Walking Access to Transit Stations

Evaluating Barriers with Stated Preference

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The last-mile problem refers to challenges that travelers experience in accessing transit stations from their activity locations. The objective of this study was to find the contributing factors that reduced people's propensity to walk and take transit. A stated preference study was conducted in the Chicago, Illinois, area with an online survey composed of questions based on the actual travel experience of the respondents. The data were used to estimate a logit choice model. The findings showed that access time, safety from crime, and sidewalk availability were important factors that influenced people's choice to walk to transit. The model was used to estimate time-based values associated with reduction in crime and sidewalk availability. The study also estimated the propensity to walk and use transit for a representative resident in each tract of the Chicago metropolitan area. These values were then used to identify census tracts where acute to minimal barriers to walking to transit existed. In addition to suburban areas that were not well suited for walking to transit, the results identified areas that were well served by transit but had other barriers that inhibited walking access to transit.

Public transportation offers a sustainable and healthy travel alternative to driving. A recent study reported that close to 70% of working-age residents in the 100 largest metropolitan areas in the United States live in areas that receive some type of transit service (*1*). Yet transit mode share is considerably low in the United States, with only 1.9% of all trips undertaken with public transportation compared with 83.4% by auto and 10.4% by walking (*2*). Although transit trips make up a small percentage of total travel in the United States, the share of transit in metropolitan areas as well as in central cities is relatively higher. The built environment (e.g., density) and personal factors (e.g., vehicle ownership) play important roles in the provision of service and the possibility that residents use transit service.

Much research has paid attention to general built environment and quality of transit service factors that affect modal preferences. These factors include transit facility location near home, work, or other activity locations; measures of service quality, such as frequency, reliability, and overall speed and travel time; wait times; and information availability about service, among others. Access and egress (last mile) components of transit trips also enter these considerations, but mainly as access distance or times and waiting times. More recently, however, issues around the last mile of transit service have received increasing attention [see, for example, Nelson/Nygaard Consulting Associates et al. (*3*), Wang (*4*), Deka and DiPetrillo (*5*), and Cheng et al. (*6*)].

The goal of this study was to contribute to this literature by identifying and valuing the factors that negatively affect the adoption of walking to stations to bridge the last mile. The study posited that these factors not only encompass variables such as proximity and sidewalk availability, but also social and other factors, such as crime, safety of the pedestrian environment, as well as availability of parking facilities. The study aimed to measure how these variables influence the decision to adopt walking as a transit access mode.

The study was a continuation of previous efforts to understand contributing factors to last-mile problems based on revealed data (*7, 8*). A stated preference (SP) experiment was employed to evaluate the sensitivity of travelers to variables that may contribute to station access mode decisions. The SP approach allowed the study to alter the prevailing conditions in the choice scenario and ask respondents whether their decisions would be different if certain aspects of their environment were altered. In this way, observations that would not have been possible for the same person in revealed contexts can be made. To ensure that the choices were realistic, all the questions were based on actual trips that respondents had previously taken. These data were used to estimate a choice model that would allow evaluation of the importance of different variables on walking to access transit boarding locations. In addition, the estimated model was used to identify locations with barriers to walking to transit boarding areas.

The rest of the paper is organized as follows. The next section provides a background on the literature. That is followed by a data section, which discusses the survey design and administration. The analysis presents the estimation of a model based on the SP data and the application of the model to the Chicago, Illinois, metropolitan area to identify places with different levels of last-mile problems. Finally, a summary of the findings is presented.

BACKGROUND

Access to transit facilities is an important factor in the choice to use public transportation and in the overall quality of public transportation trip experience. Improving access conditions can have a direct impact on the willingness of people to use transit. By some accounts, these improvements can be just as effective as transit system changes in encouraging transit use and can be more cost-effective (*9*). One important variable in facilitating access to transit is ensuring the proximity of stations to origins or destinations. Cervero et al. found that proximity is important, but that people were willing to travel further to access rail service than to access bus

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service (*10*). Similar findings were reported by Daniels and Mulley (*11*) and Ker and Ginn (*12*). The findings suggest that although proximity is important, some of the barriers it poses can be compensated by improved transit service. Loutzenheiser looked at walking access to Bay Area Rapid Transit (BART) stations in California and found that distance to transit stations is among the most important variables influencing mode choice (*13*).

In addition to proximity, factors of the built environment, such as density and conditions at the station, affect access and transit use. Cervero et al. used ANOVA and regression analysis to show that people in denser places usually walk to transit stations in contrast to individuals in suburban settings (*10*). The authors also found that people with cars are likely to drive to stations if parking is available. Lack of pedestrian-friendly environments and the land use mix around stations also influence people's decision to drive instead of walk to transit stations. Cervero suggested that converting park-and-ride lots to transit oriented developments can reduce the pedestrian access problems (*14*). Park noted that street design, the quality of path walkability, and walking distance significantly affect people's mode choice to transit stations (*15*).

Research has also focused on the safety issues surrounding transit facilities. Hess et al. showed that roads with bus stops have a higher number of pedestrian crashes (*16*). Kim et al. considered light rail transit access and showed that the level of crime around stations impacts transit ridership as well as the mode choice to transit stations (*17*). Walton and Sunseri, by contrast, found that fear of crime, distance to transit stops, carriage of goods, or concern about time are of lesser importance compared with the convenience of the car and bad weather in explaining why people drive instead of walk to transit (*18*). Olszewski and Wibowo (*19*) and Loutzenheiser (*13*) found that women are less likely to choose to walk to transit than men, because of safety concerns. Works by Dieleman et al. (*20*), Ewing and Cervero (*21, 22*), and Frank et al. (*23*) noted that the built environment is as important as sociodemographic factors in influencing people's mode choice.

Overall, the research literature has suggested that proximity, density, crime, and personal variables are important in influencing how people access transit. In many cases, these studies have used revealed preference data where variables in the analysis could not be altered for the same individual. The goal of this study was to complement these studies by collecting experimental stated preference data where individuals who use transit and walk to access transit stations are asked about what they would do if conditions in their environment were changed. Such data allowed the authors to incorporate factors that otherwise would not vary considerably for the same person over short-to-medium time frames, such as the access distance or crime or pedestrian environments.

DATA

The data for the analysis were from an SP survey that was administered in the Chicago metropolitan area in 2013. The survey was web-based and questions were based on trips that individuals had already made. Although the analysis looked specifically at walk access to transit stations, the data collection effort was broader, encompassing walking access as well as the option to use driving access, abandon a transit mode, or forgo a trip. For completeness, the entire survey effort will be described, but only a subset of the data where persons indicated they walked to access a transit station on a reference trip were used in the study.

Survey Design

A criticism of SP surveys is that they lack the realism of the constrained choices that individuals make in real life. To address this issue, the approach of the survey design was to relate the choice scenario to a trip the respondent had already experienced. For transit users, the questionnaire began by asking respondents to think of their most recent transit trip and report its characteristics and the choices they made. The survey asked where the first transit boarding station was, how the respondent arrived at the location, and how long it took to get there from their point of origin. Respondents were also asked to assess the corridor they used to arrive at the station and the boarding station for the following: safety from crime, presence of sidewalk, safety from traffic, availability of parking at the station, presence of a shelter at the boarding location, and transit information availability at the boarding location. All this information was collected on a 5-point scale.

Any alternation to the SP scenario was made in the context of the reported trip. Respondents were asked to imagine making the same trip with all the modal options they had on the reported trip. They were then told to imagine a scenario in which the existing path was closed for construction and a single alternative path was open for them to access the same boarding location. The alternative may have different combinations of access time, crime, safety from traffic, sidewalk availability, and parking availability compared with the path the respondent had experienced. The person still had the choice to use a prior mode choice or to alter it. By setting up the SP question on the basis of an experienced trip, the study aimed to provide a level of realism to the choice context that would not have been possible if the study had simply asked the respondents to make choices without providing that context.

The SP survey used a full factorial design with five variables, each having the number of levels shown in Table 1. This led to a total of $3^3 \times 2^2 = 108$ SP questions. The SP questions were then randomly classified into 12 groups, each containing nine questions. Twelve identical versions of the survey were created, each having one of the 12 randomly bundled SP questions. The questionnaires were hosted online on the Qualtrics survey platform. Each respondent was welcomed by an introduction page and, on agreeing to proceed to the survey, a program automatically assigned the visitor to one of the surveys. The assignment was done iteratively so that the first respondent was assigned to Survey 1, the next to Survey 2, and so on, and the pointer cycled back to Survey 1 after a respondent had been directed to survey 12. This process ensured that a roughly equal number of responses were received for each bundle of SP questions. In this way, each person was randomly assigned to a survey with one of the bundled SP questions; each SP question, by design, was also randomly assigned to an SP questionnaire bundle.

TABLE 1 Variables and Levels Used in the SP Experiment

Variable	Factor Level
Access time	5, 12, 25 min
Safety from street crime	1 (one of the worst), 3 (average), 5 (one of the safest)
Traffic safety	1 (one of the worst), 3 (average), 5 (one of the safest)
Sidewalk	0 = no; 1 = yes
Parking available	0 = no; 1 = yes (with fee or not)

Survey Administration

The survey was administered over the web. Recruitment followed two strategies. In an attempt to capture a demographic that it was felt might be difficult to get to a web-based survey, the study reached out to several community organizations and transportation-related institutions to circulate the survey to their members. In addition, recruitment was undertaken by mailing letters to 5,000 households in the metropolitan area. The mailing list was purchased by providing zip code areas in the following counties: Cook, DuPage, Kendall, Kane, Grundy, McHenry, Will, and Lake. The number of addresses from each zip code for the first 4,000 addresses was selected by using the proportion of the population in the metropolitan area as weights. The additional 1,000 records were sampled randomly from zip codes with predominantly minority households (exceeding 50%). Letters inviting participation were sent to 5,000 households, followed by a postcard reminder 2 weeks after the letters were mailed. The survey also offered participants the chance to win one of 50 gift cards for $15 for Target stores or a chance to win one of four Kindle Fire HD tablets. Because of incorrect addresses, 222 postcards were returned and a total of 335 respondents participated in the online survey for a 7% response rate.

The breakdown of the respondents' sociodemographic characteristics along with that for the metropolitan area is given in Table 2. The gender, race, and household structure of the respondents closely reflects those in the metropolitan area. Although the survey was able to reach respondents at the lower income range, the proportion of respondents in the middle income range was lower than that in the metro region, and those in the highest income brackets made up a significantly larger proportion of the pool.

The majority of the respondents (85%) had made at least one trip in the region by train or bus in the past 3 months. The remaining 15% of the respondents were mainly auto users, but could have taken transit for the base trip they reported (the base trip was the one on which the SP survey was based). About 80% of the reported trips started from home and 32% of the trips were destined to work in the region. Other purposes included social activity, entertainment, shopping, meeting friends, going to restaurants, and health care.

TABLE 2 Comparison of Demographic Variables Between Survey Data and Regional Data

Variable	Survey Data (%)	Regional Data (%)
Gender		
Female	50.6	51.1
Male	49.4	48.9
Race		
White	66.9	64.3
African-American	24.5	17.7
Asian	8.2	6.1
Native American	0.4	0.2
Pacific Islander	0.0	0.0
Hispanic	6.0	21.3
Income ($)		
<10,000	6.8	2.0
10,000–19,999	7.6	4.9
20,000–29,999	8.1	10.2
30,000–39,999	7.6	15.9
40,000–49,999	11.4	21.0
50,000–59,999	9.3	15.9
60,000–69,999	7.2	11.5
70,000–79,999	5.1	7.5
80,000–89,999	5.5	4.5
90,000–99,999	5.9	2.2
100,000–150,000	14.0	3.7
>150,000	11.4	0.7
Household size		
1 person	25.0	28.0
2 persons	38.7	29.2
3 persons	16.4	15.8
≥4 persons	19.9	27.0
Household vehicles		
1	18.4	35.6
2	41.4	36.2
3	29.7	11.4
≥4	10.6	4.3

ANALYSIS

The analysis first aimed to estimate the influence of last-mile variables on the propensity to walk to access transit. This was done by estimating a choice model that links responses to the stated preference variables as well as other sociodemographic variables. Once the model was estimated, it was applied to estimate the likelihood that an average resident in the various census tracts in the metro region would choose to walk to access transit based on observable neighborhood variables. The analysis was divided into two parts. The first was the estimation of the model. The second part looked at the propensity to walk to transit stations in different census tracts in the Chicago metro area.

The analysis looked at the impact of different variables in choosing to walk to a transit station. In particular, the study was interested in the weights people associate with access travel time, crime, safety, and sidewalk availability on a path. To be able to estimate the influence of these variables on the decision to walk and use transit, a subset of respondents were selected who were already familiar with the walking environment in their neighborhoods and had adopted this mode choice in their reference trip.

A binomial logit model was used to estimate whether, under the different changes in the SP variables, the respondent would continue to choose the walk–transit mode choice or abandon it. To ensure that the choice of other modes was plausible, the cases analyzed were cases where the respondent reported a base trip that originated from home. When the SP conditions faced by these respondents were examined, the presented choices had higher access time than the respondents reported in 67% of the questions. Crime was worse in 52% of the cases and safety from vehicles was worse in 51% of the cases. A sidewalk was available in 48.6% of the cases. Respondents chose to stay with their original mode of walk–transit in 47.9% of the choice presentations. The choice to use walk–transit access was modeled as follows:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 \Delta T_{ij} + \beta_2 \Delta S_{ij} + \beta_3 \Delta C_{ij} + \beta_4 \Delta W_{ij} + \sum_{l} \gamma_l E_{li} + \sum_{l} \eta_i P_i + \zeta F_i$$

where

p_i = probability that a person chooses to take the trip as walk–transit (i.e., no change from the reported base trip);

ΔT_{ij} = change in access time to get to boarding location for person i in choice scenario j;
ΔS_{ij} = change in perceived safety from traffic, measured on a 1 to 5 scale, with 1 = least safe, and 5 = very safe;
ΔC_{ij} = change in perceived crime along new corridor, measured on a 1 to 5 scale, with 1 = safest, and 5 = least safe (in original survey, responses for crime were collected using reverse scale, with 1 = least safe, 5 = safest; for analysis, scale was reversed so that higher numbers represent higher levels of crime to enable an intuitive interpretation of model);
ΔW_{ij} = presence of sidewalk on new route;
I = household income;
E_{li} = ratings of existing conditions indexed by l in corridor used by respondent i, in this case focusing on crime and sidewalk availability [E_{ci} = existing rating of crime (0 = safe; 1 = medium to high levels of crime); E_{wi} = current access path has limited sidewalk availability (0 = no; 1 = yes)];
P_i = characteristics of person i or their household (sex, age, income, etc.);
F_i = existence of parking fee at destination of trip if respondent chose to drive; and
$\beta, \gamma, \eta, \zeta$ = parameters to be estimated.

The results of the estimated model are reported in Table 3. In general, the variables in the SP survey all have the expected signs. Only changes in traffic safety perceptions were found not to impact the decision of the traveler. The model estimates the likelihood that the person repeats the transit mode choice accessed by walking. Increases in access time made it less likely that the person would repeat the choice. Each additional minute reduced the odds by approximately 6%. Crime has a large impact in the reduction of the odds of repeating the choice. All things equal, a unit shift in perceived crime conditions for the respondent reduces the possibility of access by about 32%. When the alternative route has a sidewalk, the likelihood that the person chooses to stay with his or her existing choice increases by 44%, holding all other attributes at the same level.

The choices were not independent of the person's current path conditions or sociodemographic characteristics. Those reporting that their current path had medium to high levels of crime were much more likely to switch their modes than those reporting safe conditions. All things equal, those currently experiencing such corridors had 54% higher odds of choosing to switch than their counterparts who indicated their corridors were very safe from crime. Those who indicated limited sidewalk availability were also more likely to say that they would choose to switch their pattern of travel.

Among the sociodemographic variables, gender had a significant impact on choice. Women indicated they would switch modes more readily than men. With age, respondents were less sensitive to the changes in the SP context, choosing to stay with their original choice of walk–transit mode. Those without household vehicles chose to stay with their current mode, as would be expected. Although the group without vehicles did not have the option to drive themselves, carpooling with others or changing their access mode were reasonable alternatives available to them. Their choices in the SP context overwhelmingly were to choose their existing mode more than others, with the odds being higher by 257%.

Respondents with higher incomes were less likely to stay with their original mode choice. Those with larger households were less likely to switch their modes. Those with a college education were slightly more likely to choose to stay with their walk–transit mode. The possibility that there would be a charge for parking at the destination made it more likely that a respondent would choose the current walk–transit mode.

To rank the relative importance of each measure, the study used the marginal rate of substitution between each of the SP variables and access time. This gave a value that interprets the marginal unit shifts in the different variables that can be in equivalent changes of travel time that would have the same impact on the utility of the decision maker. This value was calculated by taking the ratio of the derivative of the utility with respect to the variable of interest to the derivative of the utility relative to access time [$(\partial U/\partial X)/(\partial U/\partial T)$], where X is a variable whose value is expressed in terms of access time. Following this method, estimates for the value of a unit shift in crime perceptions are 6.2 min. That is, a shift of 1 unit in perception of crime (for example, an increase) has a similar impact as an

TABLE 3 SP Model Estimates

Category	Factor	Estimate	Standard Error	z-Value	Pr(>|z|)
Neighborhood factors (SP)	(Intercept)	–0.798	0.410	–1.95	.057
	Access time, ΔT	–0.063	0.008	–7.98	.000
	Crash safety, ΔS	0.055	0.042	1.29	.198
	Crime safety, ΔC	–0.392	0.048	–8.23	.000
	Sidewalk, W	0.370	0.151	2.45	.014
Neighborhood factors (actual)	Crime (current), E_c	–0.767	0.201	–3.81	.000
	Sidewalk unavailable (current), E_w	–0.944	0.335	–2.81	.005
Sociodemographic variables	Sex (female = 1), G	–0.487	0.168	–2.89	.004
	Age, A	0.023	0.005	4.43	.000
	Household size, Z	0.157	0.070	2.24	.025
	No vehicle, V	0.945	0.201	4.71	.000
	Household income, I	–0.006	0.002	–2.82	.005
	Education, Ed	0.299	0.181	1.65	.098
Travel cost	Destination parking fee, F	0.563	0.1765	3.19	.001

NOTE: Goodness of fit: null deviance = 1,269.6 on 916 degrees of freedom; residual deviance = 1,056.7 on 903 degrees of freedom; pseudo-R^2 = .168; Akaike information criterion = 1,084.3. Pr = probability.

increase in access time of 6.2 min. For the binary variable of having a sidewalk, the impact is equivalent to 5.9 min. The average access time in the SP survey on which these modal preferences are measured is 12 min of walk time. Based on their revealed experiences, the average travel time for respondents was 7.8 min.

IDENTIFICATION OF AREAS WITH LAST-MILE PROBLEMS

In this section, the estimated model is used to classify the Chicago metropolitan region into places with high and low levels of last-mile problems. The section identifies places where last-mile challenges make it unlikely to adopt transit use with walk access. These factors are not just related to the travel time it takes to reach a destination, but also have to do with perceptions of the safety and walkability of the path. The model allowed the analysis to move from understanding the contributing factors to evaluating and creating a hierarchy of places that take into consideration the physical and social attributes of place. In addition, these preferences are not independent of the sociodemographic characteristics of the residents. Variables such as age, household size, income, gender, and education level were also seen as influencing modal decisions. A ranking of places was generated on the basis of characteristics of place, perception of the area, and the current residents in the areas considered. The analysis was undertaken at the census tract level for the Chicago metropolitan area.

Methodology

The methodology used to generate a hierarchy of locations experiencing last-mile issues was to use the estimated model to predict the likelihood of use of the walk–transit mode in different neighborhoods (census tracts), taking into consideration area characteristics and a representative resident in the area based on census statistics. In addition, since some of the variables in the model were primarily perception variables (e.g., crime), an intermediate step was taken to predict how residents perceived the areas under consideration with a five-point scale similar to the one used in the stated preference survey.

A combination of data sources was used for the analysis. Census statistics were gathered from the 2011 American Community Survey. Crime statistics were gathered from Chicago's open data portal (*24*). Municipality crime statistics were obtained from *The Chicago Tribune* (*25*). Transit station information for the Chicago Transit Authority (CTA) and Metra commuter trains was also gathered from Chicago's open data portal. In addition, data from the SP survey were used to develop estimates of residential crime perceptions as well as neighborhood walkability.

Several intermediate steps were taken to process the data to work with the estimated model. First, although crime data for the city of Chicago are available in a very detailed format that can be aggregated to census tract geographies, municipality crime data are in general only available for larger municipal units, which often constitute several tracts. For municipalities, the study used the crime rate data from Rynkiewicz to estimate counts of crime per municipality and divided the crime into tracts with tract populations as weights (*25*). A tract was assumed to be in a given municipality if its geographic centroid fell within the municipality's boundary. These numbers were combined with data from the City of Chicago to generate crime rates for each census tract expressed in crimes per 1,000 persons [(crime count/population) $*$ 1,000].

A separate model was used to link census-level variables to the perception of crime, with the ratings provided by respondents in the SP survey. The data were used to develop an ordered logit model with the five-point ordered crime perception ratings in the SP survey as a dependent variable. The estimated model finds that perceptions of reported crime depend on the log of the actual crime rate and the median income in the neighborhood. Both variables have the anticipated sign, with higher crime rates leading to higher perceptions of crime and higher neighborhood income leading to a perception that a neighborhood is safer, all things equal. This model was then applied to all tracts in the metropolitan area to estimate how a resident would perceive crime in the area along a five-point scale. Figure 1 shows a box plot of the measured crime rate against the modeled perceived crime (1 being safest and 5 being least safe).

A similar procedure was used to estimate what the rating for sidewalk availability would be for residents of different census tracts. Because the SP model uses a binary dichotomy, the study estimated a binomial logit model relating people's ratings of their sidewalk availability and neighborhood factors [to convert the five-point response to a 0–1 variable, ratings were recorded of 1 and 2 as low levels of sidewalk availability (0) and ratings of 3 to 5 as acceptable to good levels of availability (1)]. The log of population density, median income, percentage living in poverty, and percentage of persons with no vehicles were found to be important variables for this prediction. The model was again applied to the regional data to get estimates of whether areas would be rated as having sidewalks that residents could use.

The remaining variables for the model used a representative individual from the tract under consideration. The characteristics of the person based on whom predictions for the tract were made were female, having the median age and income of the tract, the average household size of the tract, simulated vehicle ownership based on the tract's ownership profile, and assumed to be a noncollege graduate.

In addition, walking travel time for each tract to the nearest station had to be estimated. This was done by computing the distance for each block group centroid in a tract to the nearest CTA or Metra transit station or stop. That distance was then averaged to get an approximate measure of the walking distance to transit for the average tract resident. A shortcoming of this approach is that areas served by Pace transit buses will have relatively high travel times, thereby making them appear unreachable. This issue arises mainly from Pace policy allowing passengers to flag buses to a stop in many locations and avoiding fixed stop locations. As a result, areas served by Pace will have relatively high walk-access travel times. To address this problem, the study compared how the measures of last mile barriers are affected by capping walk access travel times at 45 and 60 min, and found only moderate differences where places classified as having acute problems were reclassified as having significant last-mile barriers.

Last-Mile Problem Severity Results

A hierarchy of the places experiencing last-mile problems was created on the basis of whether a representative individual in the tract under consideration would use the walk–transit mode for a generic

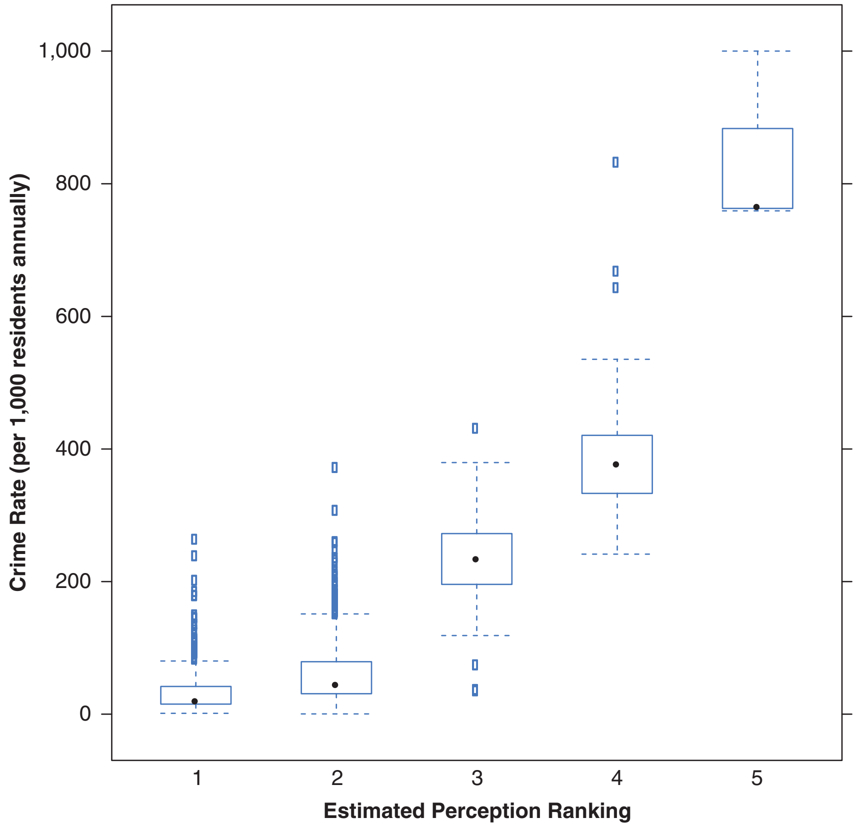

FIGURE 1 Observed crime rate versus estimated perception of crime for tracts in metropolitan region (black dot = median; box = middle 50% of data; whiskers extend to 1.5 times interquartile range).

trip. The estimated probabilities are based on three important factors: (*a*) the built environment, (*b*) the perception of social factors such as crime, and (*c*) the decision maker's characteristics. Figure 2 presents the Chicago metropolitan area color-coded into areas where walk-access last-mile barriers are presented from low to severe barriers to access on the basis of the previous three general factors.

As was expected, walk-access is identified as problematic in most suburban environments. The map in Figure 2 also shows that having transit service in an area is not sufficient for a place to be ranked as having the least amount of access barriers. As can be seen in parts of the west and south of Chicago, the model classifies areas near transit stations as having significant last-mile barriers on the basis of crime and other factors that may limit access. The analysis offers an opportunity to improve transit access and use through the use of broader tools that cities can use to ensure better pedestrian environments.

SUMMARY

This paper reported on an SP survey that was undertaken for experimental evaluation of the contributing factors to the last-mile problem. Analysis of the SP data demonstrated that the decision to walk and connect to the transit system is often influenced by variables that go beyond travel time alone. In particular, the model was able to tease out the effects of the perception of crime and sidewalk availability on the odds of choosing to walk and use transit. The findings suggest that perceptions about crime have an equivalent impact on choosing to walk as lengthening the access trip by about 6 min for the respondents. Lack of a sidewalk has the same influence as increasing access trip times by about 5.9 min. Respondents were less sensitive to perceptions of crash safety. This finding may be because respondents feel that they have control over crash safety, for example, by observing traffic rules and being cautious. However, the absence of a sidewalk or crime may be seen as things over which the respondents have little control. These values allowed the study to evaluate a ranking of environments that incorporates the relative importance of each attribute.

The estimated model based on the SP data was used to classify the metropolitan area into places that have last-mile walk-access problems that can be considered low to acute. These measurements combined access time, crime perceptions, and characteristics of neighborhoods and residents. From the map showing the prevalence of last-mile problems (Figure 2), suburban areas that are not very close to transit are captured well by the model as having acute last mile barriers. This result was intuitively expected. The map also demonstrates that having transit service in an area is not sufficient for a place to be ranked as having the least amount of access barriers. As can be seen in parts of the west and south of Chicago, the model classifies areas near transit stations as having significant last-mile barriers. Although access travel times may be good in these areas, other problems, such as perception of crime, walkability, and sociodemographic variables of the residents, make it less likely that residents find walk–transit an attractive mode to use.

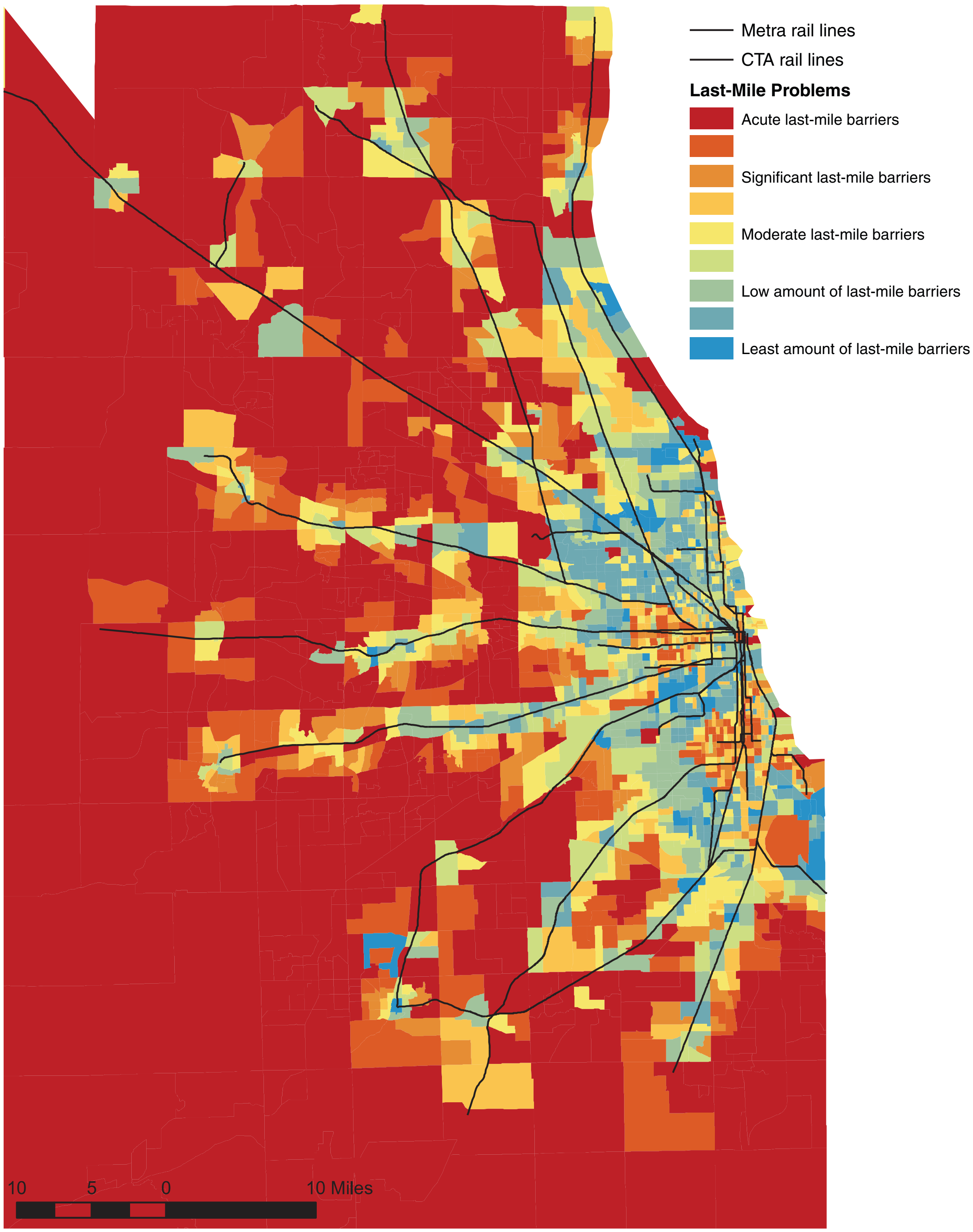

FIGURE 2 Areas of high and low levels of last-mile problems in metropolitan Chicago.

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