

Chained Trips in Montgomery County, Maryland

BY AJAY KUMAR AND DAVID M. LEVINSON

Increased participation of women in the labor force and the suburbanization of households and jobs have all altered traditional home-to-work and work-to-home commuting patterns. With increasing time spent at work by women, less time is available to perform nonwork activities. Associated with increasing work force rates is rising mobility. Vehicle ownership in many areas has reached the level of almost one car per licensed driver. The pattern of the single worker in a household returning home to share the car with nonworking household members has become less common; multiple household workers share chores such as shopping, and perform them before returning home. Suburban, drive-alone commuters find it easier to perform activities before returning home in the evening. These factors all result in a large amount of trip chaining—defined here as performing nonwork activities on the journey between home and work.

Several studies in the past decade have analyzed commuters' trip-chaining behavior in which a stop for nonwork activities is introduced to the home-work-home travel pattern.¹⁻²⁰ The recent study of trip chaining by Strathman and Dueker (1994), based on the 1990 Nationwide Personal Transportation Survey, underscores the need to understand these complex activity patterns.¹⁹ Consolidating nonwork and work trips can be viewed broadly within the paradigm of "bounded rationality": people respond

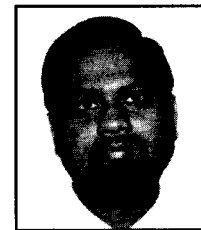
to changing urban form, demographic and life-cycle stages and rising congestion by pursuing several activities along a single trip chain to achieve travel economies. The growth in female employment and the increase in per capita income on the one hand, and the need to accommodate different daily chores within the 24-hour day on the other hand, have resulted in an emergence of complex travel patterns on a scale not known 25 years ago.²¹

This article presents the results of ongoing research into the nature of trip-chaining behavior, using travel data from a general home interview survey conducted in the Washington metropolitan region in 1987-88. Unlike earlier studies, which often used specially designed surveys or a national survey, the availability of travel characteristics for a large sample in a specific city makes it possible to analyze activity patterns in detail.

This article focuses on the nature of trip chains during both the morning and afternoon commutes. Answers to specific questions are sought, including: What proportion of trips involve multiple stops? What differences are there between morning and afternoon commutes? What differences are there between male and female commuters? To what extent does mode use influence trip chaining? What activities are most likely to be consolidated with work trips? What is the average layover of each stop on the chain? Is the relative frequency of trip

linkages influenced by commuting distance?

Analysis reveals that trip-chaining behavior is related to gender, mode of travel, and location within the metropolitan region. Residents of areas closer to the central city are less likely to link work and nonwork activities compared with those living in the outer suburbs. Commuters chain multiple



Ajay Kumar is a transportation modeler with the Montgomery County Planning Department and a consultant on transportation in developing countries. He holds a doctorate in urban and regional planning from the University of Southern California.



David M. Levinson, AICP, was a transportation modeler with the Montgomery County Planning Department when this article was written, and is now at the University of California at Berkeley. He earned his bachelor's degree in civil engineering from Georgia Institute of Technology and his master's degree from the University of Maryland. He is an Associate Member of ITE.

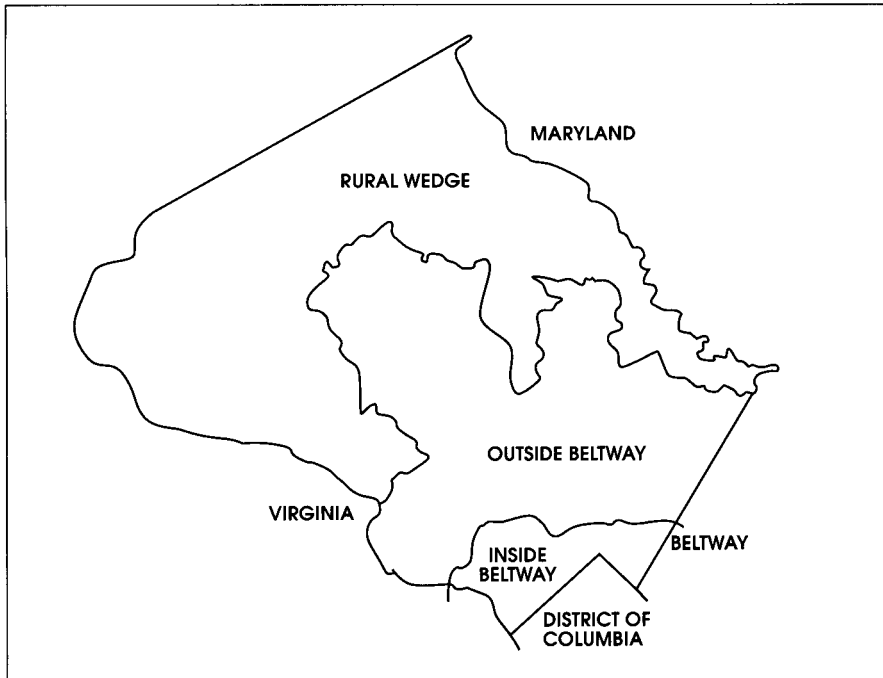


Figure 1. Montgomery County.

activity in the afternoon more than the morning. Women chain more than men. Shopping, personal business and social activities are the activities most often linked to work trips.

Table 1. Commuting Trip Volume by Number of Intermediary Stops During Morning and Afternoon Peak Period

Stops	Person Trips
Home to Work (morning peak period)	
0	245,928
1	35,646
2+	6,258
Total	287,832
Work to Home (afternoon peak period)	
0	187,447
1	57,022
2	18,249
3+	8,397
Total	271,115

Data Source: 1987-88 MWCOG Survey
 Note: Estimated number of Montgomery County trips, using survey weights

Data

The data used in this study consists of a detailed person travel survey conducted by the Metropolitan Washington Council of Governments (MWCOG) for 1987-88. The survey contains a sample of about 8,000 households making 55,000 trips, as well as weights to expand the survey to represent the population at large. Each household was assigned a specific 24-hour "travel day," and each household was asked to report all trips. A trip was defined as one-way travel from one address to another. The location of both origin and destination was reported along with purpose and time of the trip. The information on trip purpose at both the origin and destination ends was used to identify trip chains. A nested file structure was created (using FORTRAN programs) to group the trip data into a number of separate file structures, each identified by origin and destination purpose. All trips with work as the ultimate destination during the morning peak period (6 to 9 a.m.) and work as the origin purpose during the afternoon peak period (3:30 to 6:30 p.m.) were identified. The layover of each trip was computed as the time between arrival at one location and departure for the next.

Region of Study

The geographic focus of this study—Montgomery County, Maryland—had 750,000 residents and 415,000 jobs in 1990. In the past few decades, the county has grown rapidly in both population and employment, and has emerged as a major employment center. For purposes of this analysis, the county is divided into three areas: inner suburbs (the area between the District of Columbia and the Capital Beltway), outer suburbs (the suburban areas outside the Beltway), and the rural "wedge" area (see Figure 1).

Results

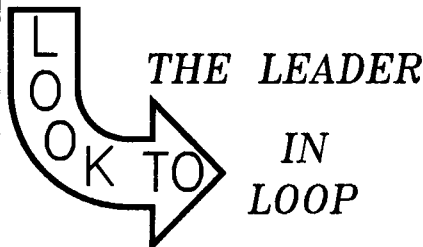
Table 1 shows the volume of work trips by number of trips during the morning and afternoon peak period. About

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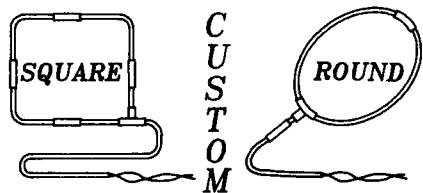
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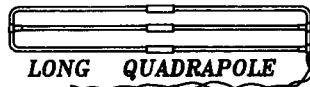
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Table 2. Percentage of Simple and Complex Trips, by Number of Intermediary Stops, during the Journey to/from Work, by Mode and Sex

Region Stops	Morning Home to Work Commute				Afternoon Work to Home Commute			
	Transit		Automobile		Transit		Automobile	
	Male	Female	Male	Female	Male	Female	Male	Female
Inside Beltway								
0	100.0	100.0	86.5	83.6	87.7	86.7	77.7	66.2
1	0.0	0.0	11.0	14.0	12.3	10.3	15.1	23.2
2	0.0	0.0	2.5	2.4	0.0	0.0	4.0	5.3
3+	0.0	0.0	0.0	0.0	0.0	0.0	3.2	5.3
Outside Beltway								
0	100.0	100.0	84.8	81.2	85.0	81.1	76.6	63.1
1	0.0	0.0	13.1	16.8	11.4	9.3	17.0	26.1
2	0.0	0.0	2.1	2.0	3.6	9.6	5.1	7.4
3+	0.0	0.0	0.0	0.0	0.0	0.0	1.2	3.4
Rural Wedge								
0	100.0	100.0	82.8	100.0	63.3	53.9	69.7	60.5
1	0.0	0.0	17.2	0.0	36.7	46.1	19.3	21.9
2	0.0	0.0	0.0	0.0	0.0	0.0	7.5	14.1
3+	0.0	0.0	0.0	0.0	0.0	0.0	3.5	3.4

Data Source: 1987-88 MWCOG Survey

290,000 work trips are made during the morning peak period (6 to 9 a.m.) The 290,000 trips represent a weighted expansion of the survey data for Montgomery County residents. Of these trips, 15 percent are home-to-work trips with at least one nonwork activity. In contrast, 31 percent of the 270,000 afternoon peak period (3:30 to 6:30 p.m.) work trips are linked to nonwork activities, involving one stop (21.1 percent), two stops (6.7 percent), or three or more stops (3.1 percent). The greater number of trips in the morning is due to the longer duration of the afternoon peak. Table 2 shows the percentage of simple (no stop) and complex (one or

more stops) commuting trips by sex and mode for both the morning and afternoon commutes, for residents of the three geographic areas in Montgomery County. Transit trips are considered "chained" if they involve multiple non-transportation activities. (Transferring from bus to rail or rail to walk is not considered a chained trip here.) Findings showed that women make more chained trips than men, and that automobile commuters chain more than transit users. The flexibility of the automobile facilitates making stops and diversions on the commute trip; commuters needing this flexibility are more likely to drive.

Table 3. Percentage of Activities Pursued on Complex Work Trips

Region	Trip Purpose	Morning Home to Work	Afternoon Work to Home
Inside Beltway			
	Shop	7.5	20.3
	Serve Passenger	54.0	21.1
	School	14.5	5.3
	Other	24.0	53.4
Outside Beltway			
	Shop	5.8	35.9
	Serve Passenger	57.7	18.5
	School	18.4	3.2
	Other	18.1	42.3
Rural Wedge			
	Shop	0.0	37.4
	Serve Passenger	63.3	17.9
	School	14.0	6.7
	Other	22.7	38.0

Data Source: 1987-88 MWCOG Survey

Kitamura [1989], among others, has suggested there exists a time-space budget, wherein commuters with longer commutes will consolidate trips to save time.¹² We examine this by stratifying the data by three geographic areas. Accessibility is a measure of how many places (for instance, jobs) can be reached in how much time: People living in areas with high accessibility can reach many places in a relatively short time; in areas with lower accessibility, they could reach fewer places in the same time, or the same number of places in a longer time. Clearly, levels of accessibility vary by the speed of travel between places—the higher the speed, the greater the accessibility. Given the nature of mass transit in metropolitan Washington, the amount of accessibility by area is lower than by auto. Also, the ratio of accessibility in the outer suburbs to inner suburbs by transit is much lower than the same ratio by automobile.²²

It is posited that people in high-accessibility areas would be less inclined to consolidate trips; people with lower levels of accessibility are more likely to consolidate trips to accomplish total travel needs. Residents living inside the Beltway have higher levels of accessibility than those who live outside the Beltway in suburban areas. Similarly, suburban residents have higher accessibility than residents of the lower-density rural areas. Thus, if a time-space budget exists, one would expect higher levels of chaining in the rural areas, followed by suburbs outside the Beltway. This hypothesis is consistently borne out for both genders and both auto and transit.

Table 3 provides a comparison of the activities pursued on trip chains in the morning and afternoon for the three geographic areas. It shows the percentage of nonwork activities (shopping, serve passenger [pick-up/drop-off], school and other) pursued during the work trip for each of the three areas. "Other" trips include social, recreational and personal business, but unfortunately these were not broken out in further detail in the survey. The predominant activity pursued on the way to work during the morning period is serving passengers, which constitutes between 50 percent and 60

Table 4. Percentage of Trips by Duration of Stop-Time at Intermediary Stops from and to Work

Trip Purpose	Duration of Stop Time (minutes)			
	0-5	6-15	16-30	>30
Serve Passenger				
Morning Home to Work	81.0	11.6	2.4	4.7
Afternoon Work to Home	64.7	22.6	6.5	6.2
Other Purposes				
Morning Home to Work	34.7	14.3	10.4	40.6
Afternoon Work to Home	14.4	12.8	8.3	64.5
Shop				
Afternoon Work to Home	3.2	9.4	34.3	53.1

Data Source: 1987-88 MWCOG Survey

Table 5. Percentage of Commuting Trips by Ratio of Travel Time from Home to Intermediary Stop (or Intermediary Stop to Home) to Total Travel Time

Trip Purpose	Travel Time Ratio			
	0-.25	.26-.50	.51-.75	>.75
Serve Passenger				
Morning Home to Work	34.4	37.5	18.2	9.9
Afternoon Work to Home	33.8	39.4	20.3	6.6
Other Purposes				
Morning Home to Work	27.7	37.3	23.4	11.6
Afternoon Work to Home	17.4	43.0	29.8	9.7
Shop				
Afternoon Work to Home	8.2	45.3	29.7	16.8

Data Source: 1987-88 MWCOG Survey

percent of all stops. In contrast, the most common purposes in the afternoon are shopping and "other" activities. The proportion of "serve-passengers" trips in the afternoon is expected to be smaller because the total number of linked trips is higher in the afternoon. Also, while school and work start at similar times in the morning, permitting the working parent to drop off their children at school, school generally lets out a few hours earlier than work. Thus the number of morning drop-off trips exceeds the afternoon pick-up trips.

Interestingly, the number of shopping stops in the outer suburbs and rural areas is almost twice that in the inner suburbs. This supports the earlier suggestion that people with different level of accessibility will exhibit different travel patterns. People with a high level of accessibility (as in the case of inner-suburb residents) are more inclined to make unlinked shopping trips because of relatively lower cost, as compared to those with a lower accessibility level.

Table 4 displays the percentage of

trips by stop time for serve-passenger, shopping, and other trips. More than 80 percent of the serve-passenger trips on the way to work in the morning are of less than five minutes duration. These involve mainly visits to day-care centers and dropping off passengers at transit stops. About 50 percent of the "other" activities pursued on the way to work are of less than 15 minutes duration. Considering the short duration of these visits, they are likely to be for personal business, such as going to the bank, the dry cleaner, the post office or the gas station. Unfortunately, it is not possible to address the issue more specifically in absence of a detailed description of "other" trips.

The activities pursued during the return trip from work in the afternoon period reveal a more interesting story. The serve-passenger trips involve, as in the morning, a short stop. The "other" trips, however, are of a considerably longer duration. Nearly 65 percent of the nonwork activities pursued on the return commuting trip are more than 30 minutes

long. By and large, they can be identified as discretionary activities, such as visiting friends, eating in a restaurant, or other recreational purposes. Shopping trips during the afternoon commuting trip are also of long duration (about 50 percent are more than 30 minutes).

In an absence of detailed information on the specific routes during each of the trips, it is not possible to analyze route choice or traffic distribution. However, it is interesting to examine whether activities pursued on intermediary stops are located closer to home or work. Table 5 displays the percentage of trips by ratio of travel time between the home and the first intermediary stop to the total travel time (or, in the afternoon, the ratio of travel time between the last intermediary stop and home to the total travel time). Total travel time represents the time taken to go from home to work (or work to home), including all the intermediary stops. It is calculated as the difference between starting time at home (or work) and the final destination time at work (or home), after subtracting the total stop time at each of the stops en route. Both serve-passenger and "other" trips are closer to home than work, while shopping stops are about halfway between work and home.

Conclusions

By examining a 1987-88 metropolitan Washington household travel survey, it is hoped some insight was gained into the nature of chained trips. Due to differing gender roles, women make more nonwork stops on the commute trip than men. The farther one lives from the center of the region, the more one conducts complex trips. Nonwork activities tend to be closer to home than work. To some extent, the growth in trip chaining has mitigated the increase in vehicle miles traveled one might expect in the outer suburbs. Given the large proportion of commuters who combine work and nonwork activities in complex trip chains, it is important that travel demand modeling reflect this complexity. However despite some attempts at this,²³ current models are clearly inadequate and further development is necessary.

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