

Urban Design, Urban Form, And Employee Travel Behavior

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Abstract

Personal travel behavior choices made by employees appear to be influenced by a number of urban design and urban form characteristics of their work place. Several important attributes include the density of development and the accessibility of non-work activities, such as eating at restaurants and shopping (frequently accompanied by a greater mix of land uses).

The research reported in this study focuses on travel choices made by employees during their commute to work and during their work day. Travel patterns were examined for employees in four different urban and suburban employment centers. The mix of uses varied from a virtual single use center to a full urban core with numerous types of activities. Walk accessibility to the various activity centers (or buildings) varied from site to site. The various sites also contain different levels of transit service.

Travel patterns recorded in a one-day diary format included the journey to work, trips made from the office to other non-work and work locations during the day, and the journey from work to home, including additional stops. These patterns resulted in trip chains of different lengths and different temporal distributions.

The research revealed strong relations between the various urban form/urban design characteristics and the total number of trips made per day, the total number of trips by individual modes (transit, walking, automobile), and the number of trips made by trip purpose. Differences in the number of auto starts and vehicle miles of travel were calculated. The data suggest dramatic differences in the travel patterns of employees with similar jobs and incomes depending on the urban character of the work place (including mix of land uses.)

An additional insight derived from the analysis was the difficulty in isolating the causal relationships between trip making and mode choice in relation to urban design, urban form and transit service variables. In many cases, the different characteristics of the travel experience occur in a synergistic format. For example, increased density, increased mix of uses, and high level transit service are all available at a single site. Another site may have a very low mix of uses, poor pedestrian accessibility and poor transit service, leading to either extremely high automobile use or reduced overall trip making.

As part of two transportation studies, a total of four employee travel surveys were developed and administered in employment centers located along Metrorail's Red Line between Downtown Washington, D.C., and the Shady Grove area in Maryland. Each of these areas has different urban form and urban design characteristics. The surveys were designed to determine differences in employee travel behavior among the areas. Among the survey objectives were to determine mode choice pattern for commuter trips and to investigate travel behavior during the work day.

Areas Surveyed

The four areas surveyed were the downtown CBD (Washington, D.C.), a suburban CBD (Bethesda, Md.), a suburban office campus (Rock Spring Park, Md.), and a suburban office/research park (Shady Grove, Md.). Bethesda is an inner suburb that has developed as a mixed use

node around the subway station. Rock Spring Park is an office campus located just outside the Capital Beltway and bounded on all sides by freeways. Shady Grove is located outside the Beltway at the suburban terminus of the Metrorail Red Line. Table 1 summarizes the characteristics of the different centers.

Survey Instruments

The surveys in Washington, Bethesda, and Rock Spring Park were administered as part of the Norfolk Downtown People Mover Study led by Douglas and Douglas, Inc. The Shady Grove survey was conducted by Parsons Brinckerhoff Quade and Douglas, Inc., as part of the Rockville-Shady Grove Area

Transit/Land Use

Study. Each of the

four survey instruments contained major sections covering:

1. The journey to work;
2. Trips made during the work day;
3. Trips made after work; and
4. Demographic questions.

Table 1: Summary of area characteristics

Measure	CBD	Suburb CBD	Campus	Park
Employees (000)	400	20	15	16
Density (FAR)	~ 5	~ 1	~ 0.5	~ 0.3
Metrorail Stations	many nearby	one at center	2 miles	1-3 miles
Land Use Mix	full	local	none	none
Pedestrian Environment	very good	good	fair	poor

The Shady Grove Area survey included some additional questions regarding deterrents to transit use and carpooling. Additionally, questions inquiring about the effectiveness of various incentives for transit use and carpooling were included.

Businesses in the study area were separated into two strata based on their tenancy status. Firms occupying 90% or more of a building were placed in a single tenant category which carries with it certain intangibles such as full control over parking. A stratified random sample technique was used in administering the survey to ensure data was collected on employees in both single-tenant and multiple-tenant buildings. The administration was divided into four basic phases: inventory, communication, distribution, and collection.

In the inventory phase, each building in the target area was classified as single tenant or multiple tenant. The approximate number of employees who work in single tenant buildings and multiple tenant buildings were estimated based on building size. Firms were selected randomly from each group until the sampling target was reached. Some firms refused to participate and were dropped from the list.

In the communication phase, building managers and employers were asked for permission to distribute the surveys and to confirm the number of employees at each site. The distribution phase followed immediately with delivery of the survey instruments to the participating employees. After about a week, the collection phase began. Surveys were picked up and reviewed for completeness. Where appropriate, interpretive staff editing was used to make surveys usable.

In total over 8,000 surveys were distributed and approximately 3,000 were returned for an overall

response rate of 35%. Table 2 shows the response rates in each of the survey areas.

Demographic Characteristics Of The Employee Population

The surveys included an optional section to determine demographic characteristics of the employee population (gender, age, ethnicity, occupation, auto ownership, income). Most respondents answered these questions.

Only when asked about income did the response rate drop off (by 15% in Shady Grove, for example). Clearly this question was appropriately placed, at the end of the survey.

Similar employment mixes were observed in each area. Table 3 provides a summary of the responses. The portion of respondents indicating they worked in a sales position was greater in the suburban locations than in the downtown.

Household income data was requested in the form of a multiple choice question. As a result, the resulting calculations of mean and median income are very rough. However, they do speak to the similarity of the demographic characteristics of the individuals surveyed. Table 4 presents a summary.

Male employees accounted for 53% of the returns. 47% were from female employees. Proportionally, more female workers responded to the survey in the CBD than in the other areas. Table 5 presents the distribution of respondents by gender.

Findings

Journey-to-work Travel Behavior

In the well-served downtown CBD area, nearly 58% of respondents took transit to work. Another 3.9% of respondents walked to work. This is in sharp contrast to the mode split in the suburban office/research park area where only 3.9% of respondents reported using transit or walking. Table 6 summarizes the responses for journey-to-work mode choice.

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A recognized contributor to the use of automobiles for commuting purposes is the availability of cheap, convenient parking during the day. In the case of the Rockville-Shady Grove Study Area, virtually every vehicle received

Table 2: Summary of response rates

	CBD	Suburban CBD	Campus	Park	Total
Distributed	2,398	2,163	884	3,299	8,744
Completed	815	782	403	1,027	3,027
% Returned	34%	36%	46%	31%	35%

Table 3: Summary of reported occupation

Description	CBD	Suburban CBD	Campus	Park	Average
Sales	2.3%	6.6%	14.5%	6.9%	6.6%
Office/Clerical	22.4%	23.9%	24.7%	19.0%	21.9%
Service	1.9%	3.3%	0.3%	4.8%	3.0%
Prof/Tech	67.5%	63.7%	58.0%	65.0%	64.4%
Prod Foreman/Worker	0.8%	1.2%	0.0%	1.1%	0.9%
Other	5.1%	1.3%	2.5%	3.2%	3.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

parking free to the user (96.7% parked at their office in an employee lot). In contrast, only 27% of downtown CBD employees had free parking. Table 7 shows the relationship between parking cost and respondents reporting they drove to work.

Midday Travel Behavior

Employees were asked to record data for the first four midday trips after the commuting trip to work. The total midday trips, particularly the trips per employee, seem to decline as the amount of mixed use and density of development declines. The data revealed that employees in the CBD make over 40% more trips than their counterparts in the suburban office/research park. The midday trips for employees represent all trips, by all modes, for all purposes. Figure 1 illustrates the differing midday trip rates of the four areas surveyed.

Table 8 indicates the trip purposes for the midday trips. The data reveal that many more downtown midday trips are for eating or

personal business than in the suburban office/research park. The suburban CBD shows similarities with the downtown CBD, while the suburban office campus is similar to the suburban office/research park. The clustered mix of activities at the CBD locations seems to

contribute to the ability of the workers to address personal needs during the midday.

Table 9 presents a summary of the travel modes used to access midday activities in each of the survey areas. A striking contrast is presented between the use of the automobile versus walking to accomplish midday activities in the suburban office environments as compared to the CBD environments. In the single-use centers there are few destinations within walking distance. In the CBD environments many activities are within walking distance to the places of employment.

Vehicle trip making was calculated for each of the surveyed areas. Vehicle trips are those trips which require an automobile for either the driver or a passenger. The calculated vehicle trips per employee represents the number of vehicle trips generated for each employee, not just those employees who make a trip. This method results in the best picture of the conduct of the overall population. It's easy to notice that the vehicle trips per employee go up dramatically as the density of development declines (Table 10).

The table shows that while more midday

Table 4: Summary of reported annual household income^a

	CBD	Suburban CBD	Campus	Park
Mean	\$47,500	\$50,500	\$50,500	\$71,000
Median	\$47,500	\$71,500	\$71,500	\$62,500

a. Figures reported in 1993 dollars.

Table 5: Gender of respondents

	CBD	Suburban CBD	Campus	Park	Average
Female	60.5%	53.5%	53.7%	46.1%	53.0%
Male	39.5%	45.5%	46.3%	53.9%	47.0%

Table 6: Journey-to-work mode shares

	CBD	Suburban CBD	Campus	Park
Auto-Driver	29.3%	76.7%	94.4%	90.5%
Auto-Passenger	6.8%	5.3%	2.7%	5.6%
Transit	57.5%	14.1%	2.7%	2.7%
Walk	3.9%	2.7%	0.2%	0.2%
Other	2.5%	1.2%	0.0%	1.0%
Total	100.0%	100.0%	100.0%	100.0%

trips are made per employee in the CBD areas than in the suburban office areas, these are mostly non-vehicle trips. The result is a much higher vehicle trip rate observed in the suburban office areas than in the CBD areas. When we incorporate the distances traversed in the vehicles, and normalize the resulting vehicle-miles traveled figure for each area to that of the downtown CBD, a very clear picture emerges (Figure 2). Employees in the suburban office/research park generate nearly 15 times the VMT per employee as those in the downtown CBD while making less than 65% as many trips.

After-work Travel Behavior

The after work travel behavior of commuters was found to be similar across all centers. Roughly 50% of respondents in each area type reported making trips to a place other than home immediately after work. It was thought

that the portion of respondents making evening trips might be less in the CBD area types than in the suburban office park environments because at least some of the needs of the employees may have been met during the midday. Instead, it seems that in large part midday trips are not substitutable for evening trips. The major trip purposes of the evening trips were for personal business (31%), shopping (27%), and child care (11%). Perhaps many of the shopping trips are for buying groceries which could not have been purchased during the day, and certainly the majority of the child care trips could not have been substituted with midday travel.

Daily Trip Characteristics

Table 8: Midday trip purpose^a

Purpose	CBD	Suburban CBD	Campus	Park
Eating	50.7%	46.9%	37.6%	31.1%
Company Business	25.2%	27.5%	41.8%	40.5%
Personal Business	29.7%	28.7%	18.2%	23.7%

a. Figures do not total 100% because more than one trip may be reported during the midday.

Table 7: Auto-drive mode share and parking cost

	CBD	Suburban CBD	Campus	Park	
Auto-Driver Share	29.3%	76.7%	94.4%	90.5%	
Parking cost	Free	26.9%	47.1%	91.7%	98.3%
	Subsidized	26.9%	21.1%	1.4%	1.6%
	Employee Pays	46.2%	31.8%	6.9%	0.1%

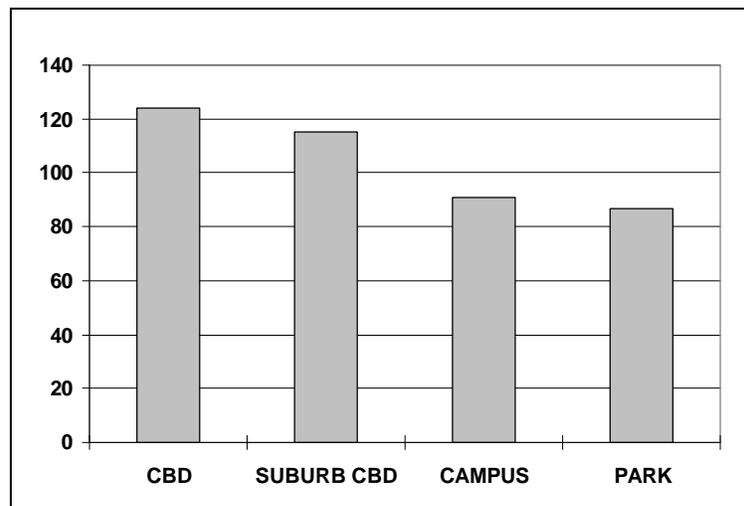


Figure 1: Midday trips per 100 employees

It is useful to put the journey-to-work and midday travel information together to draw an overall picture of employee travel behavior in the different areas. The Shady Grove survey asked about trip chaining during the midday and included a more direct method to determine the journey to work travel distance than was used in the other surveys. For purposes of

Table 9: Midday mode shares

	CBD	Suburban CBD	Campus	Park
Auto-Driver	5.6%	23.3%	80.5%	84.0%
Auto-Passenger	1.7%	3.2%	9.3%	5.3%
Transit	8.6%	6.2%	0.0%	0.7%
Walk	80.5%	67.3%	10.2%	8.5%
Other	3.6%	0.0%	0.0%	1.6%
Total	100.0%	100.0%	100.0%	100.0%

to 2.8 vehicle starts for every trip.

The Shady Grove journey-to-work trip length was about 8 miles each way. Over half of the respondents reported commute trip lengths of over 10 miles each way. Figure 3 shows the travel time distribution among Shady Grove employees.

The daily vehicle starts per employee is the sum of the midday and commuter vehicle starts. The daily VMT per employee is the sum of the commuter and midday vehicle miles of travel generated. Figure 4 displays daily travel comparisons among the activity centers. The figure shows the difference in total vehicle starts or trips compared to downtown D.C. where transit and pedestrian use sets the basis for low numbers of vehicle trips per person. One explanation for the possible difference between the Rock Spring Park and the Rockville-Shady Grove trip rates is the relative number of attractions within a short drive of Rock Spring Park (e.g., Montgomery Mall, Rockville Pike shopping, White Flint, etc.).

illustrating the daily trip characteristics, the Shady Grove statistics for midday vehicle starts per trip and journey to work trip length are used in all areas. It should be noted that the midday vehicle trips in the other areas are similar in character to those in Shady Grove. The average midday trip length in all areas are similar (10 miles CBD, 11 miles Suburban CBD, 8 miles Campus, and 8 miles Park). In Shady Grove, because of intermittent stops, the average number of stops along a journey is 1.4 leading

Table 10: Midday tripmaking

	CBD	Suburban CBD	Campus	Park
Midday Trips per Employee	1.4	1.3	1.2	0.9
Midday Vehicle Trips per Employee	0.1	0.3	1.1	0.8
Midday VMT per Employee	0.9	3.5	6.4	12.7
Midday Trips per Empl. vs. CBD	1.0	0.9	0.9	0.6
Veh. Trips per Empl. vs. CBD	1.0	3.3	11.1	7.8
VMT per Empl. vs. CBD	1.0	4.0	7.5	14.9

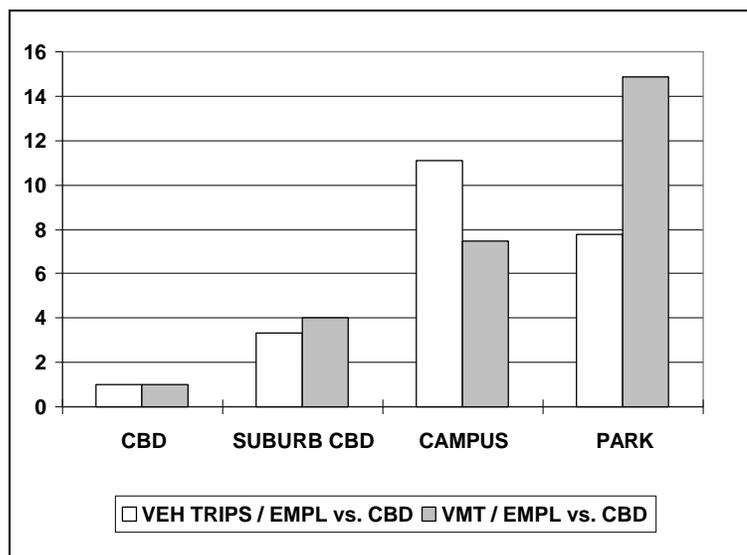


Figure 2: Midday vehicle tripmaking

While there are adequate shopping opportunities in the Rockville-Shady Grove area the relative distance may be just great enough to dissuade people from trying to take care of personal business and shopping during their lunch period.

Attitudes About Transit/Car-pooling

Although attitude questions were only asked in the Shady Grove survey, it is useful to take a quick look at the findings. When asked why they did not use transit, the 980 auto drivers and passengers surveyed cited the distance from a transit stop as the primary deterrent (37%). Other “primary deterrents” were the need for transportation during work hours (21%), irregular work hours (14%), the expense of transit (13%), and the infrequency of service (8%). Just over 22% of respondents wrote in an “other” reason. Among these were the fact that transit service took too long, was not convenient, involved too many transfers, or was just generally unpleasant.

When asked how likely they would be to take transit to work given a list of incentives, the most remarkable response was that they were not at all likely from 40% to 72% of the time. It will be noticed that the likelihood of inducing transit use through a series of incentives corresponded with the deterrents mentioned. For example, more direct service relative to the employee’s residence corresponds with the fact that the primary deterrent to transit is not living near a rail station or a bus stop. Additionally, easier access to transit stops was listed as the second most powerful transit incentive (see Figure 5).

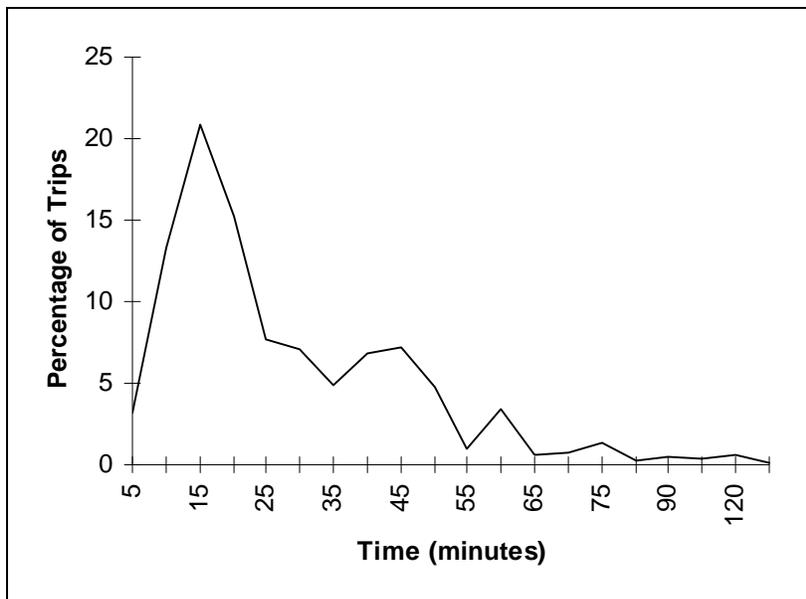


Figure 3: Shady Grove employee commute time distribution

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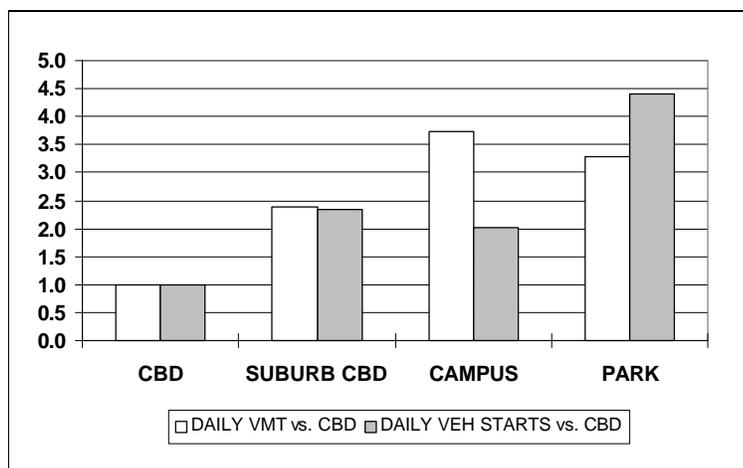


Figure 4: Daily vehicle-miles traveled and vehicle starts

A similar set of questions was asked regarding carpooling. Primary deterrents listed by solo-drivers (90%) were: freedom to have other responsibilities (32%), irregular work hours (32%), and not living near their colleagues (29%). The need for a car for emergencies (18%) and feeling uncomfortable with ones colleagues (1%) were of less concern. Drivers were also asked how likely they would be to join a car pool given a number of incentives. The most enthusiasm

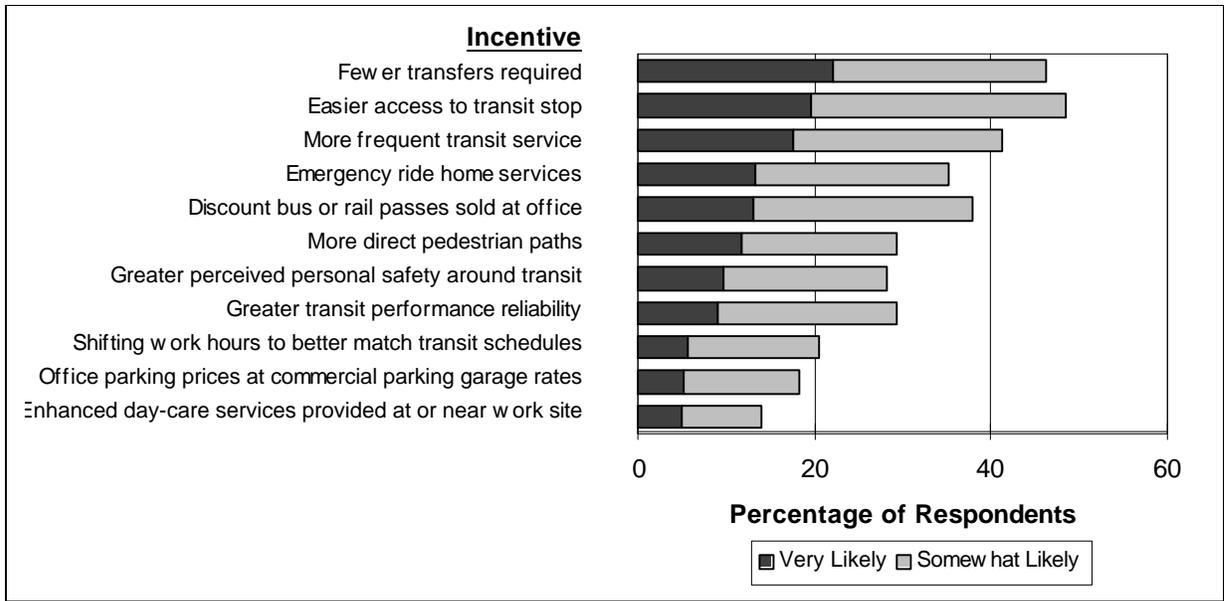


Figure 5: Likelihood to use transit given incentives

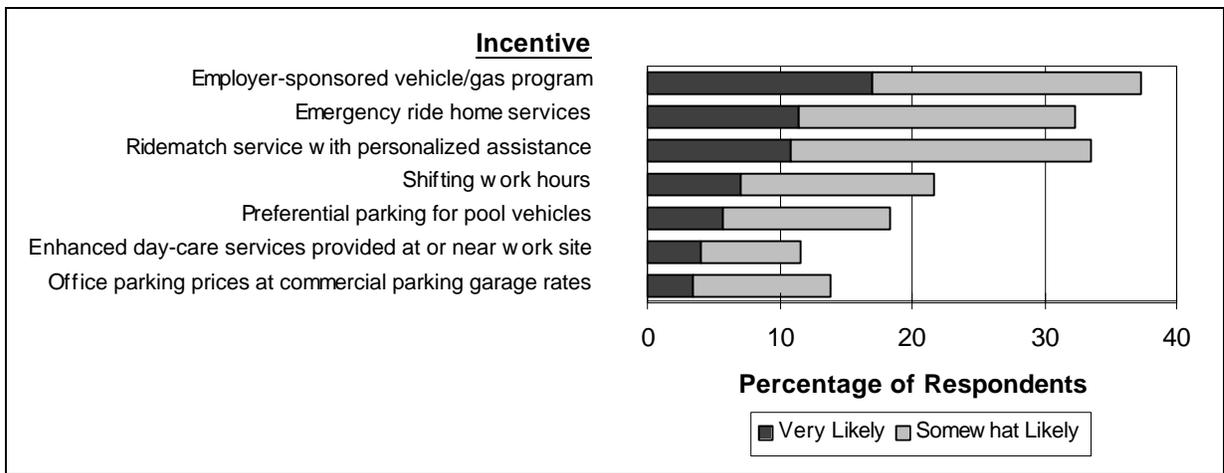


Figure 6: Likelihood to join car/vanpool given incentive

was for an employer sponsored program where the employer supplies the vehicle and/or fuel followed by an employer area wide ride matching service with personalized assistance. Figure 6 illustrates the responses graphically.

Conclusions

The results of the four employee travel surveys conducted in areas with different urban form and urban design characteristics yield two major observations:

- Greater density, mix and size (CBD and Suburban CBD forms) leads to more total trips, more pedestrian trips, more transit trips, fewer automobile trips, and more eating/shopping trips during the midday;

- Less density, mix, and size, (Campus and Park forms) leads to much higher midday vehicular traffic and much higher midday vehicle-miles traveled per employee.

The quality of daytime life for workers in the CBD areas seems better than for the suburban workers. More people are able to leave the building at midday, and they more often leave for non-work activities. These midday trips are often accomplished by walking. In the suburban office settings, most people eat at their desks (63% in the Shady Grove survey). When they do leave the building it is usually on assignment, and it is usually in an automobile. The data suggest dramatic differences in the travel patterns of employees with similar jobs and incomes depending on the urban character of the work place (including mix of land uses).

It is important to note that isolating the causal relationships between trip making and mode choice in relation to individual urban design, urban form and transit service variables proved difficult. The different characteristics of the travel experience seem to relate to these variables in a synergistic format. For example, increased density, increased mix of uses, and high level transit service are often all available at a single site, resulting in a corresponding high-transit mode share and high non-motorized mode share during the midday. Conversely, another site may have a very low mix of uses, poor pedestrian accessibility and poor transit service, leading to either extremely high automobile use or reduced overall trip making. The results of the travel surveys provide an interesting look at the relative differences among trip making in the broad categories of urban form and urban design exemplified by the areas selected.