PEDESTRIAN TRAVEL DEMAND

Boris Pushkarev and Jeffrey M. Zupan, Regional Plan Association, New York

The design of central business districts, where a substantial portion of the 1 billion sq ft of office floor space built in the nation during 1960-1970 has been located, will become increasingly important in the future. Yet, traditional transportation planning studies, including origin-destination home interviews, fail to account adequately for non-home-based, especially pedestrian, travel within the CBD. Pedestrian facilities are seldom dimensioned in proportion to the trip generation of the buildings they serve. As a result, pedestrian congestion in large central business districts is quite common. This study, focused on midtown Manhattan, first relates pedestrian density to walkway space and building floor space at two points in time. Available walkway space and building floor space in retail, restaurant, and office use are found to affect significantly the presence of pedestrians. Estimating equations are presented and evaluated. The daily cyclical variation and directional distribution of pedestrian travel at buildings with different uses and at selected street locations are given. Relationships to daily trip generation rates and the relative magnitude of design period flow are suggested. Trip length characteristics are shown for the walking portion of various trips at the CBD end and are analyzed by purpose and by mode. The average walk is found to be about ⅓ of a mile, and walk-only trips are found to compose about 26 percent of total CBD trip ends. Although Manhattan represents a limiting condition with regard to trip-end density and trip length, the factors derived represent a useful input into the development of design standards for pedestrian movement.

•THE amount of travel to any place depends on the attractiveness of the destination and its accessibility (1). In an urban situation, the amount and type of building floor space can be used as a basic measure of travel attractiveness because other features, such as the natural qualities of a site, usually play a minor role.

Accessibility is a more complex phenomenon that can be considered to have at least three dimensions. The first is the amount and type of transportation facilities traversing the place in question. The second is people's propensity to travel along these facilities—the rate at which their trips are attenuated with distance. The third is a description of the geographic distribution of opportunities for making trips around the destination, i.e., how much and what type of building floor space is located how far away from the transportation system being considered.

The first dimension is easily quantified; in the case of motor vehicles, it can be measured by the square feet of pavement provided. Thus, if two places have an equal amount of building floor space, the one that has more square feet of vehicular pavement will also attract more vehicular trips (2). In the case of pedestrians, we may measure it by the walkway area provided.

Knowledge of the second dimension—the travel propensity—is necessary for determining at what rate to discount travel opportunities with distance. In the case of pedestrian travel, 1 million sq ft of building floor space located in the next block will certainly have a great effect on pedestrian travel at a given site, whereas 1 million sq ft located several miles away will have no effect at all. In fact, as will be shown later in this

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study, half of all pedestrian trips are less than about 1,000 ft. Thus, we do not have to be concerned with large areas when calculating a weighted average distance to all possible opportunities for walking trips.

It can be a cumbersome operation to measure the distances from each site to every other site and to weight them by the amount and type of floor space at each site, with the attenuation of trips over distance taken into account. Experience indicates that the dimension of accessibility that deals with opportunities for trips surrounding an area under investigation can be disregarded if abrupt changes in land use do not occur within an area and if great precision is not required. The reason this shortcut method can work is that, in theory, attractiveness and acessibility tend toward an equilibrium; big buildings will be erected in a place if there are enough people nearby to fill them. The dimension of accessibility that deals with the proximity of other floor space to the floor space on the site in question is thus largely inherent in the measure of the latter. Therefore, to begin our investigation, we shall study (a) building floor space by type and (b) walkway surface in a selected area to determine how they relate to pedestrian movement.

The area selected for study is in midtown Manhattan, between 40th and 60th Streets, from Second to Eighth Avenues. Practical problems of pedestrian circulation in this area are acute and urgently require solution. Analytically, the area offers a large sample of pedestrian movement at a reasonable cost. No claim is made that the rates of pedestrian travel determined for this area are universally valid. Varying densities of building occupancy, varying trip lengths, and varying social habits will no doubt result in different values for different urban places. The range of variation can only be determined by more measurements at more locations. However, the methodology used here can have a wide application, and in the absence of other data the figures derived can provide useful benchmarks.

PEDESTRIANS RELATED TO BUILDINGS AND WALKWAYS

Pedestrians visible on the surface of midtown Manhattan were counted twice: during midday and during the evening rush hour. At an instant after 1:30 p.m., a total of 37,510 pedestrians could be seen in the 1.2 sq miles of midtown; 33,280 were on sidewalks, 1,680 in streets, 1,620 in plazas, 690 in parks, and 240 in other places such as yards, roofs, and construction sites. During the evening period the total was somewhat lower. The midday and evening instantaneous counts, translated into hourly flow rates, are shown in Figures 1 and 2. The counts were based on aerial photographs obtained by a Port of New York Authority helicopter and excluded people walking through covered passageways or otherwise concealed from view. The midday photographs were taken on several weekdays between April 29 and May 21, 1969, at times ranging from 1:28 to 1:59 p.m. The evening photographs were taken between May 1 and June 4 between 5:02 and 5:30 p.m. The technique proved highly successful except in the case of some evening shots, which could not be interpreted due to deep shadows; as a result, only a two-thirds sample of the evening counts was used.

The counts were tabulated by block sectors that matched an inventory of floor space and surface use. This made it possible to related statistically, by means of multiple correlation, pedestrians to building floor space and walkway space at two points in time and at some 600 block sectors. In this case, the number of pedestrians visible on any block sector was the dependent variable, or the variable to be explained, while the walkway area and the floor space in each of 10 building-use categories (office, retail, institutional, garage, manufacturing, restaurant, theater, hotel, private residence, and others) were assumed to be the independent variables, i.e., the factors that we expect would explain the variation in pedestrian travel.

Early in the analysis it became apparent that, of the ten building uses inventoried, only office, retail, and restaurant floor space appeared to be significantly associated with the presence of pedestrians. Even when treated together, rather than individually, the seven other building uses could not contribute to a more precise explanation of the dependent variable because of their relatively low trip generation rates. Only office, retail, and restaurant use, plus the walkway area available for pedestrian circulation, were retained as significant variables affecting the presence of pedestrians on a block sector in midday. For the evening, an added factor seemed important, namely the prox-

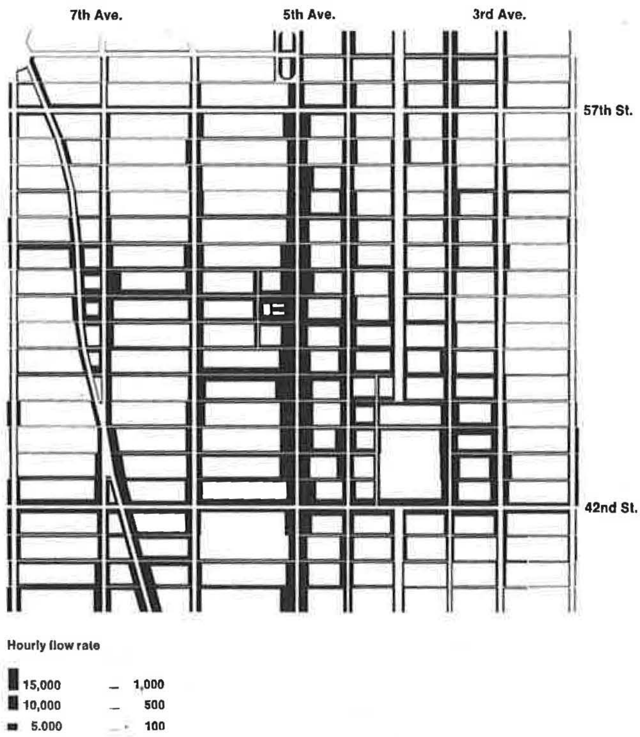

Figure 1. Mid-Manhattan pedestrian flow (12:30-1:30 p.m.).

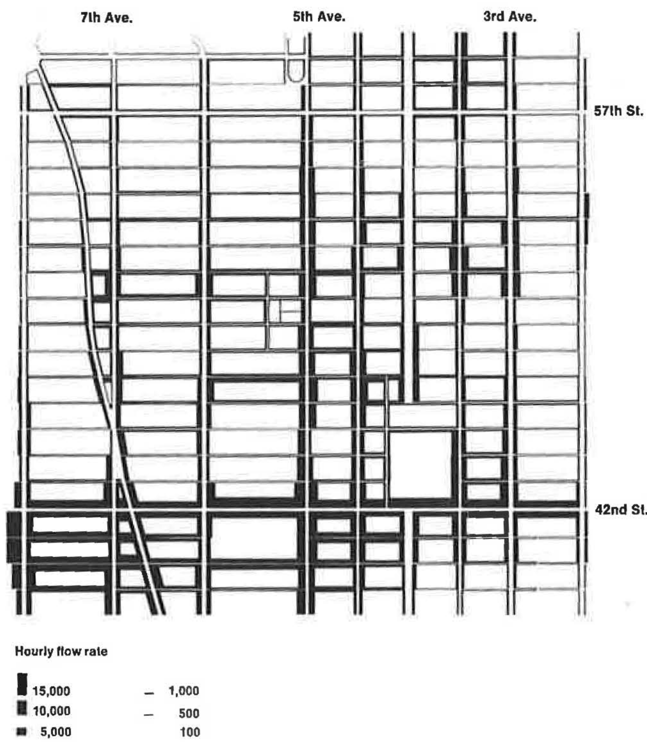

Figure 2. Mid-Manhattan pedestrian flow (5:00-5:30 p.m.).

imity of transit facilities, such as subway stops. After different measures of proximity were tested, certain functions of the distance to the nearest transit entrance proved best and were accepted as independent variables.

Another refinement that proved necessary was the differentiation between streets and avenues. Using the same equation for both tended to overestimate pedestrians in streets and underestimate pedestrians on avenues. The reason for this difference lies in the unique geometry of the Manhattan street grid. For every 5,600 ft of city width, there are about 300 lineal ft of sidewalk width on the north-south avenues and about 600 ft on the east-west streets. On the assumption that pedestrians have an equal desire to walk in a north-south direction as they do east-west, the street sidewalks should have about half the pedestrian density as the avenue sidewalks. This relationship was borne out by the helicopter counts, which found about 53 percent of the pedestrians walking north-south, and about 47 percent walking east-west, with the latter having more than twice as much room to themselves as the former.

The final result of the multiple-correlation analysis is four equations for estimating the number of pedestrians on any block or block sector at an instant after 1:30 p.m. and after 5:00 p.m., on an avenue and on a street; these are given in Table 1. The simple relationship of the avenues having about twice the pedestrian density of streets is not directly apparent from the equations because of the different incidence of building uses and the definition of block sectors, but the general tendency is for the avenue equations to produce higher values.

Intuitively, the equations in Table 1 make good sense. For example, Eqs. 1 and 2 tell us that at midday the number of pedestrians on a block sector depends on the amount of office, retail, and restaurant space—building uses that obviously attract pedestrian trips during lunchtime—as well as on the amount of surface available for pedestrians to walk on. We can also infer that retail uses attract 2 to 7 times the pedestrian trips as offices do, per unit of floor space, and that restaurants attract 13 to 25 times the trips that offices do during the noon hours. Comparing the avenue with the street equation, we see that equal increases in pedestrian space produce about equal increases in pedestrians and that the same is true of office floor space. However, retail uses on avenues attract about three times as many pedestrians as retail uses on streets, a finding that helps to explain why ground floor rents on avenues are much higher than those on streets. The main indication of the more intensive use of the avenues is the constant term at the end of the equations, which seems to indicate that, even if there is not a sidewalk or a building, there still will be 26 pedestrians per block on an avenue, whereas this is not the case on a street.

TABLE 1

EQUATIONS RELATING THE PRESENCE OF PEDESTRIANS TO BUILDING USE AND WALKWAY SPACE

Avenues, midday

$$P = 2.97 \text{ walkway} + 0.05 \text{ office} + 0.35 \text{ retail} + 1.22 \text{ restaurant} + 26.66 \quad (1)$$

Streets, midday

$$P = 3.12 \text{ walkway} + 0.06 \text{ office} + 0.12 \text{ retail} + 0.74 \text{ restaurant} - 4.01 \quad (2)$$

Avenues, evening

$$P = 0.06 \text{ office} + 0.20 \text{ retail} - 1.98\,D + 56.70 \quad (3)$$

Streets, evening

$$P = 3.17 \text{ walkway} + 0.04 \text{ office} + \frac{46.12}{D^3} + 2.17 \quad (4)$$

Symbols

P = number of pedestrians at an instant in time on the sidewalks and plazas in the vehicular roadway of a block sector.

Walkway = sidewalk and plaza space on the block sector, in thousands of square feet.

Office, retail, and restaurant = gross office, retail, and restaurant floor space respectively in the block sector, in thousands of square feet.

D = distance from the centroid of the sidewalk and plaza space to the nearest transit entrance, in hundreds of feet.

Equations 3 and 4 also include office space. Because most pedestrians during the evening rush hour are leaving office buildings, this is quite plausible. Retail floor space is significant on the avenues but substantially less attractive than during midday because fewer people are shopping. Retail space on streets ceases to be significant. Pedestrian space on streets is just as important as it is during midday, but this space ceases to be statistically significant on the avenues. This anomaly can be interpreted to mean that during the more leisurely lunch hour pedestrians probably will seek out areas with more elbow-room, and distribute themselves in relation to the available sidewalk space, whereas during the evening peak they tend to rush along the avenues regardless of available space. Restaurant space ceases to be statistically significant during the evening rush hour and does not appear in either the avenue or the street equation. However, a new factor—the distance to the nearest transit entrance—emerges in the evening equations.

The distance to transit entrances must be considered in conjunction with the constants at the end of the equation. At 100 ft from a transit entrance, the avenue equation produces, on the average, -2.0 + 56.7 = 54.7 pedestrians, in addition to those generated by office and retail uses. There is a constant drop-off of about 2 pedestrians for every additional 100 ft of distance from the transit entrance. Quite a different pattern prevails on streets. At a distance of 100 ft a transit entrance produces 46.1 + 2.2 = 48.2 pedestrians on the sidewalk of a street; however, this concentration drops off very rapidly, inversely to the cube of the distance, and becomes about 2.5 pedestrians at 500 ft. Therefore, transit entrances do not strongly affect volumes on street sidewalks beyond a 500-ft radius. As can be seen from the evening pedestrian flows shown in Figure 2, the street blocks leading to transit facilities are indeed much busier than other streets, whereas the flow on avenues stretches out in a more uniform pattern.

Even though the relationships given in Table 1 appear intuitively plausible, the significance of the equations has to be evaluated by more rigorous, statistical measures. The most common such measure is the multiple-correlation coefficient, R. The correlation coefficient squared represents the fraction or the percentage of the variation that is explained. These R^2 values for the four equations are given in the first column in Table 2; the street equations explain 52 to 61 percent of the variation in the presence

TABLE 2

STATISTICAL MEASURES OF EQUATIONS IN TABLE 1

Equation	Variable	Coefficient (not rounded)	Standard Error of Coefficient	t-Value
Avenues, midday				
$R^2 = 0.36$	Walkway	2.97	0.439	6.8
$N = 344$	Office	0.0485	0.0089	5.5
$S_e = 43.5$	Retail	0.35	0.061	5.7
	Restaurant	1.22	0.370	3.3
Streets, midday				
$R^2 = 0.61$	Walkway	3.12	0.430	7.3
$N = 261$	Office	0.0575	0.0076	7.6
$S_e = 31.6$	Retail	0.12	0.039	3.1
	Restaurant	0.74	0.277	2.7
Avenues, evening				
$R^2 = 0.23$	Office	0.0622	0.0086	7.2
$N = 228$	Retail	0.20	0.062	3.3
$S_e = 39.0$	D	-1.978	0.6212	3.2
Streets, evening				
$R^2 = 0.52$	Walkway	3.17	0.567	5.5
$N = 179$	Office	0.0388	0.0102	3.8
$S_e = 34.6$	$1/D^3$	46.121	9.9240	4.6

Symbols

R = Multiple-correlation coefficient.

N = Number of observations (block sectors).

S_e = Standard error.

of pedestrians, and the avenue equations 23 to 36 percent. In both cases, the midday equations explain more of the variation than the evening ones. An interpretation of this pattern is in order.

It must be emphasized that the values any correlation equation produces are averages and not actual observations. The spread of the actual observations around the average is measured by the standard error S_e, indicated in column 1 of Table 2. The probability is about 68 percent that the actual value lies within plus or minus one standard error and about 95 percent that it lies within two standard errors of the average produced by the equation.

A major reason for the wide spread of observed values around the calculated average in our case is that the observed values are based on instantaneous photographs. There is a considerable variation in pedestrian flow from instant to instant because of the phenomenon of platooning or bunching, which is caused, to a large extent, by changes in traffic lights and affects avenues more than the longer street blocks. This is one reason for the greater accuracy of the street equations.

The extent to which the standard error is affected by platooning is best illustrated by a numerical example. Let us assume that a block sector facing an avenue has 10,000 sq ft of walkway, 1 million sq ft of office space (comparable to the Marine Midland Building in lower Manhattan), and 10,000 sq ft each of retail and restaurant use. Inserting these values into Eq. 1, we see that the block sector should have, on the average, 122 pedestrians at a midday instant. However, the standard error of Eq. 1 from Table 2 is 43.5. After multiplying that by 2, and adding it to or subtracting it from 122, we can say with a 95 percent confidence that the actual number of pedestrians on the block will be somewhere between 35 and 209. This appears to be a large spread; the high value is 1.7 times the average value. However, if one looks at manual counts of the minute-to-minute variation in pedestrian flows of a comparable magnitude during any 15-min period, one can see that the highest minute is easily 1.2 to 1.5 times the average minute. Although the evidence is indirect—helicopter counts of a block sector at 1-min intervals were not available—it seems reasonable to suggest that perhaps one-third to one-half of the standard error may be due to the short-term pulses. Fortunately, for purposes of establishing design standards, we are not so much interested in the number of pedestrians on a block at a particular instant as we are in the general magnitude of the load that can be expected. The equations provide this, even though their standard errors, as given in Table 2, appear large.

Of course, there are other sources of error than the short-term fluctuations due to platooning. For the evening equations, which generally perform more poorly than the midday ones, a major source is the large-scale pattern of pedestrian flow toward the major terminals, such as Grand Central and the Port Authority bus terminal, evident in Figure 2. The factor of proximity to the nearest transit entrance alone cannot take care of that because transit stations vary widely in the volumes they attract. During the evening peak hour 50,000 passengers enter the Grand Central subway station, whereas only 3,000 enter the Seventh Avenue stop at 53rd Street.

A related factor, operative both at midday and in the evening, is the overflow from adjacent blocks. Although we stated at the outset that, under some conditions, it may not be essential to consider the influence of neighboring areas on an area in question, the accuracy of the estimating equations would have been improved if a measure of this aspect of accessibility had been added. Thus, pedestrian flow on the block that contains St. Patrick's Cathedral is affected by the presence of 400,000 sq ft of retail floor space across the street (Saks Fifth Avenue). Similarly, of two blocks having identical-size office buildings on Third Avenue, the one closer to Grand Central has higher pedestrian flow. The overflow phenomenon, most pronounced on avenues, is only partially handled by the constant term at the end of the equations; this represents ambient pedestrians present because of the high floor space density in the area.

Next, one should mention some purely idiosyncratic factors that could not possibly be accounted for by the equations. The number of pedestrians window-shopping in the diamond district on 47th Street is substantially underestimated, as is the number of those loitering in front of peep-shows on 42nd Street between Seventh and Eighth Avenues. People congregating in front of the Public Library are also underestimated.

25. The average walking distance for all groups is 1,720 ft but varies from a low of 1,200 ft for females over 50 to a high of 2,000 ft for males 25 to 50. In and of itself, the average walking distance column in Table 7 offers few surprises: most men walk farther than women, and, generally, younger people walk farther than older people.

TABLE 7

WALKING DISTANCE BY AGE AND SEX AT TWO OFFICE BUILDINGS

Group	Percentage of Trips	Average Walking Distance (ft)	Estimated Average Net Walking Time (min)
Males, under 25	10.2	1,502	4.70
Males, 25-50	35.1	2,044	6.83
Males, over 50	6.5	1,711	6.50
Females, under 25	28.8	1,608	5.80
Females, 25-50	14.6	1,443	5.47
Females, over 50	4.8	1,244	5.59
All males	51.8	1,900	6.37
All females	48.2	1,520	5.67
Total (16,740 trips)	100.0	1,720	6.03

Turning to the characteristics of the trips themselves, we shall focus on trip purpose and mode of travel as factors affecting walking distance. Trip purpose, as is commonly known, varies widely in the course of a day. During the morning peak in a central business district, virtually all travel consists of journeys to work. In midmorning, business calls and deliveries become important. At midday, eating, shopping, and business trips predominate. In the early afternoon, trips to home become significant and increase to an overwhelming proportion of all travel during the evening rush.

The sampling procedure used at the two office buildings where interviews took place did not make it possible to draw a statistically accurate profile of trip purposes by time of day or a summary for the entire day. However, the general impression gained is that between 50 and 60 percent of the total trips in and out of the office buildings are either coming from home or going home. The rest are non-home-based and represent the kind of swirling activity for which an urban center is built. This is in marked contrast to vehicular travel in the region as a whole, which is something like 90 percent home-based.

Of the trips that are predominantly non-home-based, eating trips are most numerous (amounting to perhaps one-third at the two office buildings studied) and are followed by business calls, shopping trips, pleasure trips, and deliveries. The high rate of business calls uncovered suggests that there is indeed intensive face-to-face communication going on between office buildings, which is presumed to be one of the major reasons why they cluster in an office center. It is also interesting that the number of pleasure trips seems to rival that of shopping trips.

The trip purposes referred to represent those at the end of a journey; they take no account of intermediate stops along the way that appear to be significant in a central business district. A question asked to ascertain the number of these multi-purpose trips received poor response (more than a third of those asked did not answer); of those who did answer, about 16 percent indicated stopping for one intermediate purpose, and another 4 percent indicated for two or more purposes. Presumably, these multi-purpose trips do not include trips with such short stops as picking up a newspaper or window-shopping.

As for the mode of travel, close to 26 percent of all trips intercepted at the two office buildings are exclusively walking trips; this compares well with other studies (3). For the rest, walking represents but the initial or final link in a journey by one or several types of vehicles. As one would expect, the interviews revealed that the most walking-oriented trip purpose is eating (about 87 percent of trips to eat are walk-only trips); shopping follows (72 percent walk only); and business calls and pleasure trips come next (50 to 55 percent walk only). With regard to walking to work, it is known from the 1960 census that between 3 and 4 percent of the initial trips to work in the Manhattan central business district are made on foot; the interviews registered a much higher percentage because of return trips from eating, shopping, and other pursuits.

Table 8 and Figure 6 present the cumulative distribution of walking distances for all trips at the two office buildings studied and single out five specific trip purposes. Table 8 further shows the average and the median for all trips, and for the five trip purposes. It is evident that 50 percent of the pedestrians interviewed at the two office buildings walk less than 1,070 ft, equivalent to about four north-south blocks in Manhattan. About

TABLE 6

EXAMPLES OF DIRECTIONAL DISTRIBUTION OF PEDESTRIAN TRAVEL

Location	Percentage of Flow in the Predominant Direction		
	8:45-9:00 a.m.	12:45-1:00 p.m.	5:00-5:15 p.m.
Building entrances			
Office, flat peak	93	60	85
Office, sharp peak	98	54	98
Department store	–	68	60
Restaurant	–	73	88
Residence	88	55	56
Walkways			
Grand Central escalators	93	56	88
Grand Central area	82	50	70
48th Street	74	58	71
Fifth Avenue	70	51	61
42nd Street at Times Square	60	52	63

Note: Based on counts shown in Tables 3 and 5.

It is also evident from the outdoor cyclical counts that the aerial photographs, taken between 1:30 and 2:00 p.m. (solid hours in Figure 5), underestimate the true midday peak by anywhere from 5 to 25 percent. The evening peak is captured more accurately, solid bars in Figure 5), but there is a very substantial difference between the first and the second 15-min period during that time, which is one source of the unexplained variation in the evening correlation equations.

One last point related to the daily cycle concerns directional distribution. Table 6 shows that directional imbalance at the entrance to an office building can be rather extreme. Thus, during the peak 15-min period, between 93 and 98 percent of the flow at the two office buildings previously dealt with occurs in the predominant direction. Similarly, at the Grand Central escalators, 93 percent of the flow at 8:45 a.m. and 88 percent of the flow at 5:00 p.m. occur in the predominant direction. Just as peaks are more attenuated on outdoor walkways, directional distribution outside buildings usually tends to be more balanced; typically, two-thirds to three-quarters of the peak flow occurs in the predominant direction. In general, the greatest imbalances occur during the morning peak, followed by the evening peak. Midday, by contrast, is split rather evenly by direction. Also, walkways connecting office buildings to transit stations tend to have highly directional flow, whereas the movement pattern in shopping districts is more ubiquitous (Table 6).

WALKING DISTANCE RELATED TO TRIP PURPOSE AND MODE

Having ascertained the number of pedestrian trips produced by different building types and having looked at how this number varies in the course of a day, we can proceed to the second dimension of travel demand, namely trip length. Trip length, in general, is a very important dimension because the amount of space that has to be provided for a given number of trips depends on the lengths of the trips. Trip length, in this case walking distance, varies according to the characteristics of the person making the trip and of the trip itself. To determine some of these relationships for pedestrians in the midtown Manhattan study area, interviews were conducted intercepting persons entering or leaving a building or a transit station. They were asked where they walked to or from, for what purpose, and what other mode of travel, if any, they used on their trip; the interviewer also recorded their sex and apparent age group. A sample of 4,055 pedestrians was interviewed, representing a universe of 63,000 persons (the sampling rate varied, depending on location and time of day, from 2 to 50 percent).

Of most interest are the results of 1,400 interviews, which represent about 17,000 pedestrians entering or leaving two major office buildings, one at Sixth Avenue and 50th Street, the other at Park Avenue and 46th Street. Starting with the characteristics of the persons making the trips, Table 7 shows that the pedestrians intercepted at the two office buildings are predominantly either males 25 to 50 years of age or females under

The general conclusion to be drawn from the outdoor cyclical counts is that the peak 15-min flow rate seldom exceeds twice the average 15-min flow rate. However, it approaches this level sufficiently often to warrant accepting twice the average 15-min flow rate, on a 12-hour 7:30 to 7:30 basis, as the critical value for design purposes for outdoor walkway conditions similar to those in midtown Manhattan. The critical flow generally occurs either from 12:30 to 1:30 p.m. if an area is shopping oriented or from 5:00 to 5:30 if an area is office-building oriented. As can be seen from Table 5, between 14 and 18 percent of the 12-hour flow occurs during the hour of highest flow.

TABLE 5

DAILY PEAKING PATTERNS OF WALKWAYS IN FIVE SELECTED AREAS

Time	Percentage of 12-Hour Two-Way Flow During Each 15-Min Period				
	Grand Central Escalators (1 location)	Grand Central Area (4 sidewalk locations)	48th St., Second to Seventh Ave. (12 sidewalk locations)	Fifth Ave., 44th to 47th St. (4 sidewalk locations)	42nd St. Near Times Sq. (2 sidewalk locations)
7:30-7:45	0.6	0.6	0.8	0.3	0.5
7:45-8:00	1.4	0.9	0.8	0.3	0.7
8:00-8:15	2.3	1.3	1.1	0.5	1.0
8:15-8:30	3.3	1.8	1.8	0.8	1.3
8:30-8:45	4.3	2.5	2.9	1.3	1.6
8:45-9:00	4.3	3.2	3.0	1.8	1.8
9:00-9:15	3.9	2.7	2.9	1.5	1.9
9:15-9:30	3.4	1.7	1.8	1.1	1.4
9:30-9:45	1.4	1.4	1.4	1.2	1.3
9:45-10:00	1.3	1.4	1.4	1.0	1.4
10:00-10:15	1.0	1.2	0.8	1.2	1.4
10:15-10:30	1.2	1.4	1.0	1.4	1.5
10:30-10:45	1.1	1.3	0.8	1.7	1.6
10:45-11:00	1.0	1.5	1.0	1.7	1.5
11:00-11:15	0.9	1.5	0.8	1.6	1.7
11:15-11:30	1.1	1.7	1.0	2.0	1.3
11:30-11:45	1.3	2.0	1.5	2.2	1.9
11:45-12:00	1.6	2.2	2.0	2.6	2.0
12:00-12:15	2.4	3.3	2.4	3.4	2.5
12:15-12:30	2.2	3.5	3.4	3.7	2.9
12:30-12:45	2.1	4.0	4.0	4.6	2.8
12:45-1:00	2.5	4.0	3.7	4.2	3.1
1:00-1:15	2.6	4.0	3.5	4.2	3.4
1:15-1:30	2.7	3.8	3.2	4.4	3.1
1:30-1:45	3.0	3.1	2.9	4.2	2.8
1:45-2:00	2.4	2.7	2.7	4.1	2.7
2:00-2:15	1.8	2.3	2.6	3.6	2.6
2:15-2:30	1.7	2.3	2.4	2.9	2.4
2:30-2:45	1.7	2.3	2.3	2.6	2.0
2:45-3:00	1.4	2.2	2.1	2.6	2.3
3:00-3:15	1.6	2.0	1.9	2.0	2.3
3:15-3:30	1.4	1.7	1.8	1.7	2.2
3:30-3:45	1.6	1.7	1.8	1.8	2.3
3:45-4:00	1.2	1.7	1.7	1.8	2.1
4:00-4:15	1.8	1.6	1.6	1.8	2.2
4:15-4:30	1.6	1.8	1.9	2.0	2.3
4:30-4:45	2.4	2.0	2.2	2.1	2.2
4:45-5:00	4.3	2.9	2.9	2.4	2.3
5:00-5:15	4.3	3.9	5.0	3.4	2.8
5:15-5:30	4.0	3.1	3.5	2.9	3.3
5:30-5:45	3.4	2.5	3.1	2.4	3.0
5:45-6:00	3.2	1.8	2.4	1.8	2.7
6:00-6:15	2.1	1.4	2.0	1.4	2.5
6:15-6:30	1.7	1.0	1.7	1.1	2.2
6:30-6:45	1.4	1.0	1.4	0.9	2.0
6:45-7:00	1.0	0.8	1.2	0.7	1.8
7:00-7:15	0.7	0.7	1.1	0.6	1.9
7:15-7:30	0.4	0.6	0.8	0.5	1.5
12-hr percentage	100.0	100.0	100.0	100.0	100.0
12-hr total	89,700	137,600	67,780	146,800	80,660
12-hr average per sidewalk location	89,700	34,400	5,650	36,700	40,300

be called turnover rate. The turnover rate is a function of how a building is used—whether it attracts primarily employees working in it, or also outside patrons, whether the patrons' transactions are short or take a long time, to what extent the employees eat in or go out for lunch, and so on.

We can now look at cyclical variation in flow at walkways rather than at building entrances. Table 5 and Figure 5 show that the peaks at walkways are flatter than at building entrances. Varying trip lengths and varied trip destinations, as well as varied peak times at individual buildings, work together to flatten out the peak flow of pedestrians in the extensive "mixing bowl" of sidewalks, plazas, and other walkways.

The shape of the daily cycle at any walkway depends very much on the predominant building uses in the area. This can be readily seen by comparing the cyclical profiles in Figure 5 with those in Figure 3. The first profile, representing the escalators leading from Grand Central Terminal to the Pan American Building, resembles the profiles at office buildings but is more attenuated. For a total of 1 hour, the 15-min flow slightly exceeds twice the average 15-min rate.

About 1,000 ft away from Grand Central Terminal, at four sidewalk locations represented in the second profile, the work-trip peaks in the morning and evening become still more attenuated, and the midday lunch and shopping peak begins to compete with them; no 15-min period exceeds twice the average 15-min flow rate.

The third profile represents the average of 12 counts on 48th Street between Second and Seventh Avenues. It is distinguished by deep troughs in midmorning and midafternoon, indicating that the street serves primarily as a corridor for work trips and lunchtime trips and does not attract walkers in its own right. Because of the heavy concentration of offices in the areas it traverses, 48th Street displays cyclical characteristics that most resemble those of an office building in Figure 3. Among the five areas represented it has the highest peak; however, it lasts only 15 min and could easily be relieved by staggered exit times in adjacent office buildings.

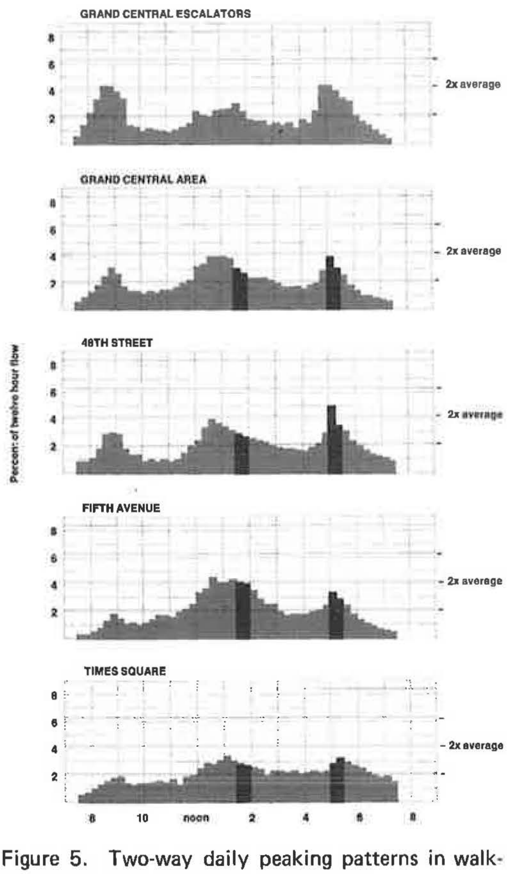

Figure 5. Two-way daily peaking patterns in walkways.

The fourth profile is quite different and represents an average of four counts of Fifth Avenue between 44th and 47th Streets. This is an area dominated by retail shopping, and the shape of its daily cycle resembles very much that of the department store in Figure 3, with a heavy midday concentration. For 1¼ hours at midday the 15-min flow is at about twice the level of the average 15-min rate. However, the morning and evening work-trip peaks are still clearly visible.

The work-trip peaks are even less prominent in the fifth profile, representing two counts on 42nd Street just east of Times Square. Heavy midday flow for shopping and lunch as well as an unusual volume of travel in midafternoon and early evening—composed of tourists and and casual strollers—combine to make this profile the flattest of all. The peak 15-min period never even approaches twice the average rate and stays at slightly over 3 percent of the 12-hour total during both the midday and evening peaks.

entries occur between 9:00 and 9:15 a.m., and almost 15 percent of the exits occur between 5:00 and 5:15 p.m., a factor 6 to 7 times the average—the building is predominantly a "9 to 5" operation. By contrast, the first building has a large part of its clerical work force on an 8:15 a.m. to 4:15 p.m. shift, and another part on an 8:45 a.m. to 4:45 p.m. shift, leaving less than half of its employees on a "9 to 5" schedule. The result of the staggered work hours is roughly a 30 percent reduction of the peak 15-min load, as shown in Figure 4.

In general, one should note that the cyclical patterns are not immutable laws of nature but are, to a large extent, responses to devices of social control and to ingrained conventions. For example, note the surges of people returning home "just before 6" or "just before 7" o'clock for dinner (Fig. 4, residential building).

A close look at the cyclical patterns enables us to gain some understanding of why trip generation rates vary widely between, and even within, particular categories of building use. Specifically, it enables us to calculate indoor densities of building occupancy and the number of trips in relation to the number of people occupying a building at a peak period.

The accumulation of people in a building at any particular time can be calculated by subtracting all outbound trips from all inbound trips up to that time, assuming the building was empty at first. The time and amount of the maximum accumulation can thus be determined. Dividing maximum accumulation into floor space, one can see how densely a building is occupied at the time of its peak use. As Table 4 shows, the restaurant investigated has about 36 sq ft of floor space per patron at midday, the department store about 76, and the space allocation in the three office buildings ranges from about 320 to 340 sq ft. (The average floor space allocation for all nonresidential buildings in the Manhattan central business district appears to be about 310 sq ft per person on the basis of the following: total nonresidential floor space, 570,000,000 sq ft; peak accumulation, exclusive of nonworking residents, 1,830,000 at 2:00 p.m. The allocations in the office buildings surveyed appear to be substantially higher than those commonly assumed. For example, in the mid-1960s, the gross allocation of office space per office employee in Manhattan was estimated to be only 240 sq ft.) The maximum accumulation at the apartment house—probably at about 4:00 a.m.—cannot be obtained from the difference between in and out trips because accumulation never drops to zero. However, the floor space allocation can be estimated from residential population data at about 520 sq ft.

As one would expect, the densities of building occupancy do influence trip production rates; generally, the more indoor space per peak-period occupant, the fewer daily trips per 1,000 sq ft of floor space. However, the variation in the number of daily trips per peak-period occupant appears to be greater than the variation in density of occupancy both between and within building use categories, as given in Table 4. Borrowing a term used in parking design, this number of one-way daily trips per peak period occupant can

TABLE 4

TRIP GENERATION CHARACTERISTICS OF SELECTED BUILDINGS

Building Type	Total 12-Hour Two-Way Trips	Peak Accumulation	12-Hour Trips per 1,000 Sq Ft Floor Space	Sq Ft of Floor Space Allocation at Peak Accumulation	Turnover Rate	Two-Way Peak 15-Min Trips as Percent of 12 Hours
Retail 1[a, b]	26,800	n.a.	385	n.a.	n.a.	8.4% at 12:45 p.m.
2[d]	44,540	2,330	252	76	9.6	6.2% at 12:45 p.m.
3[c]	2,140	n.a.	285	n.a.	n.a.	4.2% at 5:00 p.m.
Restaurant[a]	2,075	329	173	36	3.2	5.9% at 1:15 p.m.
Office 1[a, d]	13,690	2,980	13.06	330	2.3	7.4% at 5:00 p.m.
2[d]	23,060	4,775	14.11	340	2.4	6.9% at 8:45 a.m.
3[a, d]	5,360	980	17.06	320	2.7	5.5% at 4:45 p.m.
Residence[a, c] (290 apartments)	1,700	(520 est.) (-320 min.)	6.3	(520 est.)	1.6	3.9% at 5:45 p.m.

[a]Previously listed in Table 3.
[b]Based on a November count.
[c]Based on an April count.
[d]Based on a July count and seasonally adjusted by 1.053.

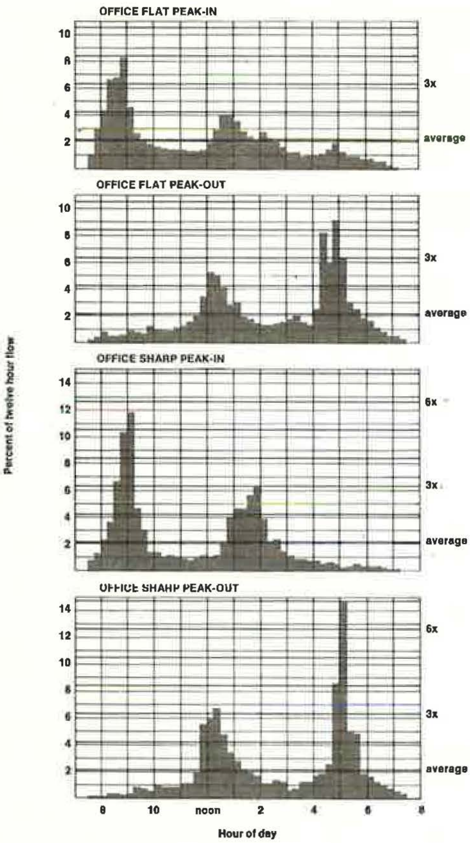

Figure 3. One-way daily peaking patterns at two office buildings.

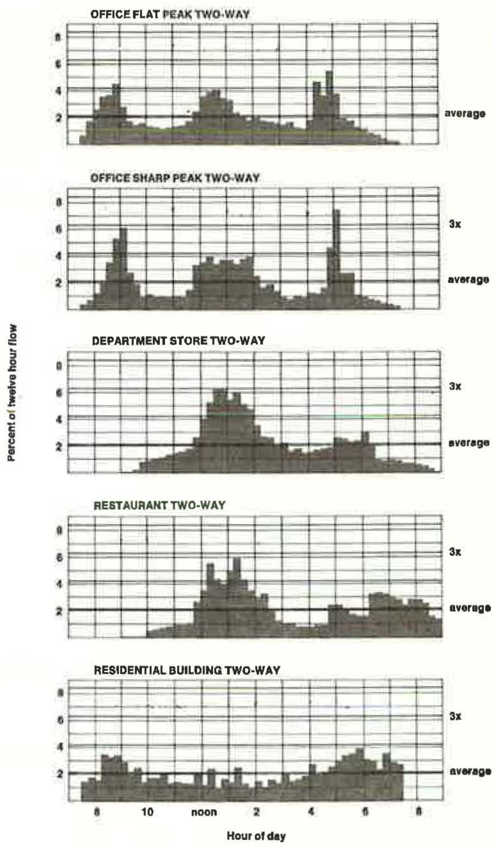

Figure 4. Two-way daily peaking patterns at five building types.

in the 3 hours after 11:45; arrivals of the "a drink after work" crowd and of the dinner patrons are clearly visible. The pattern at the apartment house is virtually the inverse of the others—some activity in the morning, a long lull with a low point around noon, and a greater amount of activity after 5:00 p.m. The irregularity of the residential graph reflects its small sample size.

A convenient way to measure the sharpness of a peak is to compare it to an average period. In our case, if pedestrian flow were even, each 15-min period would account for about 2.1 percent of the 12-hour flow. Comparing the patterns in Figure 3 on that basis, we can see that, at the second office building, two-way pedestrian flow during 15 min after 5:00 p.m. is 3.5 times the average. No other building in the figure exceeds 3 times the average flow during any 15 min. However, 2 times the average flow is exceeded quite frequently: for 45 min by each of the office buildings, for 105 min by the department store, and for 75 min by the restaurant. Only the apartment house manages to stay below that peaking level all day. The prolonged lunch peak at both office buildings approaches the level of 2 times the average. If the retail, restaurant, and residential uses shown illustrate characteristic patterns (although the detailed percentages will inevitably vary somewhat from Table 3), the question remains why the two office buildings vary so much from each other.

To answer the question, inbound and outbound pedestrian flow at these buildings is shown separately in Figure 4, based on figures in Table 3. With respect to one-way flow, peaking is even more pronounced. At the second office building, 12 percent of the begins to stir about 7:30 a.m.; reaches a peak toward 9:00 a.m., drops to a low level in the late morning; rises during lunchtime; falls in the afternoon; reaches its highest peak at 5:00 p.m.; and then gradually diminishes. Activity at the department store picks up slowly after opening, reaches a prolonged peak during the noon hours, recedes, and rises toward less than half its noontime level between 5:00 and 6:30 p.m. By referring to Table 3 we can see that this particular department store does almost 50 percent of its business during 2½ hours at lunchtime and only 6 percent during its late open hours. The pattern at the restaurant is similar. About 47 percent of the activity shown occurs

TABLE 3

DAILY PEAKING PATTERNS OF FIVE SELECTED BUILDINGS

Time	Percentage of 12-Hour Flow During Each 15-Min Period								
	Office, Flat Peak			Office, Sharp Peak			Dept. Store	Restaurant	Residential
	In	Out	Two-Way	In	Out	Two-Way	Two-Way	Two-Way	Two-Way
7:30-7:45	1.0	0.2	0.6	0.7	0.1	0.4			1.4
7:45-8:00	3.0	0.4	1.7	1.2	0.1	0.7			1.6
8:00-8:15	4.3	0.8	2.6	2.2	0.1	1.1			1.5
8:15-8:30	6.6	0.5	3.5	3.6	0.3	2.0			3.5
8:30-8:45	6.8	0.5	3.7	6.6	0.3	3.4			3.2
8:45-9:00	8.3	0.6	4.4	10.3	0.2	5.3			3.4
9:00-9:15	4.6	0.9	2.8	11.8	0.3	6.0	0.0	0.0	2.9
9:15-9:30	2.6	0.8	1.7	4.6	0.8	2.7	0.0	0.0	1.8
9:30-9:45	2.1	0.7	1.4	3.0	0.7	1.9	0.2	0.0	2.3
9:45-10:00	1.8	1.2	1.5	1.3	0.5	0.9	0.8	0.0	1.4
10:00-10:15	1.6	1.0	1.3	1.3	0.9	1.1	0.8	0.5	1.6
10:15-10:30	1.5	1.0	1.2	1.0	0.8	0.9	0.9	0.6	1.7
10:30-10:45	1.4	1.0	1.2	1.1	0.8	0.9	1.1	0.7	1.9
10:45-11:00	1.4	1.1	1.3	1.0	0.8	0.9	1.3	0.8	1.2
11:00-11:15	1.4	1.2	1.3	0.8	1.1	0.9	1.5	0.9	1.3
11:15-11:30	1.3	1.5	1.4	0.7	1.1	0.9	1.5	0.9	1.2
11:30-11:45	1.3	2.0	1.6	0.9	1.9	1.4	1.6	1.0	1.2
11:45-12:00	1.4	3.4	2.4	1.1	5.5	3.3	2.6	2.6	2.0
12:00-12:15	1.9	5.2	3.6	1.0	5.9	3.5	4.0	3.5	1.1
12:15-12:30	2.9	5.0	3.9	1.1	6.7	3.9	5.2	5.5	2.4
12:30-12:45	4.0	4.1	4.1	2.0	4.7	3.4	6.2	4.3	0.9
12:45-1:00	4.0	2.8	3.4	4.0	3.4	3.7	6.2	3.9	1.6
1:00-1:15	3.5	3.0	3.2	4.6	2.8	3.7	5.4	4.9	1.3
1:15-1:30	2.8	1.9	2.4	4.6	2.1	3.3	6.0	5.9	2.4
1:30-1:45	2.4	1.7	2.0	5.6	1.9	3.8	5.1	4.3	1.3
1:45-2:00	2.1	1.4	1.8	6.2	1.7	3.9	4.9	3.5	0.9
2:00-2:15	2.7	1.3	2.0	3.8	1.1	2.5	3.5	2.9	1.5
2:15-2:30	2.2	1.3	1.7	2.1	1.1	1.6	2.6	3.2	1.0
2:30-2:45	2.0	1.4	1.7	2.3	1.3	1.8	2.6	2.1	1.6
2:45-3:00	1.6	1.5	1.6	1.4	1.2	1.3	2.0	1.2	1.3
3:00-3:15	1.2	1.7	1.4	1.1	0.6	0.8	2.2	1.0	2.0
3:15-3:30	1.2	2.0	1.6	0.8	0.7	0.8	1.5	1.0	1.5
3:30-3:45	0.9	1.5	1.2	0.8	1.2	1.0	1.7	0.8	1.6
3:45-4:00	1.0	1.3	1.2	0.7	1.2	0.9	1.4	0.8	1.9
4:00-4:15	1.0	2.5	1.7	0.7	1.7	1.2	1.5	0.8	2.7
4:15-4:30	1.1	8.2	4.7	0.5	1.8	1.2	1.7	0.9	1.9
4:30-4:45	1.4	5.9	3.6	0.6	2.5	1.5	1.7	0.9	2.1
4:45-5:00	1.9	9.1	5.5	0.5	8.6	4.6	1.8	2.4	2.6
5:00-5:15	1.2	6.3	3.8	0.2	14.6	7.4	2.5	2.4	2.9
5:15-5:30	0.9	3.0	1.9	0.3	5.0	2.6	2.5	2.0	3.4
5:30-5:45	0.9	2.5	1.7	0.5	4.8	2.7	2.2	1.7	3.5
5:45-6:00	0.7	1.8	1.3	0.3	1.8	1.0	2.4	1.6	3.9
6:00-6:15	0.7	1.6	1.1	0.3	1.6	1.0	3.0	1.6	3.1
6:15-6:30	0.5	1.1	0.8	0.3	1.2	0.7	2.0	3.2	3.0
6:30-6:45	0.5	0.8	0.7	0.2	1.0	0.6	1.0	3.3	2.3
6:45-7:00	0.3	0.5	0.4	0.1	0.7	0.4	0.9	3.2	3.6
7:00-7:15	0.1	0.5	0.3	0.1	0.5	0.3	0.9	3.0	2.9
7:15-7:30	0.0	0.3	0.1	0.1	0.3	0.2	0.9	2.8	2.7
7:30-7:45							0.6	2.4	
7:45-8:00							0.6	2.8	
8:00-8:15							0.5	2.8	
8:15-8:30							0.4	2.5	
8:30-8:45							0.2	1.8	
8:45-9:00							0.0	1.1	
12 hours	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sample			5,090[a]			13,000	42,300	1,970	1,700

[a]Average of 5 daily counts.

Even leaving aside these extremes, it is clear that the intensity of use varies inevitably within particular categories of buildings—no two retail stores are exactly alike and office buildings vary in their densities of occupancy and in the travel patterns they produce. Moreover, residential and other uses, which could not be registered by the statistical technique employed, also generate pedestrians. Also, both difficulties of definition and measurement errors or inaccuracies (such as the timing of the helicopter flights) contribute to the unexplained variation.

Analysis of the standard error is useful not only with regard to the equations as a whole but also in reference to particular coefficients. The coefficients of the equations in Table 1 are listed in column 3 of Table 2 (without rounding), and their respective standard errors are listed in column 4. Thus, in the case of avenues at midday, we can estimate that the addition of 1 million sq ft of office space on a block will produce 48.5 additional pedestrians, with a 95 percent confidence that the actual value will be between 30.7 and 63.3 pedestrians. Similarly, the addition of 250,000 sq ft of retail space on an avenue block sector will add 88 ± 15 pedestrians. It is evident that the standard errors of the individual coefficients are relatively much smaller than those of the equations as a whole. (The t-value, given in column 5 of Table 2, in this case represents the ratio of the coefficient to its standard error; the greater this number, the greater is the relative strength of the variable. Walkway space in all equations, retail space on avenues, and office space at midday are the variables that have the highest t-values, or the smallest standard error.)

The validity of a correlation equation can be undermined if the independent variables are related to each other. Tests revealed that, in most cases, the relationships among the five independent variables are not strong enough to affect the outcome of the analysis. For example, no significant correlation was found among the three building uses; in fact, the amount of retail and restaurant use has a slight tendency to be negatively related to the amount of office space. Proximity to transit entrances is completely unrelated to the amount of building floor space—which may be an ironic comment on past planning of midtown Manhattan. The amount of walkway space is unrelated to the floor space in retail and restaurant establishments, but it shows some positive correlation with office space, partly because of plazas in front of large new office buildings. In the evening avenue equation, that relationship is sufficiently strong (because of the particular sample of block sectors available) to justify deletion of walkway space as an independent variable.

CYCLICAL VARIATION IN PEDESTRIAN FLOW

The relationships between pedestrians and building floor space given in the correlation equations have the strength of being based on a large sample—all buildings in the study area. Their limitation is that they pertain to only two points in time. Pedestrian flow varies greatly in the course of day, and this pattern is most important for design purposes. To pinpoint the daily cycle and to verify and supplement the relationship between building floor space and pedestrian movement derived from the equations, manual counts of pedestrain flow during a 12-hour period were taken at selected locations. These include a number of typical buildings, at which all pedestrians leaving or entering in the course of a day could be observed, and several sidewalk locations. We shall turn first to the building counts.

Daily counts at five of the buildings surveyed are given in Table 3. These include two office buildings with different travel patterns, a department store, a restaurant, and an apartment house, all located in midtown Manhattan. The figures in Table 3 show the percentage of the total 12-hour flow that occurs during each 15-min interval; the totals on which these percentages are based are given for reference on the bottom line. The counts for the office buildings and the apartment house cover the period 7:30 a.m. to 7:30 p.m., those for the department store and the restaurant 9:00 a.m. to 9:00 p.m. These periods account for 100 percent of the daily traffic at the department store, almost 99 percent at the office buildings, probably close to 80 percent at the restaurant, and an estimated 70 percent at the residential building.

The figures in Table 3 are shown in Figures 3 and 4; they portray familiar patterns of pedestrian movement in a downtown business district. Activity at the office buildings

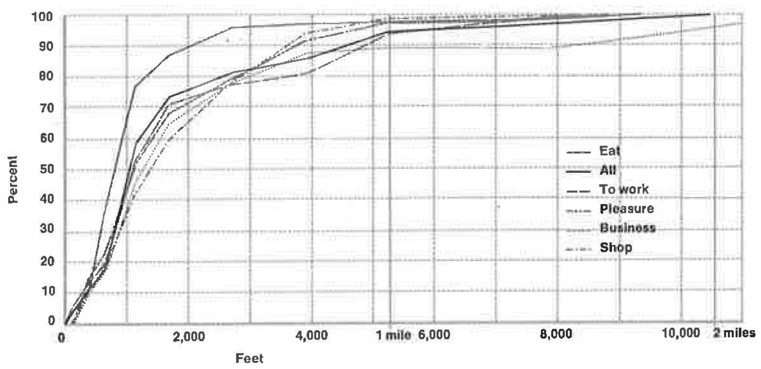

Figure 6. Cumulative walking distance distribution by purpose.

TABLE 8

CUMULATIVE WALKING DISTANCE DISTRIBUTION, BY PURPOSE OF TRIPS BY ALL MODES AT TWO OFFICE BUILDINGS

Walking Distance (ft)	Percentage of Trips Shorter Than the Indicated Distance (ft)					
	All Trips	To Eat	To Work	Pleasure	To Shop	Business
250	7	5	9	5	4	8
500	13	22	16	19	12	14
750	27	45	27	29	22	23
1,000	45	64	42	42	36	35
1,250	61	78	55	54	50	45
1,500	67	83	64	62	57	54
1,750	74	88	71	69	65	61
2,000	76	90	73	71	68	65
3,000	83	96	78	82	78	82
4,000	86	97	82	92	82	94
5,000	93	97	91	96	89	98
5,280 (1 mile)	94	98	94	98	89	98
6,000	95	98	95	99	89	98
7,000	96	99	97	99	89	99
8,000	97	99	99	99	90	99
9,000	98	99	100	100	92	100
10,000	99	100	—	—	95	—
10,560 (2 miles)	99	—	—	—	96	—
Average walk	1,720	1,073	1,880	1,666	2,253	1,737
Median walk	1,070	810	1,120	1,130	1,250	1,405
Number of trips	17,306[a]	1,118	7,294	669	640	955

[a]Trips to home, delivery trips, other trips, and those with an unreported purpose totalling 6,630 are included in this figure but not shown separately.

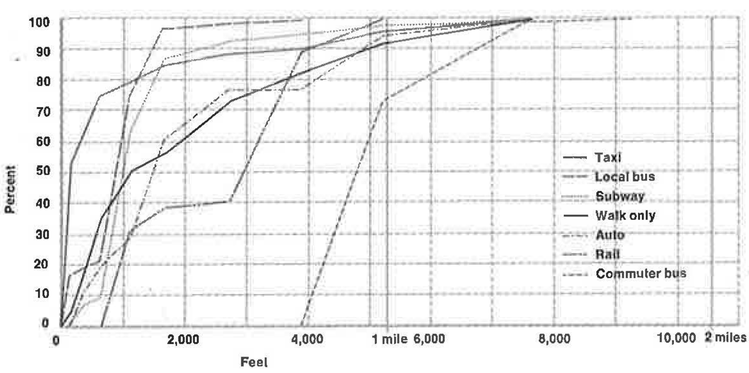

Figure 7. Cumulative walking distance distribution by mode.

TABLE 9

CUMULATIVE WALKING DISTANCE DISTRIBUTION, BY MODE, OF TRIPS TO WORK AT TWO OFFICE BUILDINGS

Walking Distance (ft)	Percentage of Trips Shorter Than the Indicated Distance						
	Taxi	Local Bus	Subway	Walk Only	Auto	Rail	Commuter Bus
250	50	18	3	10	5	0	0
500	70	20	8	25	15	0	0
750	77	35	23	39	21	0	0
1,000	79	62	50	47	26	23	0
1,250	81	81	69	52	36	33	0
1,500	83	90	80	55	51	36	0
1,750	85	97	88	58	62	39	0
2,000	86	98	89	61	66	40	0
3,000	89	99	93	76	76	51	0
4,000	91	100	95	83	78	90	5
5,000	95	–	97	90	91	98	60
5,280 (1 mile)	96	–	98	92	94	100	74
6,000	97	–	98	94	96	–	82
7,000	98	–	99	98	98	–	92
8,000	100	–	99	100	100	–	100
9,000	–	–	99	–	–	–	–
10,000	–	–	100	–	–	–	–
10,560 (2 miles)	–	–	–	–	–	–	–
Average walk	892	926	1,330	2,001	2,090	3,231	4,975
Median walk	160	890	1,010	1,100	1,490	2,970	4,820
Number of trips	347	641	2,827	807	409	1,057	228

94 percent walk less than a mile, and almost all walk less than 2 miles. However, the average walking distance is 1,720 ft, about a third of a mile, which is much higher than the median because of the distorting effect of the small proportion of very long trips.

The fact that almost 75 percent of the pedestrians studied do not walk all the way to their destination, but change to various mechanical modes of travel, suggests a closer look at walking distances in relation to the vehicular mode. In Table 9 the trips to work from Table 8 (which include return trips from other purposes at the two office buildings studied) are broken down by mode of travel. The cumulative walking distance distributions are shown in Figure 7. In addition, Table 9 gives the average and the median for each travel mode. It is clear that walking distance varies much more according to the vehicular mode than according to the purpose of travel.

The important message in Table 9 is the ranking of the different modes, with taxicabs having, quite plausibly, the shortest access distances, followed by buses and then by subways, and the commuter rail and bus terminals having the longest access distances—a function, again, of the relative scarcity of opportunities (there are only two rail terminals in midtown, whereas taxicabs or buses are ubiquitous). Interestingly, those who drive to work in the office buildings studied are willing to walk

TABLE 10

CUMULATIVE WALKING DISTANCE DISTRIBUTION AT SELECTED SUBWAY STATIONS AND PARKING FACILITIES

Walking Distance (ft)	Percentage of Trips Shorter Than the Indicated Distance			
	Three CBD Stations[a]	77 Lex IRT	Short-Term Parking	Long-Term Parking
250	17	7	19	9
500	31	16	46	16
750	44	27	49	23
1,000	56	36	55	37
1,250	64	46	65	47
1,500	69	56	70	56
1,750	74	64	75	61
2,000	80	70	80	68
3,000	95	92	88	82
4,000	98	100	98	92
5,000	99	–	99	97
5,280 (1 mile)	99	–	99	97
6,000	100	–	100	99
7,000	–	–	–	100
8,000	–	–	–	–
9,000	–	–	–	–
10,000	–	–	–	–
10,560 (2 miles)	–	–	–	–
Average walk	1,155	1,449	1,198	1,780
Median walk	900	1,380	700	1,220
Number of trips	32,611	6,336	31[b]	64[b]

[a]53rd-Lex; 50th-6th; 42nd-6th IND stations.
[b]Observations, not expanded.

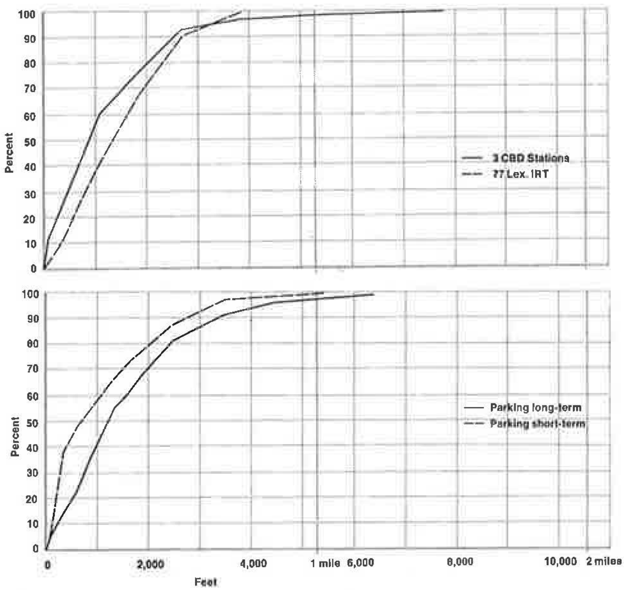

Figure 8. Cumulative walking distance distributions at parking lots and subway stations.

even farther than people on exclusively pedestrian trips—in fact, about three times the average distance reported for journey-to-work parking in cities over a half million in population (4). This reflects, to some extent, the high price of parking space in the vicinity of the buildings studied. The specific distances for walks to subway, rail, and commuter bus reflected in Tables 8 and 9 are also biased by the geographic location of the interviews and do not have general validity.

To obtain a more generally applicable measure of walking distances to subway stations and parking facilities in midtown, additional interviews were conducted, with the results given in Table 10 and Figure 8. Measured at stations, the walking distance to subways averages 1,155 ft in midtown and about 1,450 ft on the sparsely served East Side, and the respective medians are 900 and 1,380 ft. There is no significant difference between trips to work and trips for all purposes at these stations. Assuming an average walking speed of 285 ft per min (Table 7), the net walking time to the midtown stations averages about 4 min, that to the East Side station 5.1 min.

The walking distances for trip-to-work parking, if measured at the place of parking, have an average of about 1,800 ft and a median of about 1,200 ft. Both distances are about 500 ft shorter for short-term parkers.

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