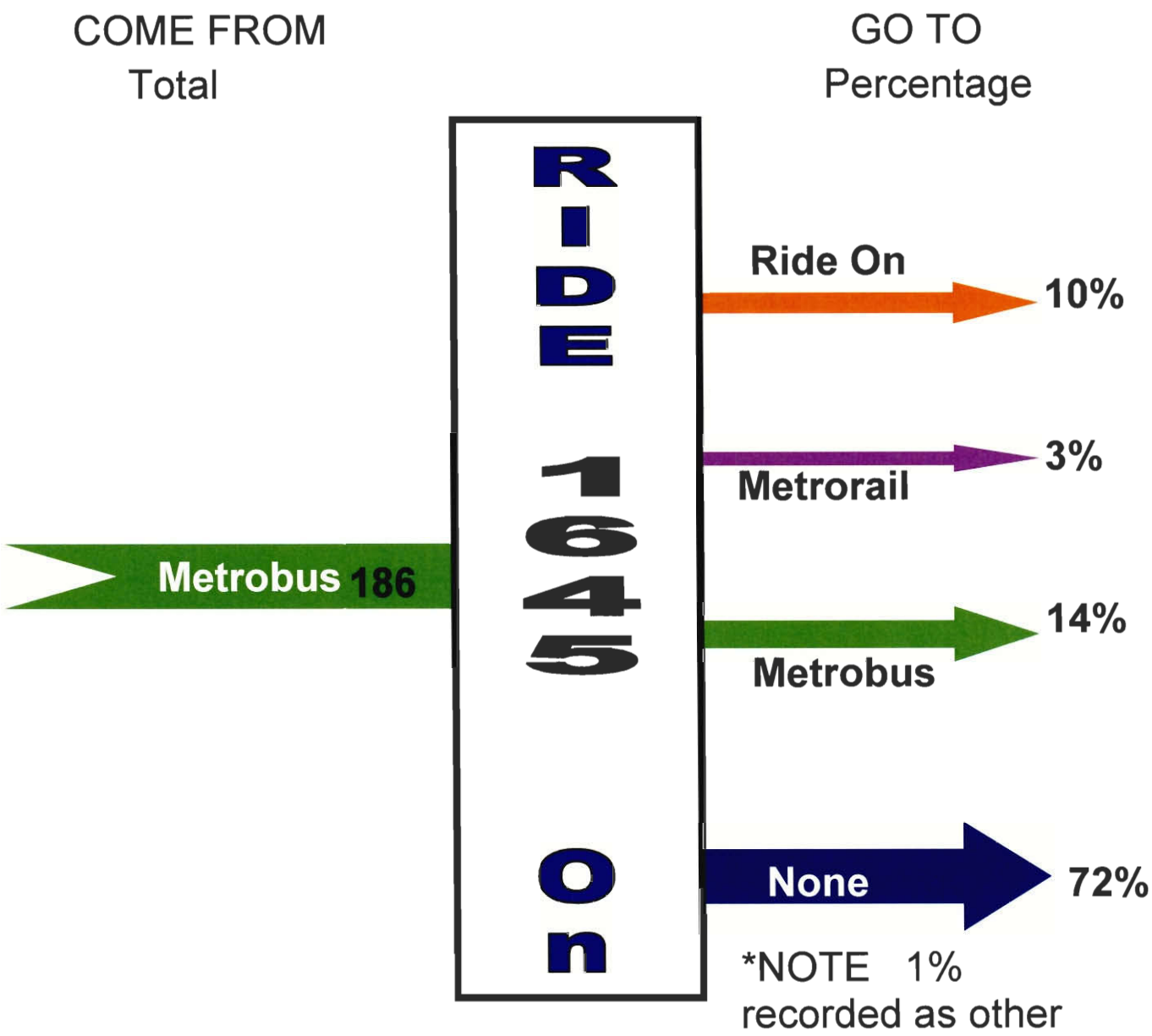


Figure 10E: Transfer Distribution From Metrobus

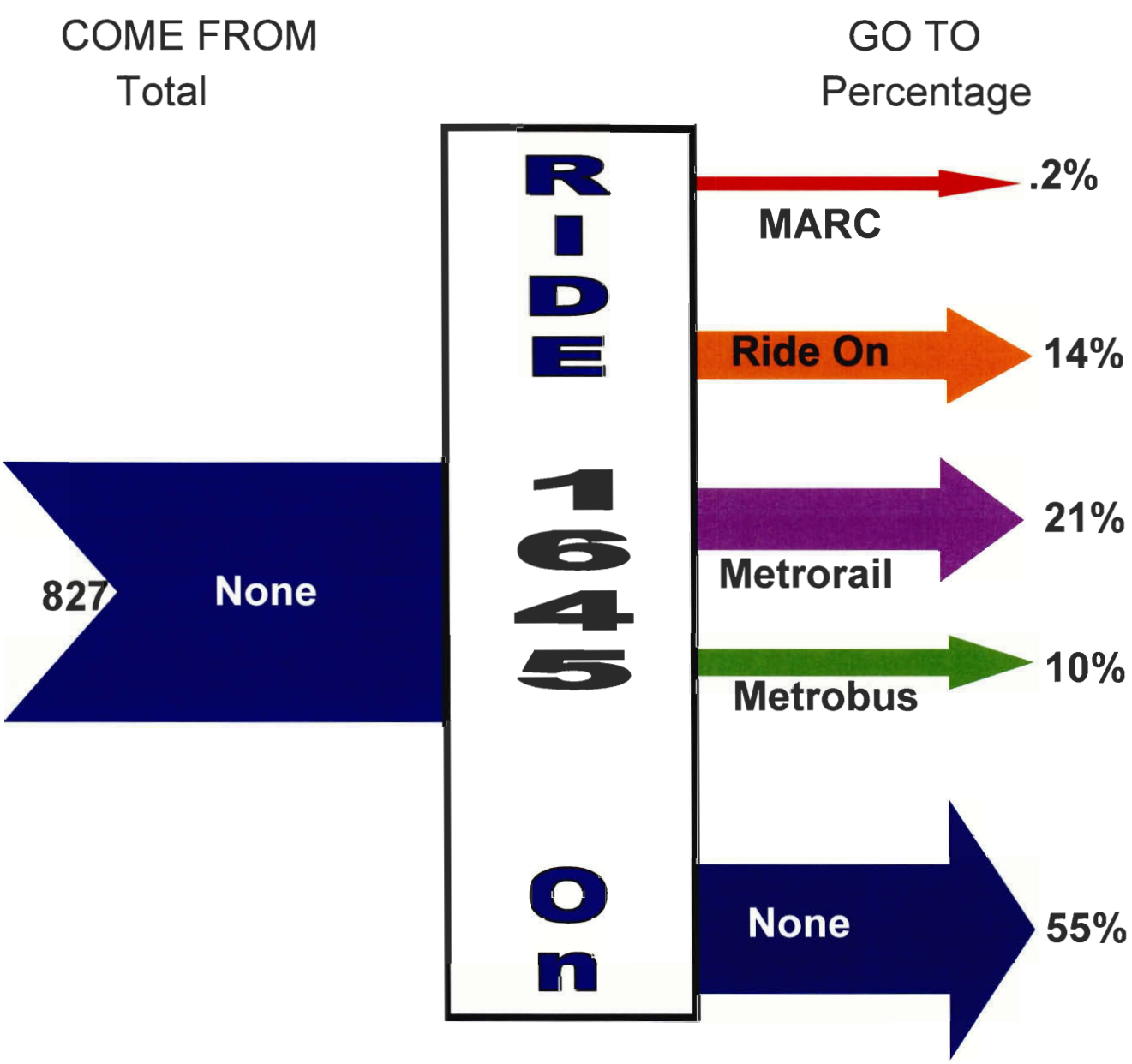


Figure 10F: Transfer Distribution Coming From Nothing

Appendix H Fare Types for Transit Vehicles in Montgomery County

Ride On

Territory:	Montgomery County (Maryland)	See Figure 9A
Days & Hours of Operation:	Sunday-Saturday 5:00am-12:00am	
Fares:	Regular Fare or Token	$1.20
	Senior/Disabled with Identification Card	$0.60
	Children under age 5	FREE
	Local Bus Transfer	FREE
	MetroRail-to-Ride On Bus Transfer	$0.35
	Senior/Disabled Transfer	FREE
	Regional One Day Bus Pass	$3.00
	Ride-About 2 Week Pass	$12.00
	Ride On 20-Trip Ticket	$13.00
	Youth Cruiser	$10.00
	Summer Youth Cruiser (June-July-August)	$15.00
	Bethesda 8 & VanGo Shuttles	FREE
	Students 18 & Under (Mon-Fri 2pm-7pm)	FREE

Metrobus

Territory:	District of Columbia, Maryland, Virginia	See Figure 9B
Days & Hours of Operation:	24 hours a day, 7 days a week	
Fares:	Regular Routes	$1.20
	Express Routes	$2.50
	Senior & Disabled	$0.60
	Bus-Bus Transfer	FREE

MARC

Territory:	Virginia, Maryland, West Virginia	See Figure 9C
Days & Hours of Operation:	Monday-Friday 5:00am-12:00am	
Fares:	General	$4.00-$13.00

Metrorail

Territory:	District of Columbia, Maryland, Virginia	See Figure 9D
Days & Hours of Operation:	Monday-Thursday 5:30am-12:00am	
	Friday 5:30am-3:00am Saturday	
	Saturday 7:00am-3:00am Sunday	
	Sunday 7:00am-12:00am	
Fares:	Minimum	$1.20
	Maximum	$3.60

Models Based on 100 Riders

	Washington Metropolitan Area Transit Authority, 2000	David Bone, 1999	Montgomery County Transit Group, 2003
Ride On	14	25	23.1
Metrobus	10	15	17
Metrorail	23	28	31.4
MARC	<1	0	0.6
CTC	0	0	0.1
MTA	0	0	0.1
Other	0	0	0.2
None	53	32	27.6
TOTAL	100	100	100.1

Figure 1: Models Based on Transfer Patterns

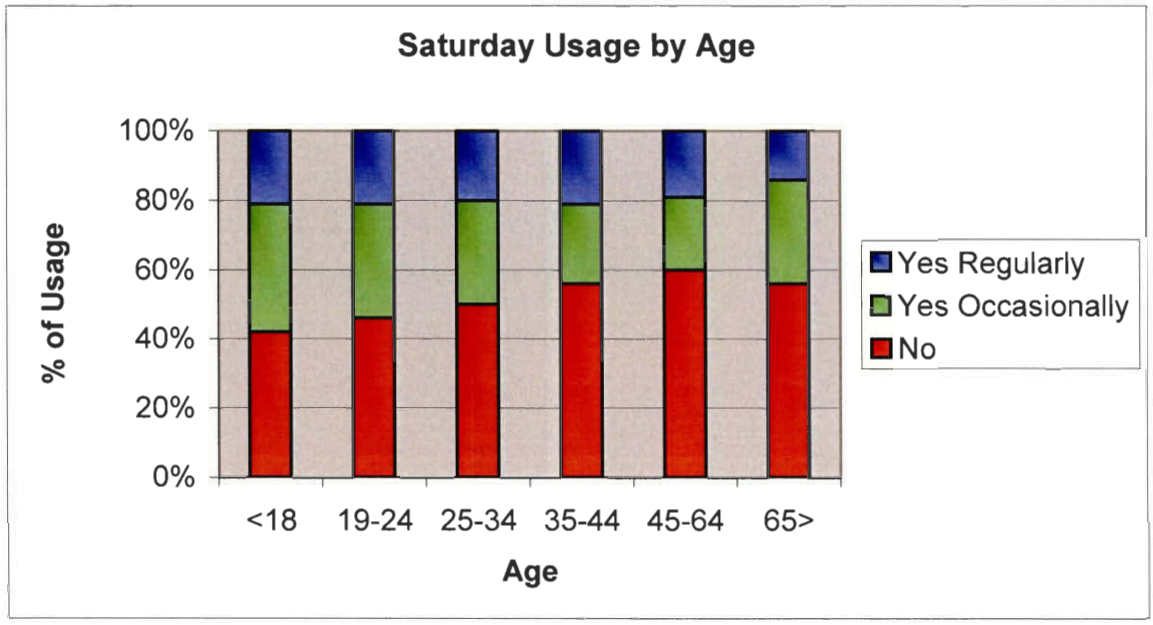


Figure 6A: Saturday Usage by Age

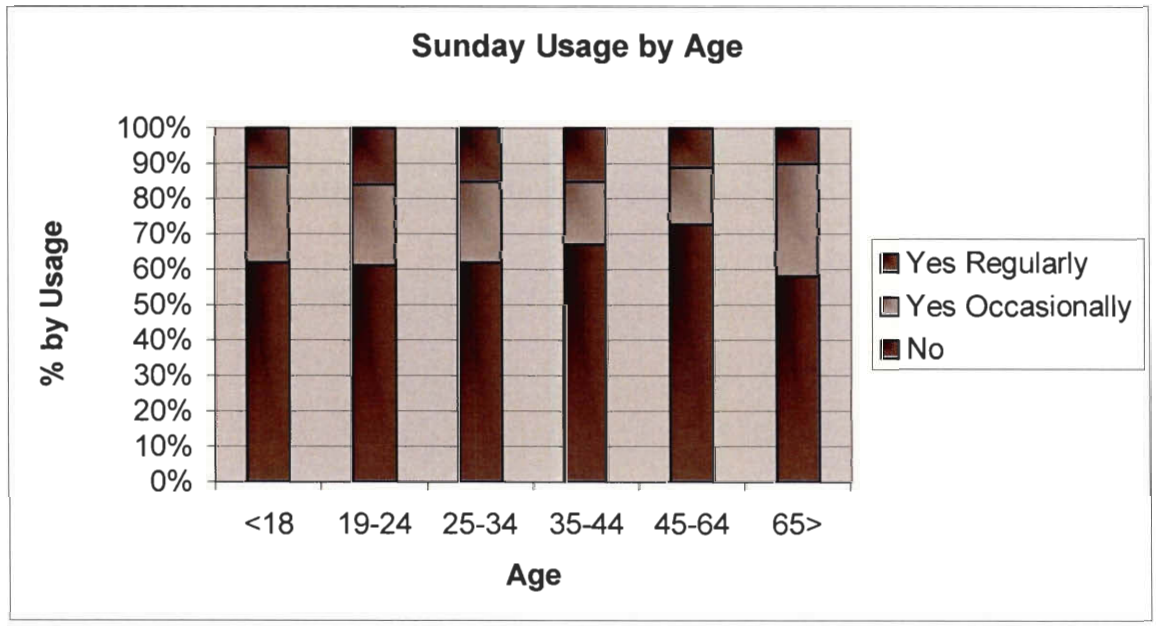


Figure 6B: Sunday Usage by Age

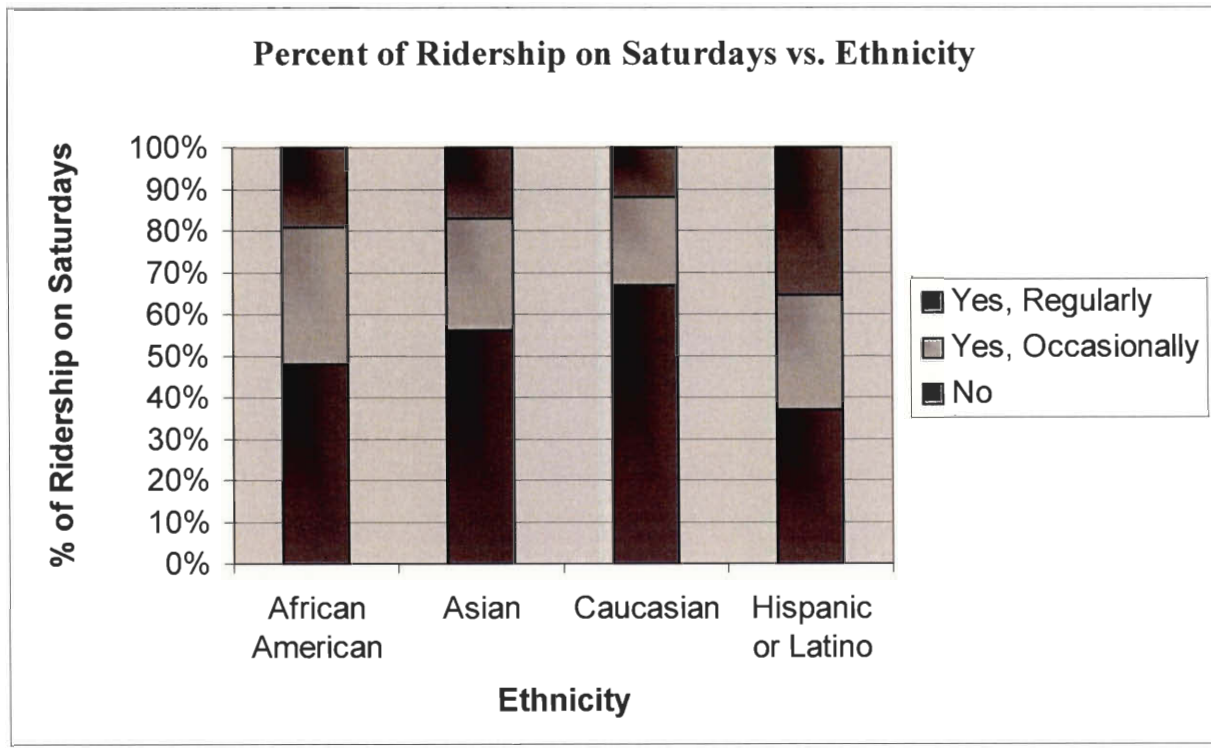


Figure 7A: Percent of Ridership on Saturdays vs. Ethnicity

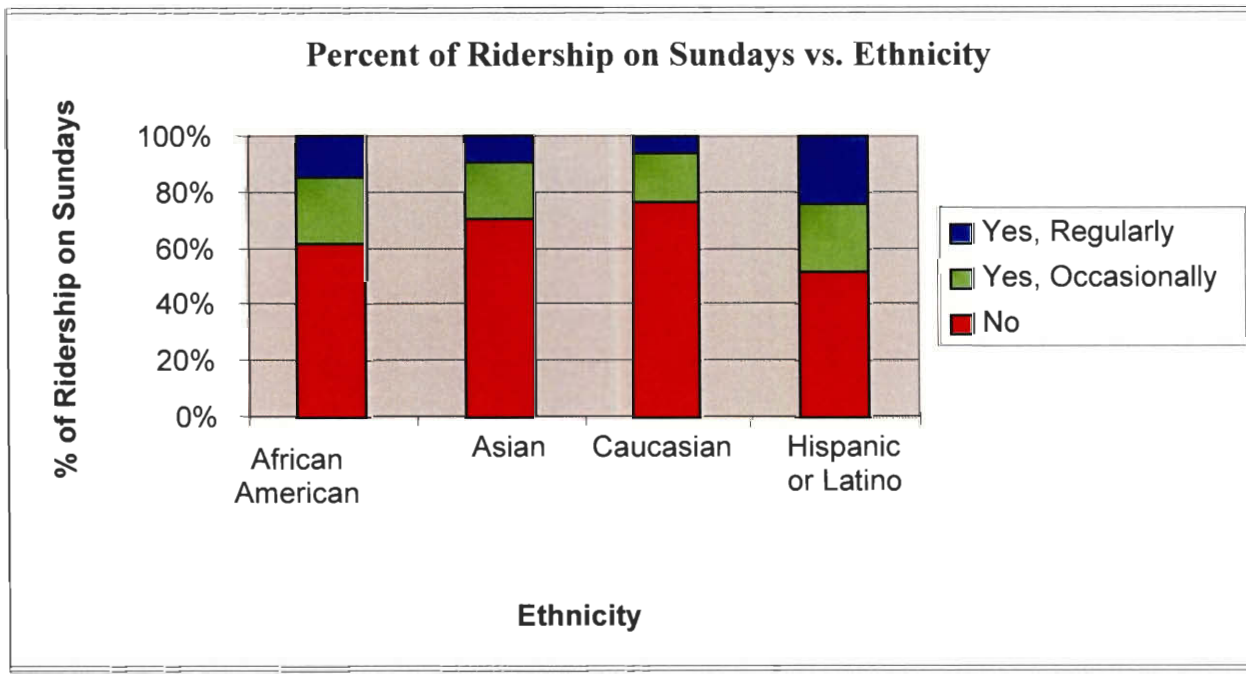


Figure 7B: Percent of Ridership on Sundays vs. Ethnicity

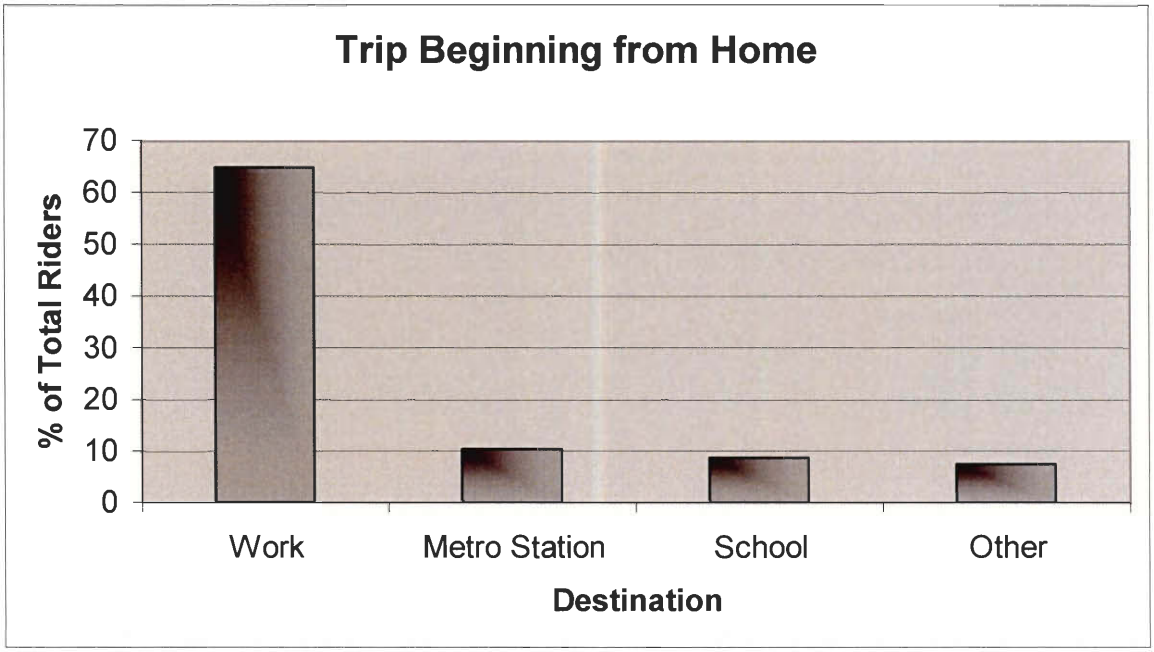


Figure 8A: Trip Beginning From Home

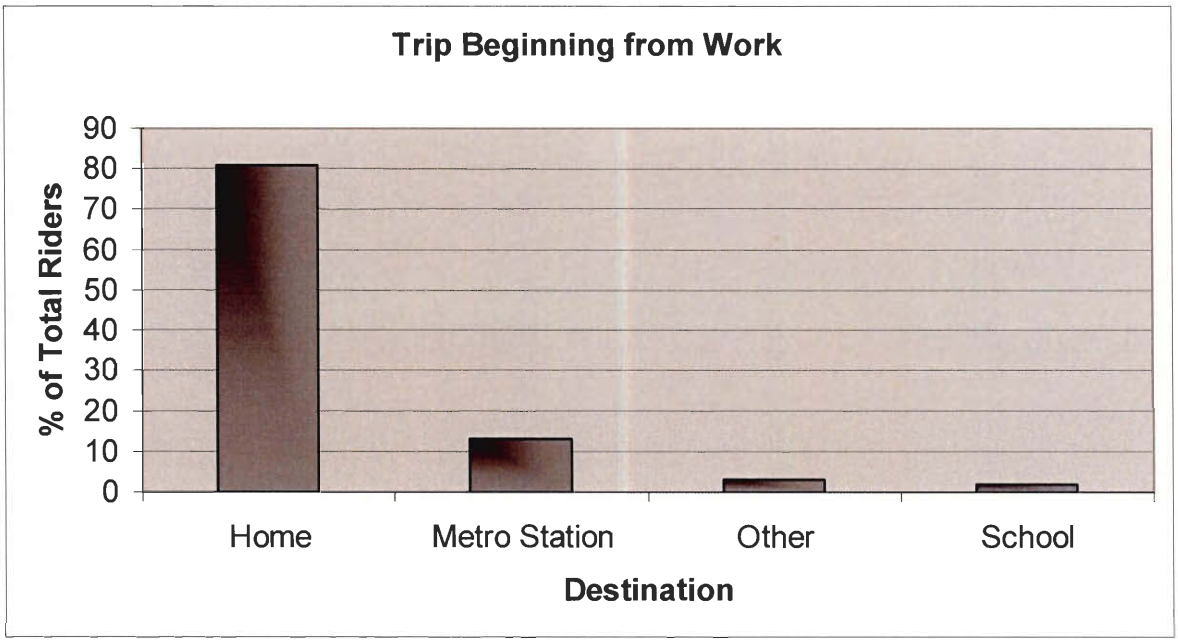


Figure 8B: Trip Beginning from Work

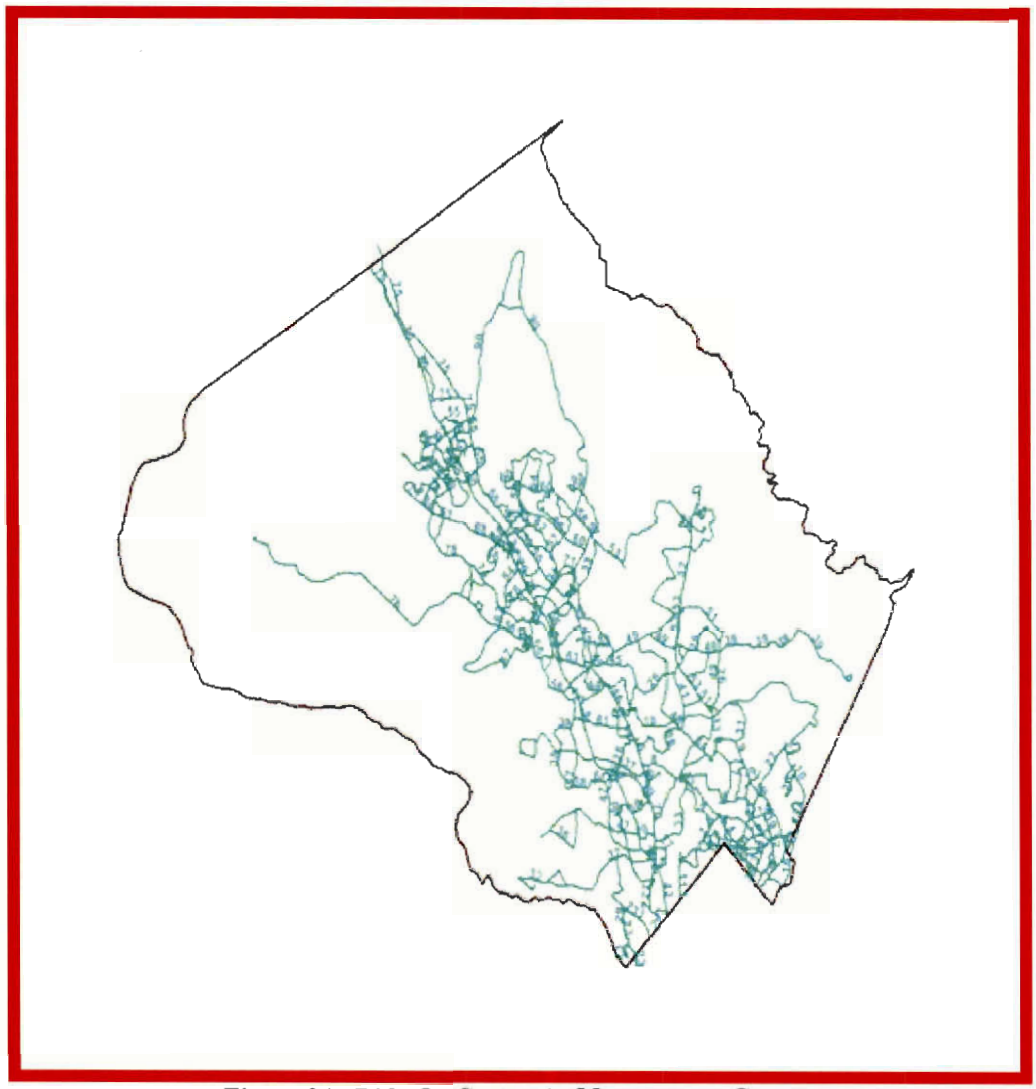


Figure 9A: Ride On System in Montgomery County

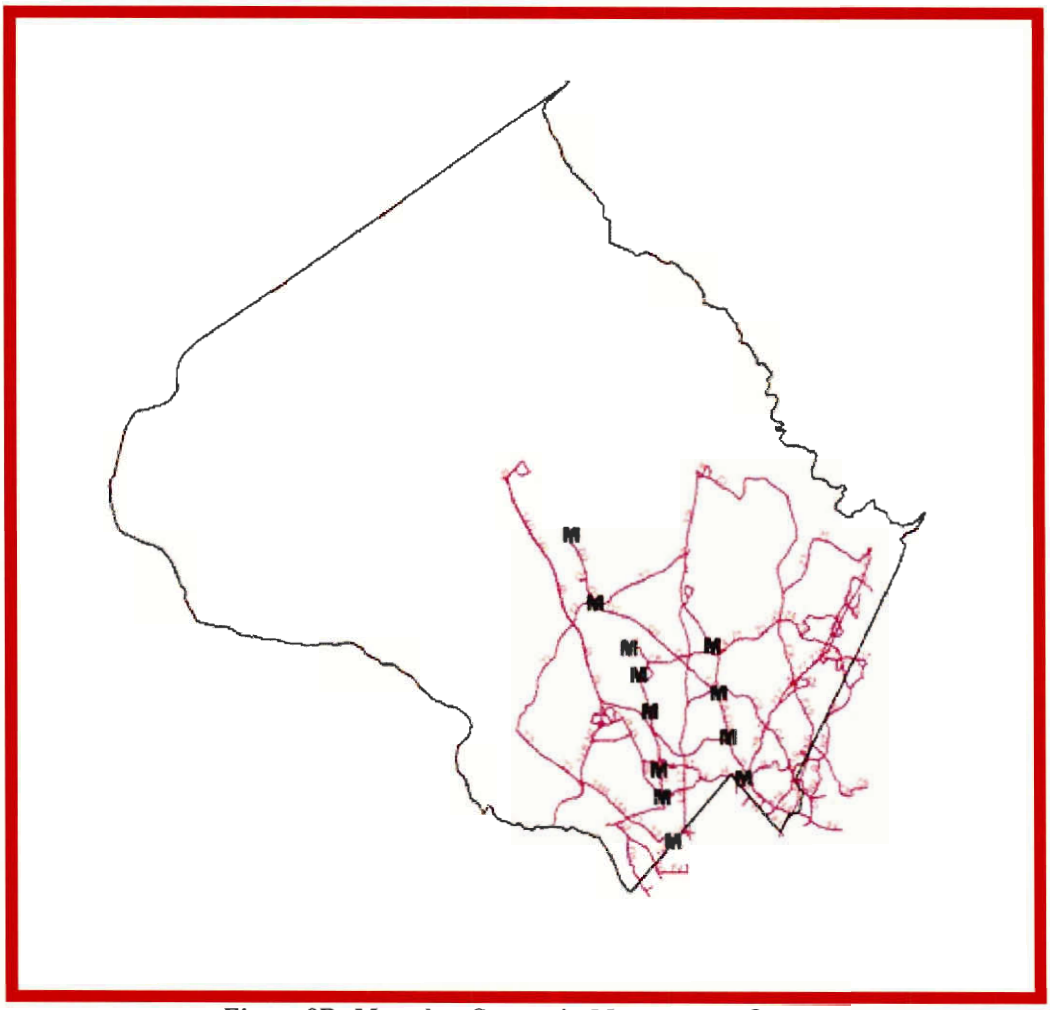


Figure 9B: Metrobus System in Montgomery County

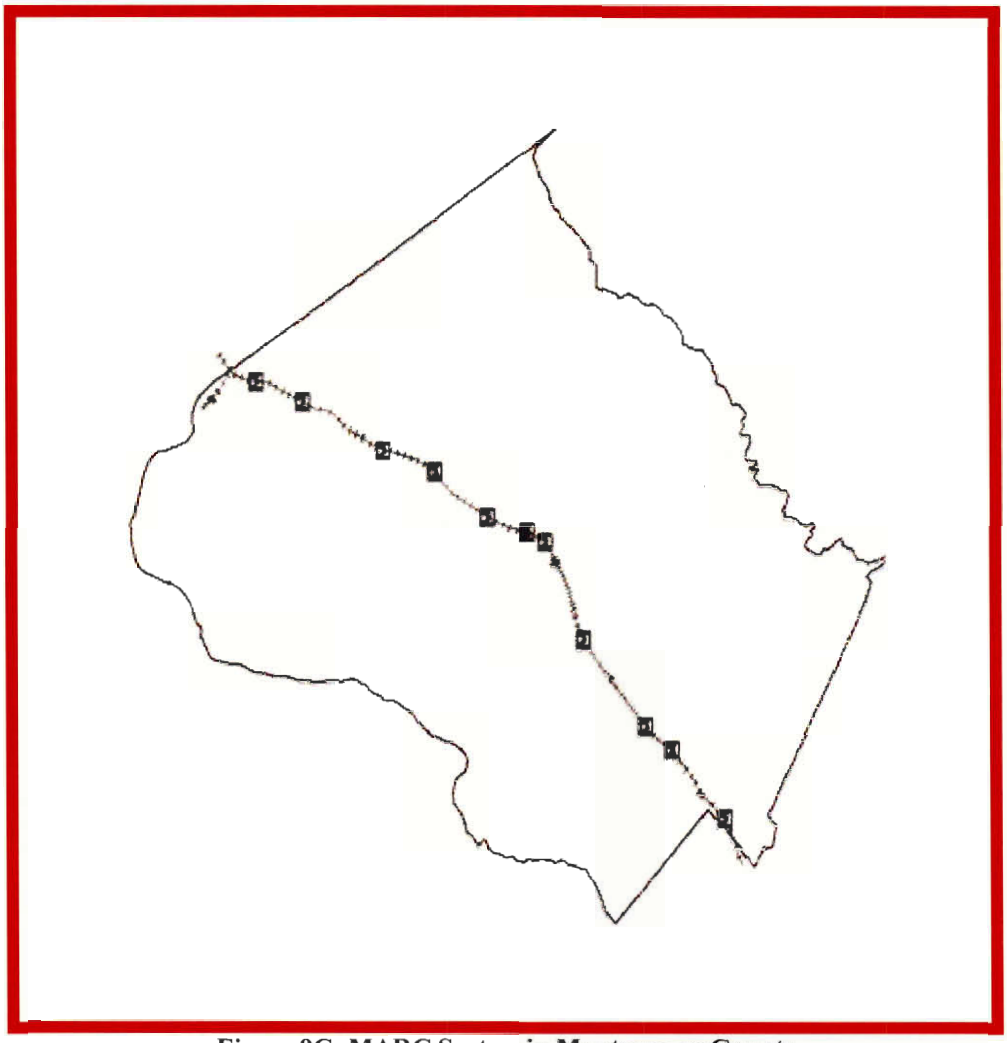


Figure 9C: MARC System in Montgomery County

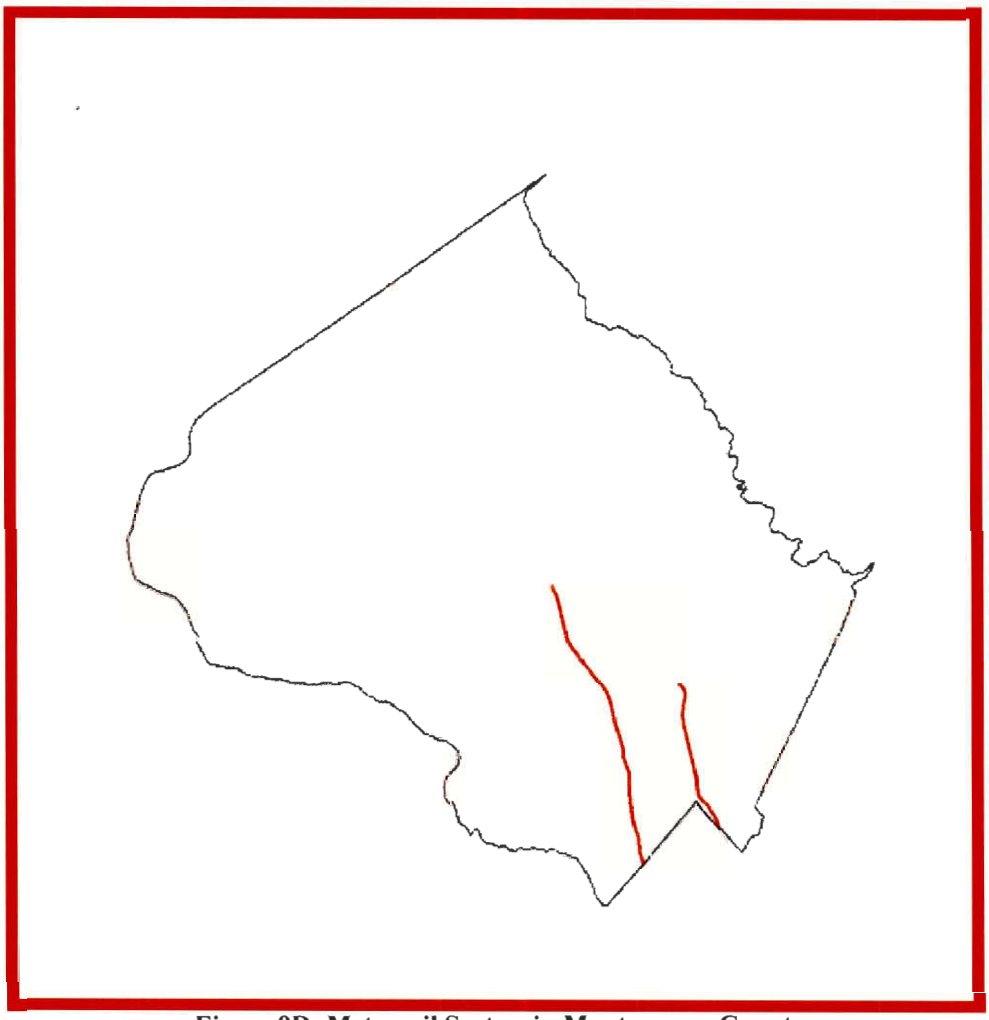


Figure 9D: Metrorail System in Montgomery County

8.0 Works Cited

Bethea, P. "Access to Public Transportation and Patterns of Career Development Among African-American Women." Oct. 1996. Women's Travel Issues Second National Conference.

Chow, Vernon. "MBTA System Wide Passenger Survey, Bus System 1995 (Quincy Garage)." 1997.

Converse, Jean M. Survey Research in the United States: Roots and Emergence 1890-1960. Berkeley: University of California Press. 1987

D'Arcier, Bruno Faivre. The Attempt To Find New Behavioral Hypotheses. INTRETS. August 2002.

Department of Public Works and Transportation. Homepage. 16 Oct. 2003. <http://www.dpwt.com>

Frank, Lawrence D. "An analysis of Relationships Between Urban From and Travel Behavior." July 1994. U.S. Department of Transportation, Federal Highway Administration. 9 Sept. 2003 <http://www.wsdot.wa.gov/ppsc/research/onepage/WA-RD3512.htm

Fink, Arlene. The Survey Kit. Vol. 1.6. Thousand Oaks: Sage. 1995

Fink, Arlene, Jacqueline Kosecoff. How to Conduct Surveys. Beverly Hills. Sage. 1985

Fredrich, Markus, Peter Mott, and Klaus Noekel. "Keeping Passenger Surveys Up to Date: A Fuzzy Approach." Transportation Research Record 1735 (2001): g5-37

Freeth, Stephanie. The Experience of the British National Travel Survey. Office for National Statistics. August 2002.

Kunert, Uwe, Jutta Kloas, and Hartmut Kuhfelf. "Design Characteristics of National Travel Surveys: International Comparison for 10 Countries." Transportation Research Record 1804 (2000): 107-115.

Levinson, Herbert and et al. Bus Rapid Transit Volume 1: Case Studies in Bus Rapid Transit. Washington: Transit Cooperative Research Program Report 90, 2003.

Litwin, Mark. The Survey Kit. Vol 7. Thousand Oaks: Sage. 1995

Los Angeles Metro Rapid Demonstration Program. Federal Transit Administration. Homepage. 16 Oct. 2003. <http://www.fta.dot.gov/brt/docs/montgomery.pdf>

Maryland Transit Administration. Homepage. 16 Oct. 2003 <http://www.mtamaryland.com/schedules/marc/marc_schedule.cfm>

Montgomery County. Homepage. 16 Oct. 2003 <www.montgomerycountymd.gov>

Montgomery County Department of Public Works. Viers Mill Road Bus Priority Project. <http://www.fta.dot.gov/brt/projects/montgomery.html>

National Academy Press. Effective Approaches To Meeting Rural Intercity Bus Transportation Needs. Washington: Transit Cooperative Research Program Report 79, 2002.

National Academy Press. Estimating the Benefits & Costs of Public Transit Projects: A Guide For Practitioners. Washington: Transit Cooperative Research Program Report 78, 2002.

Newnan, Isadore, Kieth McNeil. Conducting Survey Research in the Social Sciences. New York: University Press of America, Inc. 1998

Pisarski, Alan. "Recognizing, Creating, and Marketing Survey Quality: Guidelines for Quality Assurance in Travel and Activity Surveys." 2000. Transportation Research Boars 12 Sept. 2003 <http://Gulliver.trb.org/publications/circulars/ec008/front_matter.pdf>

Richardson, A.J. and Helen Battellino. Some Emerging Trends In Travel Surveys in Australia. Transport Research Centre and Transport Data Centre. August 2002.

Seethaler, Rita. The 1994 Microcensus on Transport Behavior: A Case Study of Switzerland. Bureau for Transport Studies. August 2002.

Simon & Simon Research Associates. Public Transit Board Governance Guidebook. Washington: Transit Cooperative Research Program Report 85, 2002.

Smerk, George M. Urban Mass Transportation: A Dozen Years of Federal Policy. Bloomington & London: Indiana University Press, 1974.

Society of Automotive Engineers, eds. Proceedings on the Intersociety Conference on Transportation. Society of Automotive Engineers, 1972.

Taylor, Brian, Brent Boyd, Daniel Baldwin Hess, Hiroyuki Iseki and, Allison Yoh. "Increasing Transit Ridership:Lessons from the most successful transit systems in the 1990's." MTI Report 01-22. June.2002. <http://transweb.sjsu.edu/publications/transitridership2/TransitRidership_7_16.htm>

TRB Bus Transit System Committee. "Concerting from Paper to Plastic: Fare Collection Case Study of Washington, D.C. Region." TRB Committee Newsletter April 2001: Vol.1 No. 2 pg. 5.

United States Department of Transportation- Federal Highway Administration. Case Study: Montogomery County, Maryland. August 1999.

U.S. Census Bureau. "History and Organization." Factfinder for the Nation CFF-4 (2000). May. 2000 <http://www.census.gov/prod/2000pubs/CH-4.pdf>

U.S Census Bureau. United States 2000 Census. (2000). May. 2000 <http://www.census.gov/>

van der Reis, Patricia. Transportation Surveys Among Illiterate and Semiliterate Households in South Africa. TRC Africa (PTY) Ltd. August 2002.

Washington Metropolitan Area Transit Authority. Homepage. 16 Oct. 2003. < http://www.wmata.com>

Washington Metropolitan Area Transit Authority. Regional Bus Study. June 2002.
<http://www.wmata.com/about/expansion/bus/presentations/mont1.pdf>

Weisberg, Herbert F, John A Krosnick, and Bruce D Bowen. An Introduction to Survey Research, Polling, and Data Analysis. London: Sage. 1996

Worcester Regional Transit Authority. Worcester Regional Transit Authority: Problems & Options Report 02-01. Worcester Regional Research Bureau, 8 Jan. 2002.