2015

Engaging Vulnerable Populations Using Participatory Mapping: Lessons Learned and Guidelines for Community Advocates and Transportation Planners

Laxmi Ramasubramanian
CUNY Hunter College

[How does access to this work benefit you? Let us know!](#)

Follow this and additional works at: http://academicworks.cuny.edu/hc_pubs

Part of the [Geographic Information Sciences Commons](#), and the [Urban Studies and Planning Commons](#)

Recommended Citation

Dr. Laxmi Ramasubramanian, PhD, AICP
Hunter College
Department of Urban Affairs and Planning
695 Park Avenue, Room 1611 HW
New York, NY 10065
Email: laxmi@hunter.cuny.edu

ENGAGING VULNERABLE POPULATIONS USING PARTICIPATORY MAPPING: LESSONS LEARNED AND GUIDELINES FOR COMMUNITY ADVOCATES AND TRANSPORTATION PLANNERS

I. INTRODUCTION AND SCOPE

Individual travel behavior shapes every aspect of transportation planning, ranging from the development and maintenance of key infrastructure to the routine management of transportation operations. The research that frames this paper takes the position that contemporary transportation planning models and decision frameworks do not directly address the travel needs of low-income people for two main reasons; first, because the travel behaviors of low-income people are not well understood; and second, the exclusive focus on the *journey-to-work* does not effectively capture the lived transportation experience of many vulnerable populations.

The research study that frames this paper is built on three major assumptions: *first*, that transportation planners and policymakers can become more effective in their efforts if they better understood the complexity of the lived experiences of low-income populations; *second*, that a web-based tool with a visual interface could gather relevant data quickly and effectively without reducing data complexity; and, *third*, that local community-based organizations can use standardized data collection and visualization methods to become more effective advocates for innovative and affordable transportation alternatives.

This paper describes the implementation of a pilot project set in Newark, New Jersey that explored the feasibility of using qualitative data collection methods (semi-structured interviews and participatory mapping) to develop a holistic understanding of the transportation experiences of low-income populations. The research identified an effective participatory approach to gather data about the entirety of people's lives, rather than exclusively focusing on their journey-to-work trips. The data gathered from a small sample of participants, (n=44) was then used to build out a web-based application to facilitate and streamline the data collection process.

The next section of the paper, Section II describes the theoretical frameworks that shaped the study. The following sections sequentially discuss the data collection approaches that were tested and the development/description of the web-based application. The concluding section discusses some guidelines for community advocates and transportation planners who want to engage vulnerable populations in planning issues.

II. EXPANDING ACTIVITY SPACES

The complexity of the travel needs and behaviors of low-income and vulnerable populations is not well understood and continues to be a subject of inquiry (for example, Transit Cooperative Research

Program (TCRP), 2008). Scholars have tended to focus their investigations on poor individuals' commutes from their usual places of residence to their usual places of work, addressing either the spatial challenges of distance (the difficulties involved in getting to work using public transportation) or the social factors that prevent individuals from finding work (such as lack of information about jobs, racial discrimination, lack of job skills) (for example, Wilson, 1996, Gilbert, 1998, Johnson, 2004). The emergent policies that strive to make jobs accessible through the provision of public transportation address the spatial mismatch between jobs and housing first articulated by Kain (1968) and has become a key driver for transportation policymakers. Proponents of this thesis observe that low-income individuals are often residents of inner cities while the jobs they seek are located in the outer suburbs not easily accessible using public transport (Kain, 1968, Kain, 1992, Ihlanfeldt and Sjoquist, 1998). To ameliorate the problem, the federal government created the Jobs Access/Reverse Commute (JARC) program to fund projects that transport welfare recipients and other low-income workers from their homes to their jobs (Federal Transit Administration, 2014). This approach has found favor across all sides of the political spectrum because stable employment is viewed as one of the key stepping stones to prosperity. .

Critics of JARC programs have pointed out that low-income people are forced to make complex residential and employment location decisions in order to balance work and household responsibilities. Although JARC programs have solved commuting challenges for some job-seekers, they have not been effective in creating stable employment opportunities for the poor because the provision of transportation services alone has not been sufficient (Allen, Misek and DiJohn, 2014) For low-income people, the search for meaningful paid work is mediated by many other considerations (Blumenberg and Waller, 2003; Chappelle, 2006). For example, parents or caregivers of young children are likely to engage in localized job searches in order to identify jobs that better accommodate their child-rearing and household management responsibilities (Blumenberg, 2002). Understanding the nature of the work that low-skilled, low-wage earners undertake is also central to making meaningful planning decisions on their behalf (Horner and Mefford, 2007). Shift workers and part-time workers commute during odd hours, many begin their trips when conventional white-collar workers are heading home. Work hours are seldom consistent; one week's commuting pattern can be very different from the next. Workers' arrival and departure tends to be monitored more rigorously. Without owning a private vehicle, low-income people cannot reliably participate in the labor market, especially in auto-dependent areas without reliable public transportation alternatives (Kawabata, 2003)

An individual's age and disability status affects their socio-economic status (APA, 2014). For example, 23% of people with a disability live in poverty, a rate higher than those without a disability (U.S. Census Bureau, 2014). Older adults are more likely to unemployed, underemployed or have dropped out of the labor force (Rix, 2014). Yet, these individuals also have many necessary travel obligations -- to search for work, participate in a variety of routine activities such as visiting doctors, getting physical therapy, or simply shopping for groceries.

The lack of understanding of travel behavior and the mobility barriers facing low-income individuals is further exacerbated because low-income individuals are less likely to participate in travel behavior research. When low-income people do participate in research studies, the focus of the research is often issue specific – e.g., responding to questions about the barriers in accessing a particular job site or inquiries that are focused on a particular industry sector (e.g., retail). The confusing complexities associated with day-to-day travel experiences of low-income people is seldom documented. Without supporting data and evidence it is difficult for public transportation advocates and policymakers to make a case for new transportation alternatives to serve low income people.

Developing a holistic understanding of individuals' travel behavior and examining their mobility barriers require that we link travel to *individual agency*, *space*, and *time*. *Individual agency* addresses motivation – why do people travel? *Space* refers to the physical geography or terrain that must be traversed using a variety of travel modes – where do they go? *Time* accounts for how long it take to get to a particular end destination but it also considers when people begin and end their journeys.

The challenges of traversing great physical distances can sometimes be overcome by changing travel modes *or* by changing the temporal constraints. In other words, the same physical distance, say one mile, can be accessed in about a minute in a private motorized vehicle, whereas it may take about twenty minutes to cover on foot. If a bus is involved, then, the wait time for the bus may have to be considered in computing the time taken to reach the destination. Particular characteristics of the natural or built environment, such as presence or absence of sidewalks or a steep slope can increase travel time depending on the choice of travel mode. Individuals' *abilities* and *perceptions* of their physical environment including their judgments about the trip distance, difficulties likely to be encountered along the way, and considerations such as safety, comfort, and the costs of the trip all influence travel behavior.

Researchers have coined the term *Activity Space* to help understand travel behavior in a holistic way. For the purposes of this paper, activity space is a "graphical representation of the [geographic] space within which a group of activities are carried out for an individual or a household" (Newsome, Walcott, & Smith, 1998. page 361). It is important to note that an individual's activity space may or may not represent the maximal geographic area over which he or she could engage in activities. The activity space defines the geographic area over which individuals are *likely* to engage in those activities depending on real and perceived constraints. The Activity Space concept approaches travel from a time-geography perspective (Hägerstrand, 1970) and makes it possible for geographers, planners to examine individual activity patterns across space-time with a view towards understanding, explaining, and predicting individual travel behavior and commuting patterns (Hanson and Hanson, 1981; Goodchild and Janelle, 1984; Adams, 1995) Although not a focus on this paper, it must be noted that there is an extensive GIScience literature on measuring accessibility (for example, Miller, 1999; Kwan et.al., 2003).

In this paper, the research team posits that policies aimed at increasing mobility, instead of job access, may prove more beneficial in the long-run for improving the economic opportunities and quality of life of low-income people. We further propose that the activity space framework can help researchers examine the travel needs, decisions, and behaviors of low-income travelers, looking at how, when, where, why, how often, and with whom trips are made; how trips are prioritized; the choices and tradeoffs that are made; the trips that are forgone; and the impact of those choices on mobility and quality of life.

In addition to beginning to shift the focus to overall mobility, this project also offers to add new insights and data, both qualitative and quantitative, to existing data sets to help visualize the activity space of low-income populations and understand the issues that limit that space. Traditional transportation planning relies heavily on census data, household surveys, employment data, and other official data sets to highlight the transportation gaps in moving people from major origins to major destinations. By allowing the public to provide data from their own experience, a clearer picture of the important transportation gaps will emerge. The incorporation of individual narratives and personal data can help depict and interpret the connections and contexts of people's travel experiences from

the household, to the neighborhood, to the metropolitan scale and how they impact mobility patterns. This will strengthen on-going mobility research by linking the transportation experience to the socio-economic and cultural context in which the trip is made and to the circumstances of the individual making the trip.

Mapping and data visualization have become an increasingly important technique to help the public better understand the transportation planning process and to foster public participation about complex planning issues (Ramasubramanian, 2010). While transportation planners have used maps and other data visualization techniques to support research, modeling, and analyses, little attention has been given to the importance of using map-based visualizations as a tool for helping community organizations and other grassroots groups to better understand and plan with, and for, the public they serve. By engaging the public in a candid discussion about their travel experiences using spatial and visual cues, planners will have a better understanding of the most significant issues that need to be addressed for a particular community or sub-population. The incorporation of individual narratives and personal data can help depict and interpret the connections and contexts of people's travel experiences across geographic scales and over time. This will strengthen on-going mobility research by increasing our understanding of the socio-economic and cultural contexts that shape individual travel behavior.

III.   RESEARCH DESIGN

The research project sought to i) develop a holistic understanding of the transportation experiences of low-income populations, focusing on the entirety of their lives, rather than exclusively focusing on their journey-to-work trips; ii) develop and use visual representations to communicate issues that are not adequately or easily addressed in the traditional transportation planning processes like space and distance; and, iii) develop opportunities for low-income individuals to participate in creating spatio-temporal narratives in order to participate actively in the development of transportation alternatives. The goal of the data collection was to field test different approaches to engage the public in gathering data about individual travel experiences while identifying the essential data needed to build a web-based application.

Two community based organizations supported the research by: i) providing space to conduct focus groups and ii) identifying potential field work participants. Flyers inviting participants to attend focus groups were distributed in various locations around Newark. Most compensation was offered to study participants.

Data collection focused on both quantitative and qualitative information. Quantitative data included origins and destinations, type of trip, frequency of trip, day, time, mode, duration, trip chains, and measurable problems (e.g., missed connection) encountered during the trip. Qualitative information was gathered to provide context for the quantitative data and included responses to open-ended questions to better understand:
- Household needs, responsibilities, and finances that affect transportation choices
- How trips are prioritized and scheduled
- Distances people feel they can reasonably travel
- Perceptions of safety using different modes of transportation

Numerous interactive methods were used to collect the qualitative data with the main data collection modality being a structured interview using a paper-based questionnaire along with a mapping activity.

During these interviews, participants answered questions about their specific travel behavior and provided detailed and descriptive information about any problems they experienced during their travels. They also annotated study area maps with key information about trips, including their perceptions and understanding of space and distances. A smaller set of volunteers agreed to participate in maintaining a one-week travel diary. These diaries offered insight into routines and captured data about trips that did not occur daily. A few individuals whose daily trips included significant mobility constraints agreed to have a researcher travel with them for part of the day (to walk a mile in their shoes).

The plethora of different methods and modalities of collecting data (focus groups/discussions; individual interviews, traditional paper/online surveys, individually maintained travel diaries, and shadowing) was proposed for two reasons – first, to conduct an informal assessment whether the quality and reliability of the data gathered varied by method and two, to filter down to a small standardized list of questions that could become part of a comprehensive data collection effort.

IV. DATA ANALYSIS

The structured interview included four major sections: I) Background/Respondent Characteristics; II) Understanding Mobility Barriers; III Mapping Exercise (A Typical Day); IV Understanding the Types of Trips (e.g., work, shopping, childcare, medical, recreation, church).

In the first phase of data analysis (sample = 44; males=27 and females=17), some interesting patterns emerged. A typical male respondent in the study sample lives in a household with two adults and one school age child. On average, he is a parent of one child living with another caregiver outside of his household. He indicated that he had lived in his current residence for at least 2 years prior to the date of the interview. Of 26 male respondents that provided their primary reason for their choice of residence, 19% indicated "being close to family" while 23% indicated that the affordability of their housing choice was the determining factor. The typical male respondent spent on average $ 125 per month on transportation expenditures and spent 3.5 hours per day commuting.

A typical female respondent in the study sample lives in a household with more than two adults (average 2.5) and one school age child with another child living elsewhere. She indicated that she had lived in her current residence for over a year but less than two years (average 1.52). Of the 16 female respondents who provided their primary reason for their choice of residence, a full 50% indicated, "affordability of housing" while another 19% cited the need to be "close to family". Women spent on average $132 per month on transportation expenditures and spent close to 2.9 hours per day commuting

As the data collection phase ended and the preliminary data analysis was complete, the research team began the discussion about how the data collection process could be streamlined. The data collection process revealed that while "good" data could be gathered through a focused conversation or interview, long and complex data collection instruments impeded this effort. Interactive approaches appeared to work better (i.e., the conversational interview) rather than asking individuals to take responsibility for monitoring and documenting their travel behavior themselves. (i.e., by keeping a travel diary).

The mapping activity originally began with the goal of asking participants to trace "actual" routes, example turn-by-turn directions or actual bus routes. The complexity of this activity necessitated a

simpler analysis of Euclidian distance, rather than focus on the particular routes traversed. This decision also proved to be useful in conducting the mapping exercise with paper and pencil with individuals who had limited understanding of their own geography, and had difficulty orienting themselves on a map. We asked individuals to situate their home (not actual address but nearest cross street). From that point, we asked individuals to map their travel on a typical day. The mapping exercises revealed the limited range within which individuals traveled – most were reliant on walking or taking the bus. A couple of individuals also used their bicycles in good weather but immediately noted the various challenges they encountered especially that they could not get across or onto major thoroughfares and freeways.

Based on the interview/focus group discussion and the mapping exercise, the research team determined that the best way to map the responses to particular survey questions was for the map to be automatically generated step-by-step as a respondent answered each survey questions. Ideally, as the individual finished describing his or her travel on a typical day, they would be able to view their own activity space map.

In addition to being able to view many individuals' activity space maps to look at a composite view of the activity-space range (how far to people in one neighborhood actually travel), it proved to be useful to filter and sort the data by particular demographical characteristics (e.g., activity spaces of men versus women) or life circumstances (e.g., activity spaces of employed people versus unemployed people).

With the support of a web development company, Urban Interactive Studio, the Expanding Activity Spaces website (see Figure 1) now allows for the display of individual activity space maps that can automatically created, edited, and modified by the individual by entering their travel routine by answering a form-based survey. The form-based survey provides the electronic equivalent of the interview process and is suitable for large scale deployment. The activity space map that is generated based on survey responses allows low-income individuals to participate in creating unique spatio-temporal narratives.

Figure 1 about here.

V. DEPLOYMENT OF EXPANDING ACTIVITY SPACES WEB PORTAL

The web platform used is a stable open source programming environment called Drupal. Google Maps provides the base maps upon which the individual activity spaces are drawn. The website is currently live. The website is protected by a login/password to ensure privacy protection of individual users who are creating their own personalized activity space maps. There are two levels of access – one for individuals and another for community-based organizations. The vision of the research team is that an individual can enter their own data and use it to better understand the characteristics of his or her own travel and movement patterns. Representatives of community-based organizations have access to data entered by people in a particular zip code. This is because the zip code boundary is large enough to mask individual information but allow these community advocates to understand the commuting and travel patterns of people who reside in their service/catchment area.

Data Visualization
For the individual, the activity space mapping process is educational. The questions and the map provoke new inquiries: For example, "*why* is my activity space shaped in this particular way? (Some people's activity spaces are not polygons but simple straight lines that go from point A to point B on

the map); What are the recreational, shopping, and cultural resources *near* my activity space that I can access? What are the resources *contained within* my activity space that I can visit? These are inherently geographic questions that can be used to address both transportation and non-transportation questions including discussions about neighborhood quality of life.

The website has the potential to be a modality for travel behavior data collection and analysis and also a way for transportation advocates to advocate for new and integrative ways to plan for new transportation investments. The activity space maps are coded to show types of destinations and the qualitative data associated with the trip. This information can be particularly useful for launching community-wide conversations about new public transportation services or identifying specific problems associated with individual transportation providers or locations.

VI.   DISCUSSION OF KEY FINDINGS

Short Surveys *versus* In-Depth Interviews

As was noted in the previous section, the idea of testing different methods and modalities of collecting data (focus groups/discussions; individual interviews, traditional paper/online surveys, individually maintained travel diaries, and shadowing) was to make an informal assessment whether the quality and reliability of the data gathered varied by method and to filter down to a small standardized list of questions that could become part of a comprehensive data collection effort. These goals were both achieved. In the research team's view, the survey that is deployed on the website includes the shortest list of questions (see Figure 2) that provide the detail necessary to undertake holistic transportation planning.

Figure 2 about here.

Travel Experience and Mobility Barriers

The research team began this research with the premise that the travel experience and choices made by low-income people is not well understood. It would appear that our findings, even if they are based on a small sample provide some new avenues for research.

Time Spent Traveling on a Typical Day

Because this research is framed about a typical day of travel, rather than asking about the journey to work, the authors were able to document that the choice of residence is not determined by proximity to work (either because of high housing costs near the work location or more likely because of the need to be closer to family). The ease of commuting was not mentioned as a major factor in determining housing choice. According to the US Census, the average commuting time to and from work is about 50 to 70 minutes per day. Even if one factors additional time for non-work commuting, the average travel time should be well below two hours. The travel times for low-income populations such as the project community participants are significantly higher. The mapping activity with project participants revealed some of the reasons why these trips took longer. In the Newark, NJ study area, the transportation network is designed to move people into the central location. The spoke and hub public transportation network does not facilitate inter-neighborhood commuting which is very feasible for those with access to a private car. The transportation network also limited respondents' ability to link different types of trips (trip chaining). In study area, there are many neighborhoods that are without any large grocery stores. Respondents from these neighborhoods reported traveling to a particular grocery store in a particular geographic location because of the availability of a bus service to the location and a car service to return home (with heavy shopping bags). Complex narratives of

relying on the kindness of friends and relatives to undertake shopping trips were noted. Likewise, there are some people who are on fixed incomes who simply cannot afford to take the bus. These people walk everywhere if they can or remain house-bound if they are disabled.

Responsibilities that Limit How Far Away You Can Be From Home
47% of our male respondents indicated that they had family responsibilities that limited how far away they could be from their home. These obligations usually involved child care or elder care. Interestingly, only 29% of our female respondents mentioned similar constraints. When we began our study, we made an assumption that the travel behavior of low-income women was constrained by child rearing activities. As family structures change, child care obligations affect men as well as women. As the population ages, elder care will increasingly take on a more significance.

The Quality of Travel Experience
When we asked our respondents to speak specifically to their transportation experience, in other words to respond to the question, what are the most important change they would like to experience, 37 % of the men and 24% women focused on reducing their travel time. Their concerns included barriers associated with long wait times, missed transfers and connections, and limited/slow service during off-peak hours, particularly holidays and weekends. Another 26% of men and 35% spoke directly to the quality of the travel experience. It is important to note that top on this wish list was civility, courteousness and professional behavior from bus drivers. Other concerns included safety, cleanliness of facilities and vehicles, and a stronger police presence on buses to minimize bad behavior by unruly passengers. During our interviews, our respondents described taking particular routes to avoid discourteous drivers and neighborhoods that were viewed as "dangerous". While some people expressed a wish to acquire a private vehicle, only two our sample of 44 respondents mentioned the "high" cost of transportation. Collectively, the quality of the experience was more important than the costs associated with the experience.

VII. CONCLUSIONS AND LESSONS LEARNED
This research project focused on three goals: provide a holistic understanding of the travel behavior of low-income people; use innovative visualization methods to gather and analyze the data; and engage the public in the data collection, analysis, and review of the results. Within these goals, the intent was to test a variety of data collection methods with a small sample so as to provide a basis for a larger study.

The Expanding Activity Spaces website serves as a modality for demonstrating an innovative way of gathering and analyzing data. The data can be visualized by individuals and community advocates. Different methods were tested and a streamlined set of questions has been identified – the list is short enough that it can be deployed over a larger sample of the US population. The design of the website and the standardized nature of the survey instrument allows for a high degree of transferability across geographic regions within the United States.

One of the limits of this research study is our inability to actively and effectively engage the public in reviewing and analyzing the results. The login/password format, while protecting privacy creates a barrier to entry and exploration of the website.

Policies aimed at increasing overall mobility, instead of job access, may prove more beneficial in the long-run for improving the economic opportunities and quality of life of low-income people. Job

search and commute trips are important but significantly less relevant if one is unable to satisfy household responsibilities such as getting children to and from daycare, shopping for groceries, and having access to health and educational facilities. An emphasis on greater mobility would require a broader examination of the travel needs, decisions, and behaviors of low-income travelers, looking at how, when, where, why, how often, and with whom trips are made; how trips are prioritized; the choices and tradeoffs that are made; the trips that are forgone; and the impact of those choices on overall mobility.

REFERENCES

Adam PA. 1995. A Reconsideration of Personal Boundaries in Space-Time. *Annals of the Association of American Geographers*, **85**(2): 267-285.

Allen K, Misek S J DiJohn. 2004. *Job Access and Reverse Commute Program Transportation Clearing House: Final Report*. Project 99-03 for the Workforce Boards of Metropolitan Chicago in cooperation with the Regional Transportation Authority. Chicago: University of Illinois-Chicago Urban Transportation Center.

APA (American Psychological Association) 2014. Age and Socio Economic Status Fact Sheet. Online resource available at: http://www.apa.org/pi/ses/resources/publications/factsheet-age.aspx, last accessed 18 Dec 2014.

Blumenberg E. 2002. On the way to work: welfare participants and barriers to employment, *Economic Development Quarterly*, **16**(4): 314-325.

Blumenberg E and M Waller. 2003. The long journey to work: A federal transportation policy for working families. *The Brookings Institution Series on Transportation Reform*, **July** 2003. Washington, DC: The Brookings Institution Center on Urban and Metropolitan Policy.

Chappelle K. 2006. Overcoming mismatch: Beyond dispersal, mobility, and development strategies. *Journal of the American Planning Association*, **72**(3): 322-336

Federal Transit Administration. 2014. FTA Grant Programs: Jobs Access and Reverse Commute Program Overview. Online resource available at: http://www.fta.dot.gov/grants/13093_3550.html, last accessed 18 Dec 2014.

Gilbert M. 1998. 'Race', space and power: the survival strategies of working poor women, *Annals of the Association of American Geographers*, **88**(4): 595–621.

Goodchild MF and DG Janelle. 1984. The city around the clock: Space-time patterns of urban ecological structure, *Environment and Planning A*, **16**(5): 807-25 820.

Hägerstrand T. 1970. What about people in regional science? *Paper of the Regional Science Association,* **24**: 7–24.

Hanson S and P Hanson. 1981. The travel activity patters of urban residents: dimensions and relationships to socio-economic characteristics. *Economic Geography*, **57**: 332–347.

Horner M and J Mefford. 2007. Investigating urban spatial mismatch using job-housing indictors to model home-work separation. *Environment and Planning A*, **39**: 1420-1440.

Ihlanfeldt K and DL Sjoquist. 1998 The Spatial Mismatch Hypothesis: A Review of Recent Studies and Their Implications for Welfare Reform. *Housing Policy Debate*, **9**(4): 849-891.

Johnson, J. 2004. *Finding Work in the City*. Doctoral Dissertation, Urban Studies and Planning, Massachusetts Institute of Technology, Cambridge, MA. MIT Libraries.

Kain JF. 1968. Housing Segregation, Negro Employment, and Metropolitan Decentralization. *Quarterly Journal of Economics*, **82**(2): 175–197. doi:10.2307/1885893.

Kain JF. 1992. The Spatial Mismatch Hypothesis: Three Decades Later. *Housing Policy Debate*, **3**(2): 371-460. DOI:10.1080/10511482.1992.9521100.

Kawabata M. 2003. Job access and employment among low-skilled autoless workers in US metropolitan areas. *Environment and Planning A*, **35**: 1651-1668. DOI:10.1068/a35209.

Kwan MP, Murray AT, O'Kelly ME and M Tiefelsdorf. 2003. Recent advances in accessibility research: Representation, methodology and applications. *Journal of Geographical Systems*, **5**:129–138.

Miller HJ. 1999. Measuring space-time accessibility benefits within transportation networks: Basic theory and computational methods. *Geographical Analysis*, **31**:187–212.

Newsome TH, Walcott WA and PD Smith. 1998. Urban activity spaces: Illustrations and application of a conceptual model for integrating the time and space dimensions. *Transportation*, **25**: 357–377.

Ramasubramanian L. 2010. *Geographic Information Science and Public Participation*. Heidelberg, New York: Springer.

Rix S. 2014. The Employment Situation, January 2014, and a Look Back at 2013: Fewer Older Workers Unemployed, More Out of the Labor Force. Factsheet 302. Washington, DC: AARP Public Policy Institute. Online resource available from http://www.aarp.org/content/dam/aarp/research/public_policy_institute/econ_sec/2014/the-employment-situation-january-2014-AARP-ppi-econ-sec.pdf, last accessed 18 Dec, 2014.

Transit Cooperative Research Program, 2008. Understanding How Individuals Make Travel and Location Decisions: Implications for Public Transportation. *TCRP Report* **123**. Washington, DC: Transportation Research Board.

U.S. Census Bureau. 2014. Anniversary of Americans with Disabilities Act: July 26. *Profile Facts for Features*. Washington, DC: U.S. Census Bureau News. Online resources available at https://www.census.gov/newsroom/releases/pdf/cb14ff-15_ada.pdf, last accessed 18 December 2014.

Wilson WJ. 1996. *When Work Disappears*. New York: Alfred A. Knopf.
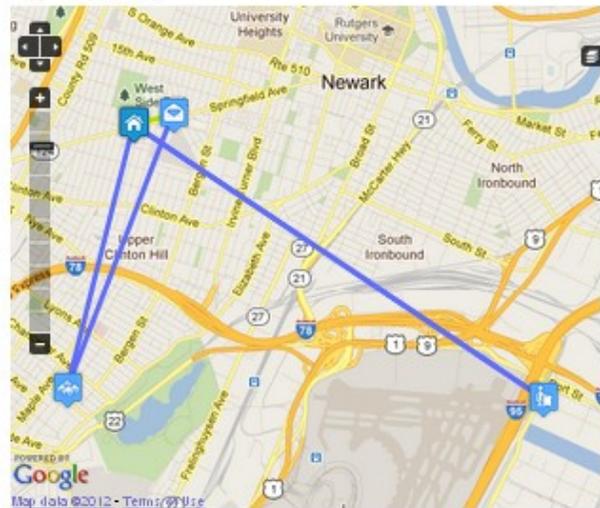
Figure 1. Temporal and Spatial Representations of a Typical Day.

Sevilee

Where do you live?:

Address:
Irvington Ave & Manor Dr, Newark, NJ 07106, USA
City:
Newark
ZIP Code:
07106

┌─Personal───┐

Gender:
Male
Age:
16 to 54 years
Do you have any physical limitations or disabilities?:
No
Do you have responsibilities at home that limit how far you can be away from home?:
No

└───┘

┌─Family───┐

What were the two most important reasons that you chose your current place to live?:
close to family or friends
Did you think about transportation when you moved?:
No

└───┘

┌─Transportation───┐

About how much do you normally spend on transportation every month?:
$75
Approximately how much time do you normally spend traveling on a typical day?:
>2 hours
Do you or does someone who lives with you own a car?:
No
Do you have a driver's license?:
No

└───┘

Figure 2. Preliminary Data Capture Associated with a User Profile.