CENTER FOR
TRANSPORTATION STUDIES

UNIVERSITY OF MINNESOTA

RESEARCH REPORT

How Affordable is Transportation? A Context-Sensitive Framework

Yingling Fan
Arthur Huang

Humphrey School of Public Affairs
University of Minnesota

CTS 11-12

Technical Report Documentation Page

1. Report No.	2.	3. Recipients Accession No.
CTS 11-12		

4. Title and Subtitle	5. Report Date
How Affordable is Transportation? A Context-Sensitive Framework	May 2011
	6.

7. Author(s)	8. Performing Organization Report No.
Yingling Fan, Arthur Huang	

9. Performing Organization Name and Address	10. Project/Task/Work Unit No.
Humphrey School of Public Affairs University of Minnesota 301 19th Ave S Minneapolis, MN 55455	CTS Project #2010023
	11. Contract (C) or Grant (G) No.

12. Sponsoring Organization Name and Address	13. Type of Report and Period Covered
Center for Transportation Studies University of Minnesota 200 Transportation and Safety Building 511 Washington Ave. SE Minneapolis, MN 55455	Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes
http://www.its.umn.edu/Publications/ResearchReports/

16. Abstract (Limit: 250 words)

Transportation affordability refers to the financial burden households bear in purchasing transportation services. Traditional measures, which focus on what share of household disposable income or total budget goes to transportation services, often fail to consider the wide variation in households' transportation needs and locational settings. In this project, we propose a contextualized transportation affordability analysis framework that differentiates population groups based upon their socio-demographics, the built environment, and the policy environment. The necessity of such a context-sensitive framework is demonstrated via a case study of the Twin Cities metropolitan area, which shows heterogeneity among different population groups in terms of their transportation needs and resource availability. The proposed context-sensitive framework points to two dilemmas associated with transportation affordability. First, the socio-economically disadvantaged group has the lowest auto ownership rate, yet its transportation needs are better served by automobiles. Second, while automobiles can reduce transportation hardship for the socio-economically disadvantaged, the existing auto-oriented urban landscape in the U.S. requires more travel for access to destinations, which leads to higher transportation costs. The dilemmas call for a multi-modal transportation solution: reducing societal auto dependence and providing financial subsidies for car access among disadvantaged populations are equally important to enhance transportation affordability and social welfare.

17. Document Analysis/Descriptors	18. Availability Statement
Affordability, Travel costs, Transportation, Transportation modes, Public transit, Infrastructure, Built environment, Transportation policy, Urban transportation policy, Policy, Accessibility, Context sensitive design	No restrictions. Document available from: National Technical Information Services, Springfield, Virginia 22161

19. Security Class (this report)	20. Security Class (this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	48	

How Affordable is Transportation? A Context-Sensitive Framework

Final Report

Prepared by:

Yingling Fan
Arthur Huang

Humphrey School of Public Affairs
University of Minnesota

May 2011

Published by:

Center for Transportation Studies
University of Minnesota
200 Transportation and Safety Building
511 Washington Avenue, SE
Minneapolis, Minnesota 55455

This report represents the results of research conducted by the authors and does not necessarily represent the views or policies of the University of Minnesota.

The authors and the University of Minnesota do not endorse products or manufacturers. Any trade or manufacturers' names that may appear herein do so solely because they are considered essential to this report.

Acknowledgments

The researchers thank the project's Technical Advisory Group (TAG) members for their constructive comments and insightful suggestions. TAG members are Matt Kane, Mark Filipi, Mark Nelson, Dennis Farmer, David Levinson, Mike Iacono, John Levin, and Gina Baas. This project was funded by the University of Minnesota Center for Transportation Studies.

Table of Contents

List of Figures

List of Tables

Executive Summary

Transportation affordability refers to the financial burden households bear in purchasing transportation services. Traditional measures, which focus on what share of household disposable income or total budget goes to transportation services, often fail to consider the wide variation in households' transportation needs and locational settings.

In this project, we propose a contextualized transportation affordability analysis framework that differentiates population groups based upon their socio-demographics, the built environment, and the policy environment. The necessity of such a context-sensitive framework is demonstrated via a case study of the Twin Cities metropolitan area, which shows heterogeneity among different population groups in terms of their transportation needs and resource availability.

The proposed context-sensitive framework points to two dilemmas associated with transportation affordability. First, the socio-economically disadvantaged group has the lowest auto ownership rate, yet its transportation needs are better served by automobiles. Second, while automobiles can reduce transportation hardship for the socio-economically disadvantaged, the existing auto-oriented urban landscape in the U.S. requires more travel for access to destinations, which leads to higher transportation costs. The dilemmas call for a multi-modal transportation solution: reducing societal auto dependence and providing financial subsidies for car access among disadvantaged populations are equally important to enhance transportation affordability and social welfare.

Chapter 1 Introduction

In 1908, Henry Ford unveiled what was to become known as “the people’s car” and “the universal car”—the Model T, and marketed on its affordability. Following the success of this first mass-produced model, private car companies have frequently touted affordability when promoting their vehicles [1]. Yet, U.S. transportation policy has rarely centered on the issue of transportation affordability, and has long endorsed a vision of motorization, speed, comfort, and convenience. The Federal-Aid Highway Act in 1956 authorized $25 billion for the construction of 41,000 miles of the Interstate Highway System over a 20-year period, which inevitably led to an era of auto dominance. Improved auto mobility had made daily long-distance trips possible, and fueled suburbanization and sprawl of homes and businesses which in turn reinforced auto dependence [2]. According to the 2009 US National Household Travel Survey, personal vehicles (cars, vans, trucks, and SUVs) accounted about 88.3 percent of work commute trips and 90.3 percent of shopping trips [3]. In 2008, Americans owned about 255 million personal vehicles [4], threefold the 1960s level and ninefold the 1930s level [5]. The prevailing auto dominance comes with an unintended consequence: researchers and practitioners in transportation often assume universal access to private transportation and overlook the issue of transportation affordability and its impact among low-income population groups.

In a society of auto dominance, low-income households without access to automobiles have only limited capability to access desired destinations and opportunities. The direct consequence is that their social welfare is negatively impacted. For example, owning an automobile, all else equal, is associated with higher probability of employment and longer working hours per week [6]. Raphael et al. (2001) found that after controlling for other variables, the difference of the black and white employment rates can be significantly explained by the difference in car ownership rates [7]. A study in the UK suggested that the top two barriers for young people looking for work are: no jobs nearby and lack of personal transport [8]. Low-income groups without a vehicle are also associated with weaker social ties and smaller social networks [9]. Affordable transportation is critical for meeting basic living needs and enhancing quality of life among low-income populations.

Promotion of affordable transportation requires a robust framework that defines and measures transportation affordability appropriately. A review of relevant literature shows existing definitions and measures overlook the increased variation in transportation resources and costs across population groups and locational settings. To address this limitation, this study proposes a context-sensitive framework for analyzing transportation affordability, aiming to inform policy strategies for promoting affordable transportation. More specifically, this research:

- Reviews existing definitions and measures of transportation affordability, and discusses their advantages and disadvantages;
- Based upon the review and discussion, develops an alternative framework for evaluating transportation affordability;
- Demonstrates the newly developed framework using a case study of the Twin Cities metropolitan area; and
- Discuss possible policy solutions to promote affordable transportation based upon the newly proposed evaluation framework of transportation affordability.

Chapter 2 Transportation Affordability: Definitions and Measures

Affordability refers to people's ability to purchase important goods and services. Considering transportation as a normal good, transportation affordability can be measured by evaluating people's financial ability to make physical movements through space. Although such a measurement approach seems reasonable, it is at odds with the complexity and variation of transportation needs, costs and resources across population groups and locational settings. In the following text, we review existing definitions and measures of transportation affordability.

2.1 Review of Existing Definitions and Measures

In Collins English Dictionary, affordability is defined as "being able to pay without incurring financial difficulties". Researchers in transportation have generally referred to transportation affordability as people's financial ability to pay for or purchase transportation-related services and goods [10]. With such a broad and vague definition, it has been difficult for transportation researchers to come up with standard, uniform measures of transportation affordability.

Nonetheless, efforts attempting to measure transportation affordability can be categorized into two types. The first type is concerned with the proportion of household's disposable income spent on transportation (see equation #1), and focus mostly on the out-of-pocket part of the expenditures, such as fuel price, parking fees, vehicle maintenance fees, and transit fares [11]. This line of work shows that over time transportation costs have accounted for an increasing share of household income in the U.S. For example, a Surface Transportation Policy Project study finds that the proportion of household disposable income spent on transportation increased from 10% in 1935 to 20% in 2003 [11]. In addition, the proportion varies across income groups. According to the 2009 Consumer Expenditure Survey, the mean transportation cost was 28.7% of the average annual income after taxes among the lowest quantile of earners[1]; while for the highest earner quantile, the ratio was 9.4% [12].

Equation #1: $$TA\ Index\ = \frac{Transportation\ Expenditures\ (\$)}{Household\ Income\ After\ Tax\ (\$)} \times 100\%$$

The second type of measurement for transportation affordability uses total household expenditures rather than household income as the benchmark against which to compare transportation-related expenditures (see equation #2). This type of measure can lead to very different conclusions from the first type. For example, Blumenberg (2003) notes that by this measure the lowest-income group is not very different from the highest-income group [13]. As the 2009 US Consumer Expenditure Survey shows, low-income households on average spent approximately 13.2% of their total expenditure on transportation, while the middle- and high-income groups spent about 16.3%, and 15% respectively [12].

Equation #2: $$TA\ Index = \frac{Transportation\ Expenditures\ (\$)}{Total\ Household\ Expenditures\ (\$)} \times 100\%$$

[1] Note that annual average total expenditures are far larger than annual income before or after taxes for the low income group.

Researchers and policy makers who apply Equations 1 and 2 all need to establish an affordability threshold first. Using statistical classification methods, Cain and Jones (2001) define the transportation affordability threshold as the "average proportion of income currently spent by households in the lowest three income deciles on motoring costs" [14]. Using the Edinburgh Travel Survey data, they concluded that transportation is affordable for a household if its transportation costs account for no more than 32.5% of its income [14]. A report by the South Africa Department of Transport chooses 10% as the threshold [15]. A report by Victoria Transport Policy Institute defines transportation as affordable when a household spends less than 20% of its budget on transportation and less than 45 % of its budget on transportation and housing combined [16].

These measurement strategies have the following major limitations:

- Using a single benchmark is "blunt and ambiguous" because spending on transportation may have different meanings for households of various locations, different family structures, and income levels [15],
- Both types of measures (either comparing transportation expenditure against total household income or total household expenditure) focus on evaluating people's financially ability to conduct physical movements through space. Such evaluations do not account for the potential substitution of time for money—or vice-versa–when it comes to travel decisions. Further, these measures focus on mobility, and do not directly consider accessibility. This is problematic because the ability to conduct physical movements through space (mobility) does not necessarily equal the ability to fulfill basic needs by accessing various daily destinations (accessibility).

A recent innovation in measuring transportation affordability is the H+T affordability index (i.e., the housing plus transportation affordability index) [17]. The H+T index is defined as the sum of housing costs and transportation costs divided by household income. The index helps to improve transportation affordability measurement by incorporating the concept of location efficiency. As shown in Figure 2.1, the average American family devoted 15 cents of every dollar spent to transportation in 2009. However, depending where they live, a household may spend as much as 19% (Detroit, MI), or as little as 12.6% (Baltimore) of their total expenditure transportation. Much of this variation is due to the development patterns, the availability of public transportation, and the level of infrastructure for non-motorized transportation. By incorporating the location efficiency concept, the index offers a more accurate picture of people's ability to fulfill basic needs for accessing various daily destinations, compared to traditional measures that focus on people's ability to conduct movements in space. Despite this improvement, the "H+T" index was not intended to improve the measurement of transportation affordability but rather to illustrate the true cost of housing, as well as to educate policy makers and the public about the advantages of smart growth and transit-supportive land uses. The index does not respond to the complexity of individuals' transportation needs or to transportation resources available to them and is limited in providing policy implications.

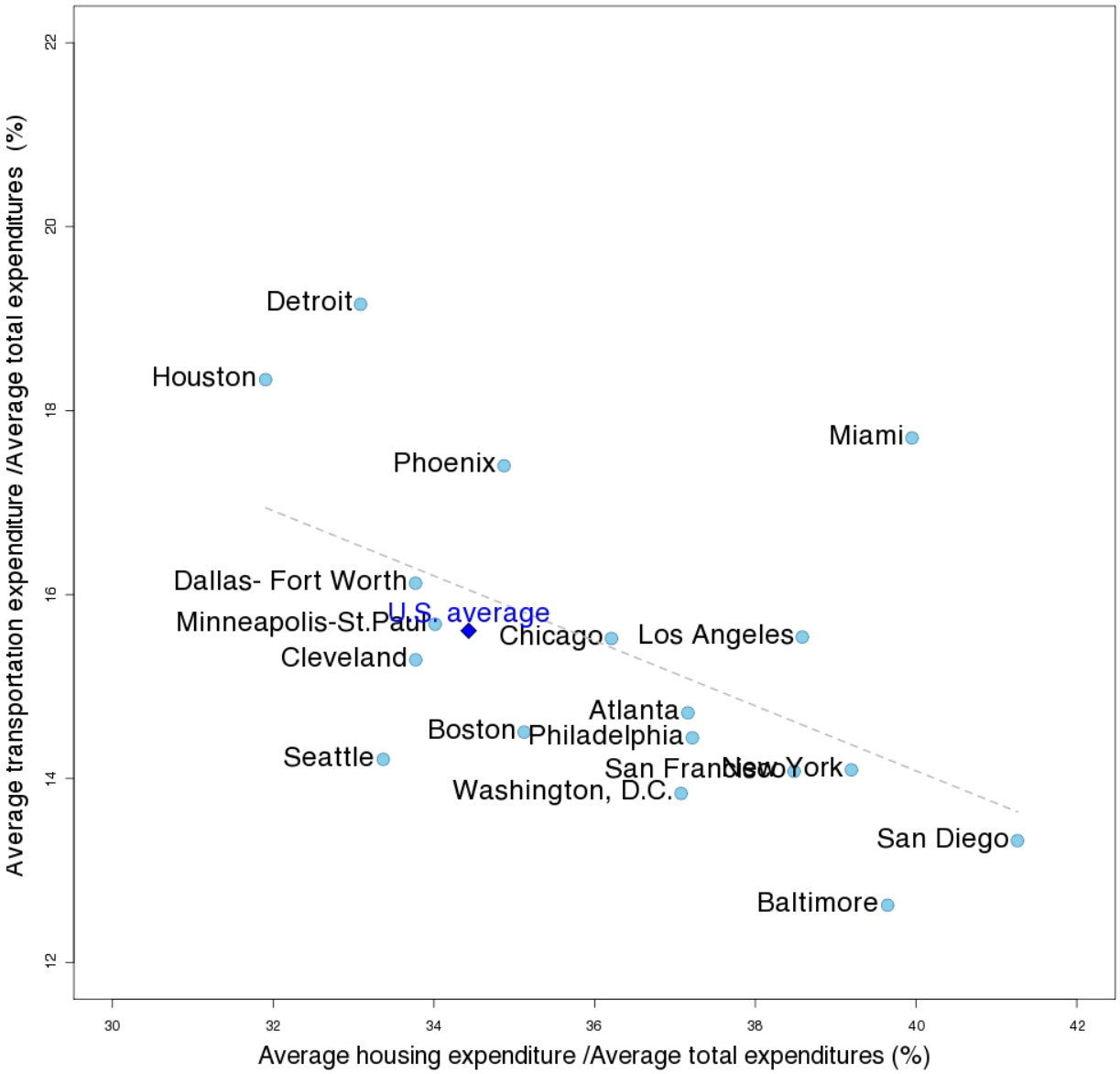

Figure 2.1: Household spending on transportation and housing by metropolitan areas, with linear trend line.
Data source: Consumer Expenditure Survey, 2008-2009.

2.2 An Alternative Direction

The review above suggests that existing methods are limited when it comes to measuring transportation affordability, and as a result are limited in deriving implications about which transportation subsidy programs and policy strategies may make transportation more affordable. The complexity of measuring and addressing transportation affordability lies in the various transportation needs associated with different population groups and different environmental settings. Household demand for transportation is heterogeneous, closely related with household characteristics [18]. For example, a single-mother household has very different needs in terms of travel time, destination, and mode than does an unmarried female who lives alone. Single

mothers may depend more on private transportation for meeting household daily needs because they have less time flexibility; as the only adult in their households, they shoulder almost all household responsibilities [19]. Making transportation affordable is not merely about maintaining a low cost of travel, but also about when, where, and how transportation assistance could be adequately provided to meet people's desire of accessing destinations. It is therefore important to develop population-specific standards against which to measure the affordability of transportation.

Further, people in different locational settings may have distinct transportation needs and be subject to different prices of transportation. An individual living in a high-density mixed-use neighborhood can mostly travel to nearby destinations without having to own a vehicle, but for someone in a place marked by urban sprawl, owning a vehicle is likely a must. Dodson et al. (2004) argue that transportation affordability should be examined in the context of jobs-housing balance, social and economic status, auto ownership, and quality of public transportation services [20]. The population- and location-sensitive nature of transportation affordability calls for an analysis framework that incorporates the key factors that shape it.

In this research, we propose a new, contextualized framework for measuring transportation affordability. To be population-sensitive, we take into account the differences in households' transportation needs, time availabilities, and resource availabilities. The framework is also location-sensitive as it considers variation in the built and policy environments at different locations. The built environment is measured by accessibility, indicating the capacity to access desired services (e.g., housing, food, work, school, and healthcare) by different modes of transportation. Overall, this new transportation affordability analysis framework aims to provide a foundation for policy making by asking how affordable transportation options are, for whom, and in what temporal and spatial settings.

Chapter 3 Contextual Factors Influencing Transportation Affordability

To develop a new framework for defining and measuring transportation affordability, we begin with identification of the various attributes affecting transportation affordability. We categorize attributes related to transportation affordability into three groups: household socio-demographics, the built environment, and the policy environment (see Figure 3.1). In the following sections we discuss each category's relationship with transportation affordability.

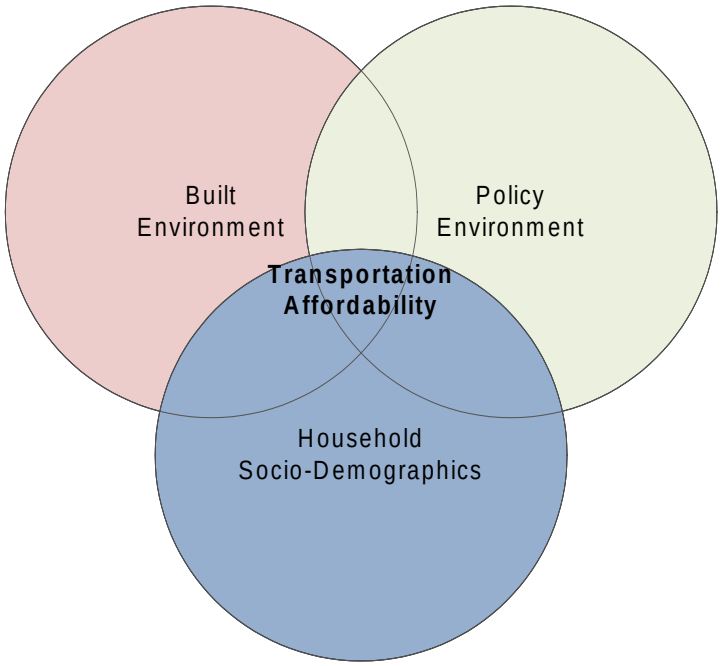

Figure 3.1: Contextual factors affecting transportation affordability.

3.1 Household Socio-Demographics

It is difficult to overstate the influence of household income on transportation affordability because income level determines what financial resources the household has to purchase transportation goods and services. In the U.S., 7.7% of all households have no private vehicles, so do 17% of "low-income" households and 30% of "poor" households [21][2]. The fact that the majority of low-income and poor households own cars does not mean cars are affordable transportation, but may instead indicate "forced car ownership" [22]. Using data from the Iowa Transportation and Employment Survey, Fletcher, Garasky, and Nielsen (2005) illustrated how private vehicles, while important transportation assets, may exert hardship on families by laying claim to households' financial resources [23]. Gleeson and Randolph (2002) discussed the forced

[2] Guiliano used the Department of Housing and Urban Development's (HUD) definition of low income to define "low income" households. The HUD definition corresponds to roughly 85% of a region's median household income. Guiliano used the federal poverty threshold to define "poor" households. The federal poverty threshold is much more restrictive than HUD's low income threshold.

car ownership phenomenon as “transport poverty”—meaning a household has to bear higher travel cost, especially the cost related with owing and using an automobile [24].

Why do low-income households choose to own vehicles even though that ownership brings additional hardship? The answers to this question are rooted in the complex transportation needs of low-income households—needs often determined by household structure. For example, a household with multiple workers or with children, all else equal, is more likely to own a car [25]. Different household structures help explain different household travel needs and travel activity patterns. For example, a household with children generally requires more travel time for household activities than a household without children. Dual-worker households have different travel behavior than single-worker households (households with one adult working and another adult staying at home) as these two types of households have different time constraints—dual-worker households are likely to have greater time pressure due to longer combined hours of work. Households with teenagers often need provide rides on weekends for teenagers to participate in sports/recreational events, while households without teenagers do not engage as much in such trips. Evans (1970) posits that different households of different structures have different expenditures on transportation even given the same income level [26].

It is also important to note that using observed transportation expenditures to measure transportation affordability could be misleading as low income households may suppress travel demand to save money. Such suppression may mean trip cancellations, changes in destinations, and reduced trip frequency, as well as shifts in mode choice and timing for trips. Focusing on observed/realized transportation expenditures and using a single benchmark for all types of households may overestimate transportation affordability among the most disadvantaged population groups.

3.2 The Built Environment

Transportation affordability is affected by the built environment which comprises urban design, land use, and the transportation system. A variety of studies have identified the connection between the built environment and travel needs [27-30]. For example, Cervero and Kockelman (1997) established the statistical connections among travel demand, population density and road design [31]. People’s travel behaviors respond to the built environment: different built environments yield differences in travel distance, mode choice, and trip frequency.

Greater density in a neighborhood with good transit and a walkable environment, all else equal, is associated with a lower auto ownership rate [29] . Residential density, employment density, and jobs-housing balance affect the distance between origins and destinations. When destinations are far from each other, automobiles become more important. Other built environment characteristics such as land-use mix, street connectivity, and aesthetic qualities influence mode choice by making the environment more friendly to non-auto transportation modes. From the perspective of affordability, a transit/pedestrian/biking friendly environment lowers demand for the automobile—the most expensive transportation mode. This type of built environment, then, improves affordability and benefits populations with limited financial resources.

Transportation affordability may also be improved by reducing the amount of travel required to access destinations. By placing destinations close to homes, land patterns with higher accessibility have been found to be associated with lower vehicle miles travelled (VMT) [28, 29,

31]. To conclude, the built environment not only influences whether more expensive transportation services are needed, but also partly determines the amount of travel needed to carry out activities.

3.3 The Policy Environment

Publicly funded subsidy programs exist in the U.S. to help low-income households combat transportation hardship. However, which transportation mode to subsidize is up for debate.

Some studies argue that car ownership should be encouraged for low- and moderate- income families in order to increase their welfare [32-34]. However, car ownership promotion can be controversial because such promotion may lead to greater societal car dependence. Cullinane & Cullinane (2003) found that even with excellent public transportation, once a person acquires a car, he/she becomes dependent on it for all trips [35]. To many policy makers who wish to address transportation affordability, it is the car culture that made transportation increasingly unaffordable in the first place. Excessive auto use is responsible for suburbanization and related phenomena such as sprawl, white flight, and urban decline, all of which lead to longer-distance travel and increasing transportation expenditures.

Further, policy makers face increasingly widespread and strong public opposition when promoting car ownership programs. Across the nation, there is growing public awareness that excessive auto use has negative societal consequences such as declining social capital, deteriorated environmental quality, and increasingly sedentary lifestyles. In addition, some have stereotyped people on welfare as cheats. One well-known stereotype is that of the "welfare queen": a woman who receives excessive benefits from the government using aliases or many children. Such misperceptions and stereotypes make it difficult for policy makers to promote car ownership for low-income people—especially minorities—because cars, like wristwatches and living room furniture, are often perceived as status goods, i.e., "purveyors of social position", in U.S. society [36].

As such, there are more researchers and policy makers support subsidization of public transportation and provision of high-quality public transit services than car ownership promotion [37]. Golub (2010) found that transportation-related welfare loss is greatest for commuters with poor public transit options; in particular, low-income group with low-performing transit services suffer greater loss than those with high-performing transit service [38]. Cervero (1990) presents evidence that low-income riders change their travel behavior less than higher income groups in response to transit fare increases because low-income riders have very limited transportation alternatives [39]. Deka (2002) argues that transit services should especially cater to those incapable of owning and operating an automobile [40].

Land use and housing policies can also influence transportation affordability. There are a variety of housing programs that encourage residents to live in high-density, high-accessibility areas that reduce their need for cars. Holtzclaw, et al. (2002) studied Location Efficient Mortgage (LEM) policies in Chicago, Los Angeles, and San Francisco [41]. The LEM allows household to commit what it saves from not owning a car (the avoidance of car payments, interest, taxes, and insurance, fuel and maintenance costs) to buy a more expensive home in an area marked by location efficiency. Other similar programs include Smart Commute Mortgage and additional transit-supportive home loan programs [42]. Regional policies that promote jobs-housing balance

may also impact transportation affordability. A policy example is the “Live Where You Work” program in Baltimore, Maryland, which subsidizes the cost of home purchases in the city to encourage homeownership. Another example is the Southern California Association of Governments’ 1989 proposal to implement measures redirecting new jobs from job-rich to job-poor areas and redirecting new housing to job-rich areas [43].

To sum up, our review indentifies three key factors that are closely related with transportation affordability: household-demographics, the built environment, and the policy environment. Solutions for transportation affordability should be investigated in a conceptual framework comprised of these population-specific and location-sensitive factors. We will discuss such a framework in the next section.

Chapter 4 The Proposed Transportation Affordability Framework

The discussion in Section 3 calls for a contextualized evaluation to measure transportation affordability across different population groups living in different built environments. Another challenge to be addressed when exploring transportation affordability is that time and money are exchangeable when people make transportation choice. Transportation represents both utility and disutility because transportation not only helps to get to desired destinations but also consumes time—another important resource. Disadvantaged households may be forced to choose slower, lower-quality transportation services and thus may spend less money on transportation, appearing to need it less. To address this issue, we broaden our framework to incorporate the time dimension. Accordingly, we define transportation affordability as a household's capacity to pay transportation costs (including both monetary and time-based costs) without incurring financial difficulties and time pressures.

Figure 4.1 illustrates how population-specific and location-sensitive factors impact transportation affordability, as well as how the time dimension can be incorporated into transportation affordability. As shown in Figure 4.1, a household's total transportation cost depends on the amount of household travel needs (i.e., quantity of transportation needs) and the price of transportation. Household travel needs are directly influenced by household socio-demographics and the built environment, and indirectly influenced by the policy environment as the policy environment partly determines the built environment. The price of transportation is exogenous and thereby influenced by the built and policy environments but not socio-demographics. The availability of a household's resources (including both time and income) to accommodate transportation-related time and monetary costs is determined by the household's socio-demographics and the policy environment. In the following text, we first explore these links in greater detail and then offer a population- and location-stratified evaluation matrix as a framework to measure transportation affordability.

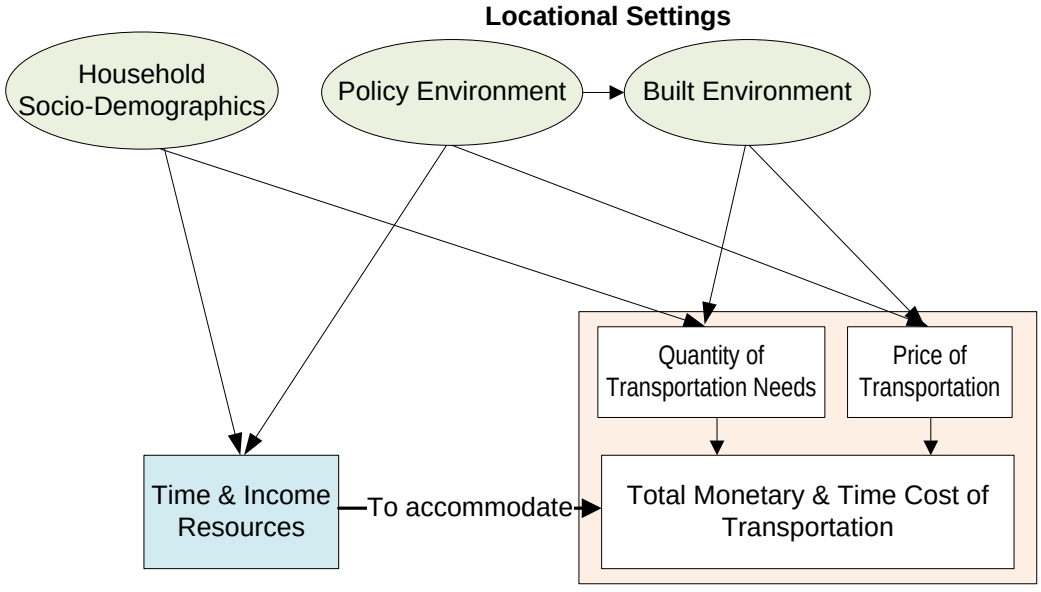

Figure 4.1: The alternative model to understand transportation affordability.
Note: Price of transportation refers the monetary and time cost of transportation per unit of travel.

4.1 Differentiation in Resource Availability and Transportation Needs by Socio-Demographics

We highlight two important household-level resources for accommodating transportation needs: time and income. Figure 4.2 illustrates how population groups can be classified into four categories: people with high time and income availability, people with high time but low income availability, people with low time but high income availability, and people with low time and low income availability. The figure reflects the ranking of average family income and time availability as reflected in the 5 year American Community Survey (2005-2009) and the American Time Use Survey (2003-2009) with each dimension ranked from 1-12 (low to high availability).

Figure 4.2: Classification of families by income level and time availability. (Positions reflect rank order based on ACS data (2005-2009) and American Time Use Data (2003-2009) ranked from 1-12 on each dimension from low to high.)

The illustration in Figure 4.2 helps to shed light on the vulnerable groups affected by transportation affordability. Those in the upper right corner are examples of population groups with both high income and relatively high time availability. This group is married but has at least one person that is available to balance needs around the household with that of paid work. In terms of income, those in this group fare lower than married dual worker households but compensate for it by having some time flexibility.

The upper left corner shows that married households with and without children have higher family incomes as compared to all other groups but dual income households with children have

significantly lower time availability as compared to all other categories. Singles without children also fare well in terms of income are around the middle of the pool in having time available. This group is likely younger, and the time limitation may reflect the number of hours spent at work. Overall these population groups may opt for faster transportation services as they have the financial capability to save time.

In the lower left corner are groups with limited income as well as time availability. In terms of income, singles occupy the lower half of the income scale, and with significant time impacts on those that are working and have children at home. These households face a constant challenge to balance time spent on paid work with time spent on care-giving. They often cannot opt for cheaper transportation modes due to time pressures. To them, affordable transportation could mean job security, health, happiness, and more time available for family activities.

In the lower right corner are groups who have low-income but have relatively high time availability. This group is all singles and unemployed. Time availability for this group is highest as compared to all other groups since they do not have to spend a significant part of the day at work. Time availability and limited income in this group would suggest that members in this group would opt for transportation modes that have higher travel time costs and lower out-of-pocket costs. However, this lack of financial resources for better quality transportation services can often diminish their potential economic opportunities and create significant hardship in their lives.

Besides socio-demographic differentiations in income and time availability, there is a wide range of socio-demographic differentiation in transportation needs. Because most U.S. cities and regions lack the density and land use that can support high quality transit, complicated travel needs are often better served by private automobiles. This creates a modal mismatch issue among low-income population groups who cannot afford private cars to meet these travel needs. Those who face complex transportation needs and at the same time have limited income and time resources are the ones most negatively affected by unaffordable transportation. We imagine that needs for automobiles in general increase as households expand to include children and decline as available free time increases.

4.2 Differentiation in Transportation Needs and Prices by Location Settings

Following the connections shown in Figure 4.1, both built and policy environment settings can influence household transportation budgets by affecting the price of transportation at a location and the amount of transportation that residents of that location need. Nevertheless, policies exert higher-level impacts than the built environment, because policies not only directly affect transportation costs but also indirectly affect the costs by their impact on the built environment. For example, transportation policies such as congestion pricing and parking management directly increase the cost of auto use. Land use policies such as urban growth management promote compact development patterns, and indirectly influence the type and amount of transportation that residents need by offering a built environment that allows short-distance travel and is friendlier to non-motorized transportation.

From the perspective of improving transportation affordability, it is important to reduce the amount of transportation needed and the price of transportation. However, such reductions are difficult in the U.S. context of the prevailing sprawl and auto-oriented subsidy systems [44]. The auto-oriented urban landscape not only requires more travel for access to destinations—meaning higher transportation costs, but also is less supportive of alternative transportation— meaning a higher price of transportation for those who depend on non-auto modes. Different cities and regions have varying degrees of auto dependence. As such, it is important to develop a location-sensitive framework for evaluating transportation affordability.

4.3 A Population- and Location-Stratified Evaluation Matrix

To address the population- and location-based differentiations in transportation resources and costs, this study proposes a population- and location-stratified evaluation matrix for measuring transportation affordability. This framework divides population into different groups by socio-demographics. Location settings will be stratified based upon the policy and built environments, measuring the level of accessibility to basic daily activities, transit service, and level of transportation subsidy. The idea is illustrated in Table 4.1.

As shown in Table 4.1, we proposed to establish two affordability thresholds for each specified population group at a specified location setting: one refers to transportation-related time expenditures and another refers to transportation-related monetary expenditures. Correspondingly, we calculate two transportation affordability indicators as shown below:

Equation #3: $$TA_{Monetary} = \frac{Needs\ oriented\ transporation\ expenditures}{Household\ disposable\ income}$$

Equation #4: $$TA_{Time} = \frac{Needs\ oriented\ travel\ time}{Household\ disposable\ time}$$

Table 4.1: Transportation Affordability Evaluation Matrix

Built	Accessibility >	High	High	High	High	Low	Low	Low	Low
	Transit >	**Strong**	**Strong**	**Weak**	**Weak**	**Strong**	**Strong**	**Weak**	**Weak**
	Subsidy >	**Strong**	**Weak**	**Strong**	**Weak**	**Strong**	**Weak**	**Strong**	**Weak**
Population Groups									
Married dual-worker household with children		TA_M / TA_T	…	…	…	…	…	…	TA_M / TA_T
Married dual-worker household w/o children		…	…	…	…	…	…	…	…
Married single-worker household with children		…	…	…	…	…	…	…	…
Married single-worker household w/o children		…	…	…	…	…	…	…	…
Single male worker living alone		…	…	…	…	…	…	…	…
Single female worker living alone		…	…	…	…	…	…	…	…
Single male worker living with children		…	…	…	…	…	…	…	…
Singe female worker living with children		…	…	…	…	…	…	…	…
Single male unemployed living alone		…	…	…	…	…	…	…	…
Single female unemployed living alone		…	…	…	…	…	…	…	…
Single male unemployed living with children		…	…	…	…	…	…	…	…
Single female unemployed living with children		TA_M / TA_T	…	…	…	…	…	…	TA_M / TA_T

The use of needs-oriented expenditures rather than actual observed ones is intended to address the travel demand suppression issue among disadvantaged population groups. Studies on social exclusion have identified the following transportation needs as basic and critical to households' welfare [8]:

- Access to work;
- Access to learning;
- Access to healthcare, including self-care and caring for household members;
- Access to food shopping; and
- Access to social, cultural, and sporting activities.

In this research, a household's disposable income is measured as the income remaining after taxes—in other words, "take-home pay." A household's disposable time is measured by subtracting average daily time spend on work, learning, healthcare, and food shopping activities[3] from 24 hours.

In this next chapter, we use Twin Cities Metropolitan area as an example to discuss the components of the framework. We focus on exploring transportation resource and cost variation by socio-demographics and the built environment, as well as the general policy environment in the region as it relates to transportation affordability.

[3] In this research, we do not consider social, cultural, and sporting activities as basic activities because these activities are often perceived as relatively discretionary and low-priority compared to work, learning, healthcare, and food shopping. As a result, demand for these activities may be heavily suppressed among households subject to higher time pressures and with lower income. Observed time use for these activities may not be an accurate measure of time needed to be allocated to these activities.

Chapter 5 Case Study: Minneapolis-St. Paul Metropolitan Area

5.1 The Policy Environment and Transportation Affordability

As discussed in the previous section, the policy environment can impact transportation affordability by directly affecting the price of transportation and by indirectly affecting transportation needs through influence over the built environment. In the following text, we divide policy environments in the Twin Cities context into five categories: highway system policy, transit system policy, policy for the biking and walking system, land use policy, and household-based subsidy policy.

5.1.1 *Highway System Policy*

As is the case in most other places in the US, driving is the main transportation mode of choice in the Twin Cities, accounting for over 80% of all person trips [45]. However, this region has shown commitment to moving away from strong dependence on the automobile. In the 2030 Transportation Plan from the region's Metropolitan Council, the main transportation policy focus of the region is not on highway expansion but on facilities' preservation, operations, and maintenance [46]. Further, the 2011-2014 Transportation Improvement Program (TIP) in the Twin Cities identified the objective of creating a multi-modal transportation system, maintaining the highway system, and enhancing transit, biking, and walking projects. By properly managing the automotive travel demand and improving infrastructure for non-auto modes, such policies may help reduce situations where a household is "forced" to own an automobile.

5.1.2 *Transit System Policy*

According to the Twin Cities 2030 Regional Development Framework, one of the four principles in regional development is to "enhance transportation choices and improve the ability of Twin Cities residents to travel safely and efficiently throughout the region" [47], recognizing transit as an important mode choice. A variety of efforts have been made to build a cost-effective regional transit network. Strategies have included: (1) tailoring transit services to diverse market needs; (2) expanding regional park-and-ride facilities. (3) increasing connections from pedestrian and biking systems to transit corridors; and (4) continuing to build transitways [46]. These strategies have helped make transit services a funding priority in the region. Examples include park-and-ride facilities, bus-only shoulders, and signal priority for the Hiawatha light rail line. The Twin Cities area has about 290 miles of bus-only shoulders, more than five times than the sum of bus-only shoulder miles in the rest of the nation [48].

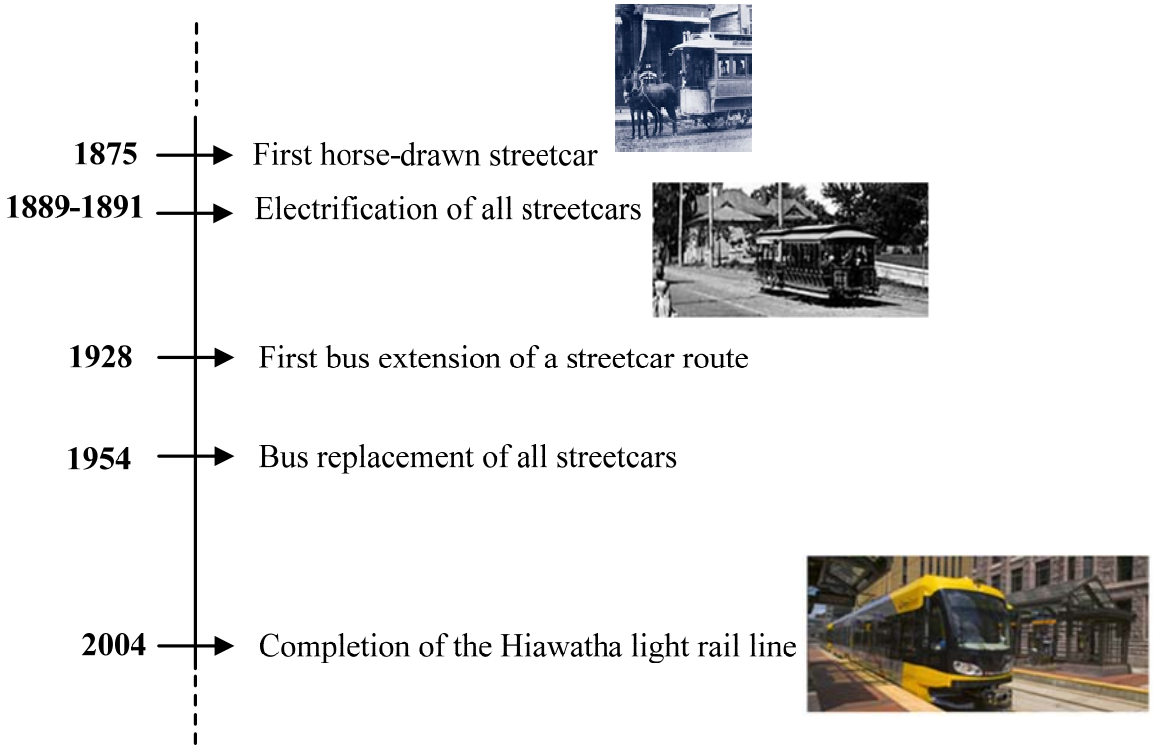

Figure 5.1: Brief history of rail transit in the Twin Cities.
Timeline source: Minneapolis Pubic Library, 2010.

5.1.3 *Biking and Walking System Policy*

In addition to the transit system, the biking and waking infrastructure is also important for those who do not own a vehicle. The Minneapolis-St. Paul area has 1,692 miles (2,722 kilometers) of off-street bike paths, the most extensive bike network in the US [49]. State agencies and local jurisdictions provide and maintain bike and pedestrian facilities, such as paved shoulders, on-road bike lanes, and sidewalks with curb ramps.

Many strategies have been implemented in the areas of financing and road design to promote the use of biking and walking. In financing biking and walking, Minneapolis and its adjacent cities are using a federal grant of $21 million through 2011 to improve walking and biking infrastructure. The Metropolitan Council provides funding for projects that improve multi-use paths and bike lanes [47].

To encourage cyclists, the Metropolitan Council provides users an online map of on-road and off-road bike trails in the seven-county metropolitan area, and invests in a bicycle trip planning tool called Cyclopath (http://cyclopath.org/). Further, Nice Ride Minnesota, the largest bike-sharing program nationwide, encourages short-term rental of bikes. After paying a membership fee, the program charges no fees for the first 30 minutes of a bike trip; once a trip is finished, the rental bike can be returned to any station when the user arrives at his/her destination. For the first year, the program reaped 100,817 checkouts, exceeding its goal by 817 [50].

In road design, complete streets is a concept that has been promoted in the region. The complete street policy concept aims to encourage multi-modal transportation on roads by considering the needs of pedestrians, transit users and vehicles, bicyclists, motorist, and emergency vehicles. It is an effort that systematically investigates the layout of bicycle and pedestrian facilities to provide safe and comfortable biking and walking environments. The Metropolitan Council 2030 Transportation Policy Plan states that "when a principle or minor arterial road is constructed or reconstructed, off-road walkway designs and both on- and off-road bikeway designs must be considered, with special emphasis placed on safety and barrier removal with the goal that the street meets the needs of all users" [46].

5.1.4 *Land Use Policy*

Efforts have been made to foster place making in local centers to reduce dependence on automobiles. The Metropolitan Council's 2030 Transportation Policy Plan says that land use objectives must be coordinated with transportation services to "support and encourage and intensification of development" within the metropolitan area. The Policy Plan has the following land use objectives: (1) the "centers and corridors" strategy that encourages development along major centers and corridors and redevelopment of underutilized sites; (2) 30% of all future growth should happen in already urbanized areas [46].

The Metropolitan Council has promoted transit-oriented development, i.e., developing compact, mixed-use development near transit stops and stations. The Metropolitan Council has issued a Guide for Transit-Oriented Development, which includes information about compact development (TOD scale, block size, and land use densities), mix of uses, pedestrian orientation, and transportation interfaces (transit stops and stations, and parking in TOD) [51].

5.1.5 *Household-Based Subsidy Policy*

A handful of household-based transportation subsidy policies are in effect in the Twin Cities region. One example is the Temporary Assistance for Needy Families (TANF) Program, created as part of a federal effort to provide cash welfare to poor families. Each state uses the TANF funds to provide services and supports, such as income assistance, child care, health care, and transportation.

"Ways to Work" was a local program run by the McKnight Foundation which started in mid 1980s as a program to help single mothers in Minnesota move off and stay off of welfare [52]. The program has evolved into the nation's largest and most successful alternative to predatory auto loans for working poor families. Since the mid-1980's, Ways to Work has helped more than 27,000 families stabilize or improve their financial situation through over $50 million in loan funds used for a variety of work-related purposes. Ways to Work is now a unique Community Development Financial Institution (CDFI) based in Milwaukee, WI which continues to provide auto loans to working poor families.

5.2 The Built Environment and Transportation Affordability

Figure 5.2 shows the distribution of low wage workers and jobs (average monthly wage< $1,340) in the Twin Cities metropolitan area. The map not only depicts uneven distribution of residence

and employment, but also clearly shows jobs/housing mismatch. Such mismatch suggests high transportation costs may be in play for low-wage workers to access their jobs.

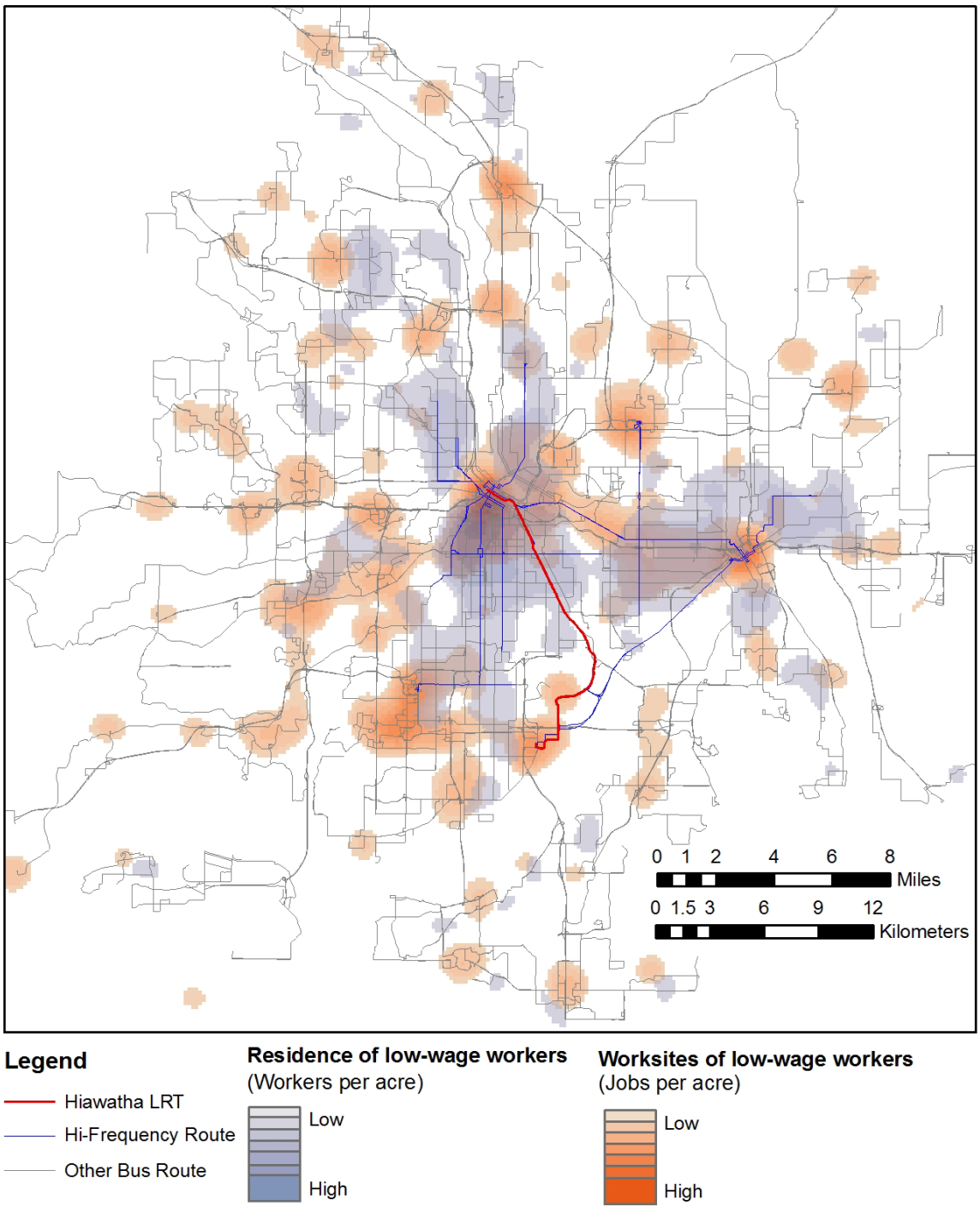

Figure 5.2: Concentration of low-wage jobs and workers in the Twin Cities region, 2002.

Figure 5.3 examines transit accessibility to all job opportunities and food shopping opportunities in the Twin Cities region. The accessibility measure shown in the maps is in the form of cumulative opportunities, i.e., the total number of jobs that can be accessed within 45-minute transit travel.

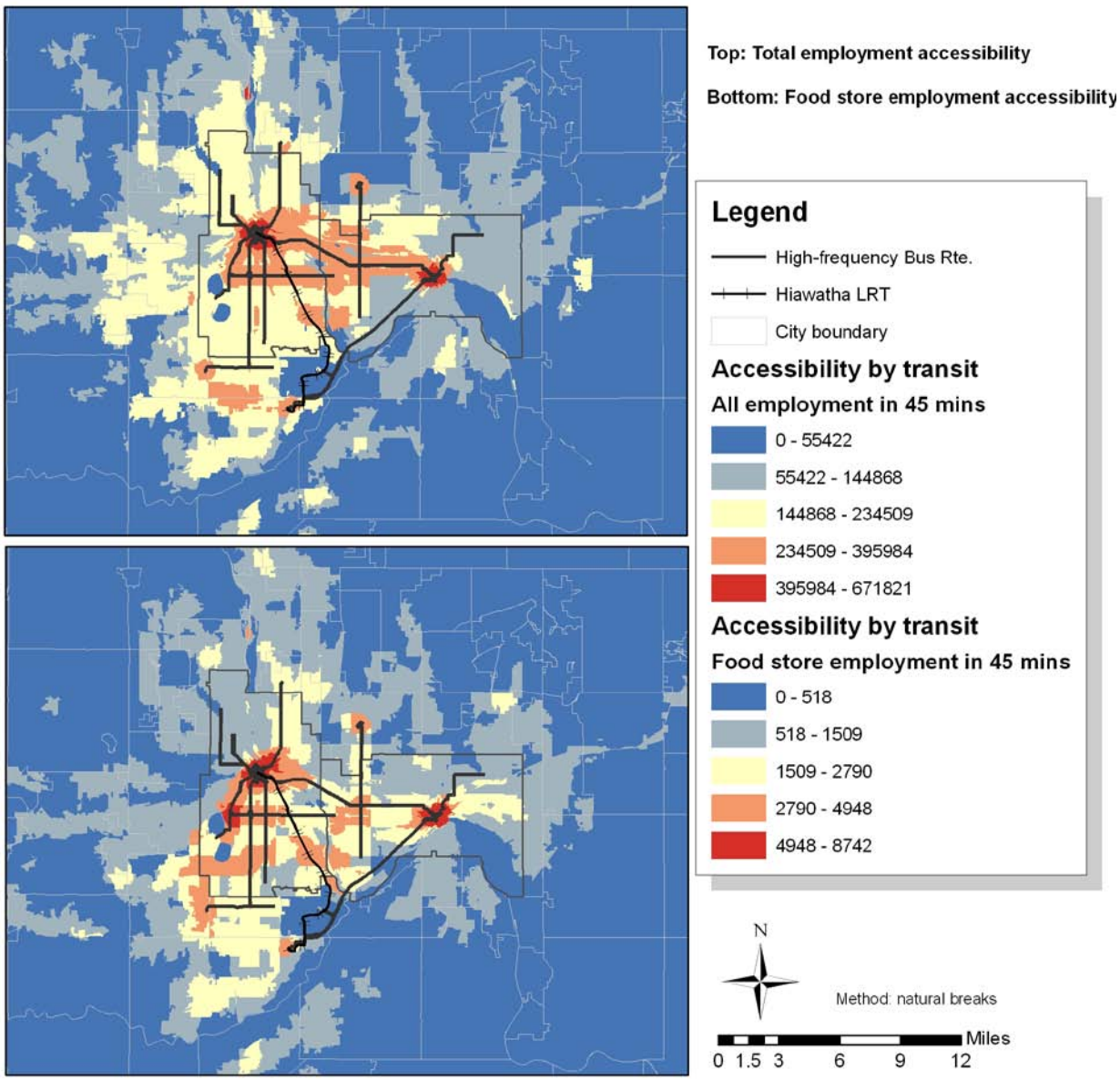

Figure 5.3: Transit access to all employment and food store employment in the Twin Cities region, 2005.
Data source: Dun & Bradstreet Business Dataset, 2005.
Note: For food store employment, NAICS IDs 445110 through 445299 were used.

Maps in Figure 5.3 show large spatial variation in access to jobs and food store-related jobs. An important observation is that residents of North Minneapolis, compared with residents of South Minneapolis, have significantly lower access to both job and food shopping opportunities. North

Minneapolis contains significant concentrations of low-income minority population. Compared to low-income residents who live in South Minneapolis, North Minneapolis residents are more likely to be affected by transportation affordability issues. In addition, transit accessibility is very low in the suburbs.

5.3 Socio-Demographics and Transportation Affordability

This section focuses on variations in transportation needs and resources by socio-demographics in the Twin Cities. According to Census 2010, the Twin Cities area is home to 3.15 million people, of whom about 22% are minority populations [53]. Households with different socio-demographics have different financial resources and transportation needs. The data sets we use in this analysis include:

- The 2005-2009 American Community Survey (ACS) which contains households' socio-demographic information from the 1% ACS samples for five years.
- The 2003-2009 American Time Use Survey which documents Americans' time use information for seven years.

Figure 5.4 shows wide variation across different population groups in average daily time spent on basic activities including work, learning, food shopping, self healthcare, and caring for household members. On average, a married dual-worker household with children spends 400 minutes per adult per day (including both weekdays and weekend days) on basic activities. This household type allocates the most time to basic activities. The household type with the second highest time allocation to basic activities is single-parent working-father households, followed by single-parent working-mother households.

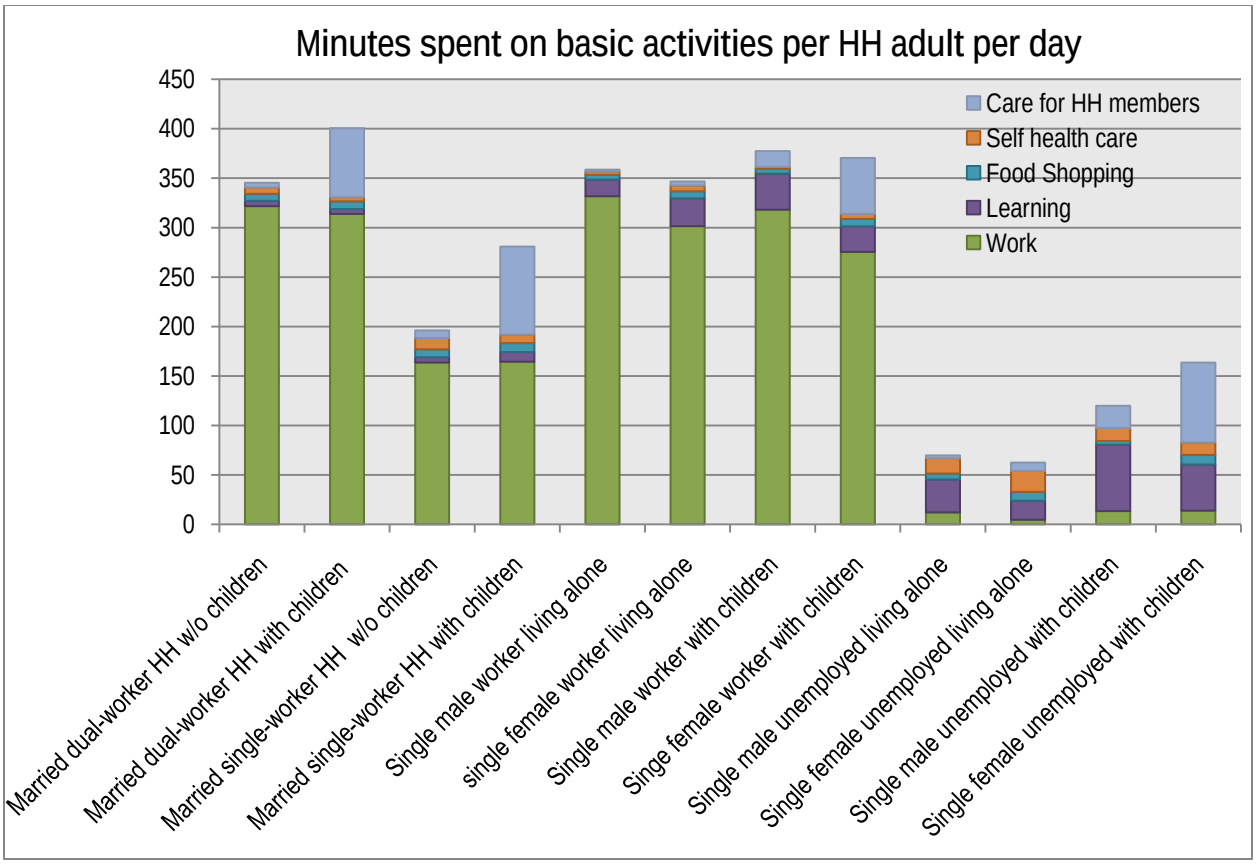

Figure 5.4: Average time spent on basic activities.
Data source: 2003-2009 American Time Use Survey (N = 93,978). (National-level data).

Figure 5.5 shows daily time spent on travel related to basic activities. Again, the married dual-worker households with children are the household type with the highest time allocation to basic travel—on average adults of this household type spend 43 minutes per day on basic travel. The household type with the second highest time allocation to basic travel is single-parent working-mother households, followed by single-parent working-father households.

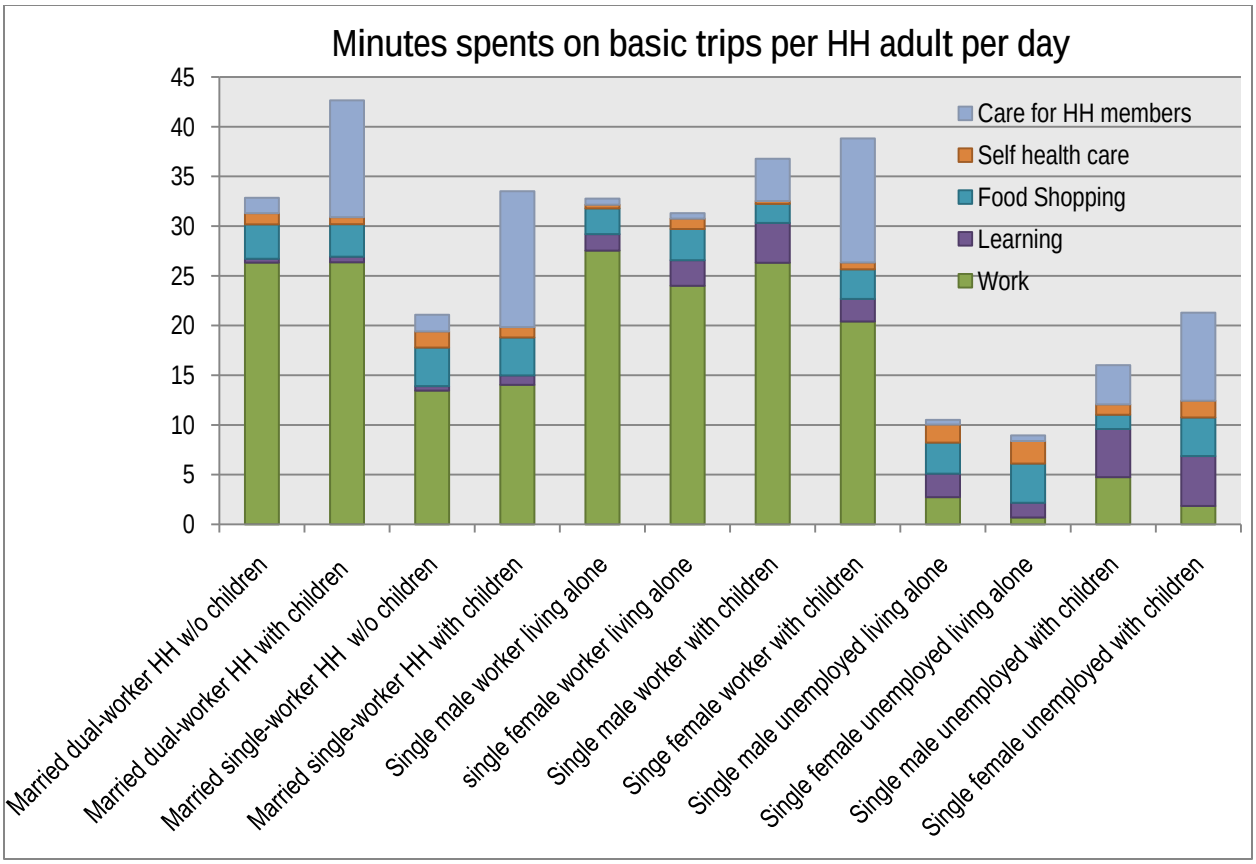

Figure 5.5: Average daily time spent on travel related to basic activities.
Data source: 2003-2009 American Time Use Survey (N = 93,978). (National-level data).

The data in Figures 5.4 and 5.5 allow us to generate a time-based transportation affordability ratio—the proportion of basic travel time out of household disposable time. The calculated results are shown in Figure 5.6. Higher ratio values indicate the households have to spend more time out of their disposable time on fulfilling basic travel needs—meaning lower levels of time-based transportation affordability. As shown in Figure 5.6, married dual-worker households with children have the lowest affordability, followed by single-parent working-mother households and single-parent working-father households.

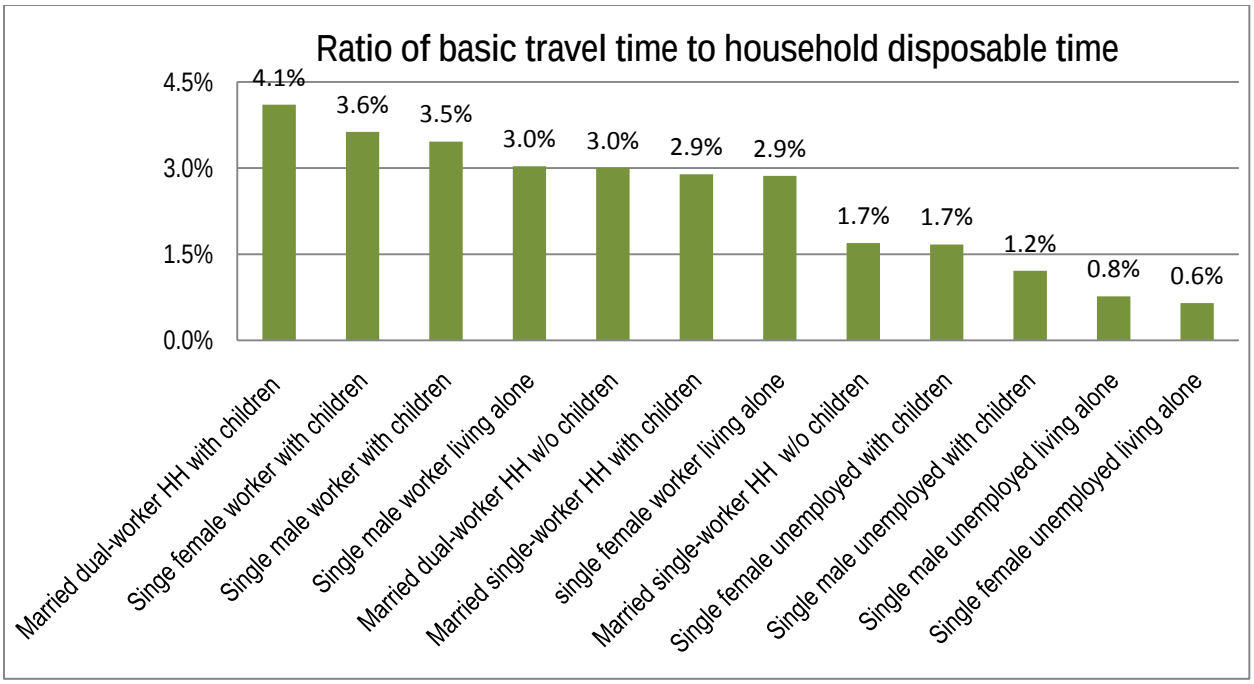

Figure 5.6: Ratio of basic travel time to household disposable time.
Data source: 2003-2009 American Time Use Survey (N = 93,978). (National-level data).

Figure 5.7 shows the average annual household income across different socio-demographic groups using the 2005-2009 5-year ACS data. Married dual-worker households on average have the highest income levels. Among households with at least one working adult, single-mother households have the lowest income level ($22,813). Among households headed by unemployed adults, again single-mother households have the lowest income level ($10,008). This means single-mother households have the least financial resources for meeting household members' transportation needs. This may be exacerbated by our previous finding that single-mother households have one of the lowest levels of time availability.

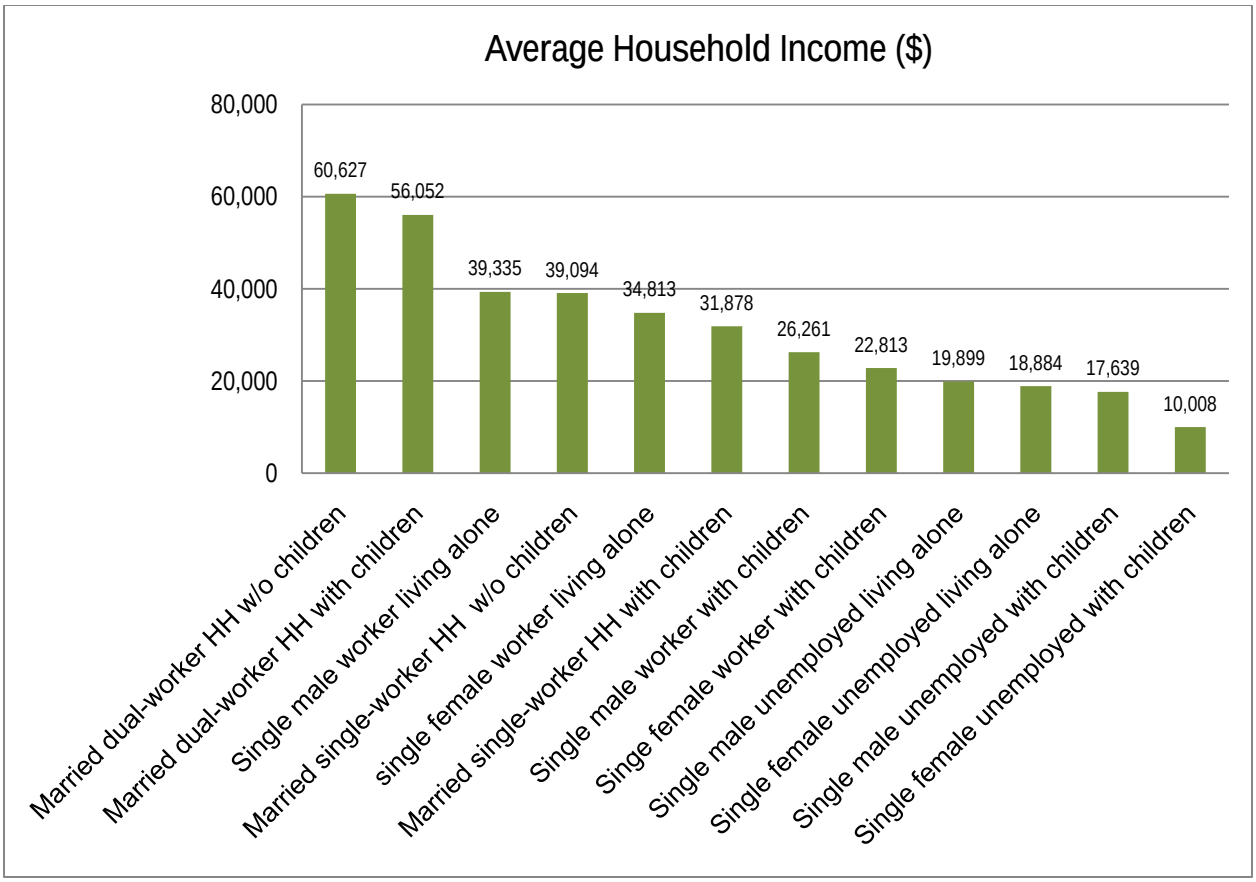

Figure 5.7: Variation in household income by socio-demographics.
Data source: 2005-2009 5 year ACS. (National-level data).

The analysis above shows that travel needs and resource availability differ considerably by socio-demographics. Coupled with the locational variation in transportation affordability, the variation in transportation needs and resources across population groups in the Twin Cities region confirms the importance of a population- and location-specific approach to measuring and addressing transportation affordability.

Chapter 6 Discussion and Conclusions

This study proposes a contextualized transportation affordability analysis framework that differentiates population groups based upon their socio-demographics, the built environment, and the policy environment. The need for such a context-sensitive framework is demonstrated via a case study of the Twin Cities metropolitan area, which shows heterogeneity of different population groups in terms of their transportation needs and financial resources. This research also points out two dilemmas associated with transportation affordability.

- The socio-economically disadvantaged group has the lowest auto ownership rate, yet their transportation needs are better served by automobiles.
- While automobiles can reduce transportation hardship for the socio-economically disadvantaged, the existing auto-oriented urban landscape in the US imposes greater distances between destinations, which leads to higher transportation costs.

The existence of the two dilemmas call for a multi-modal transportation solution: reducing societal dependence on the automobile and providing auto access for the socio-economically disadvantaged may be equally important to enhance transportation affordability and social welfare. First, transportation policies need to promote long-term changes in the built environment in order to reduce auto dominance. Moving to a more compact, mixed use urban form that offers multiple modes of good transportation services can improve transportation affordability by reducing household reliance on automobiles as well as reducing the amount of travel required for daily activities. Second, when it comes to transportation modes, policies promoting auto access among the socio-economically disadvantaged need to be considered, given the unique and more complex travel needs among this population. If full access to private cars is not possible, even having occasional access could make a big difference for meeting the travel demands of low-income households [19]. Programs supporting access to private transportation may include financial subsidies for car ownership and cooperative car-sharing programs.

To sum up, the study suggests that while it is important to gradually change our auto-dominated environment for reducing transportation cost in the long run, providing low-income households' access to automobiles is a necessary strategy for making transportation more affordable to them.

References

1. Smith, J. *Ads Across Time Tout Reliability, Affordability*. July 2008; cited 12/20/2010; available from: http://www.npr.org/templates/story/story.php?storyId=92357271.

2. Glaeser, E. and M. Kahn. "Sprawl and Urban Growth." *Handbook of Regional and Urban Economics*, 2004, 4: pp. 2481-2527.

3. Oak Ridge National Laboratory. *2009 National Household Travel Survey*. 2010; cited 3/20/2011; available from: http://nhts.ornl.gov/tables09/FatCat.aspx.

4. Bureau of Transportation Statistics. *Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances*. 2010; cited 3/10/2011; available from: http://www.bts.gov/publications/national_transportation_statistics/html/table_01_11.html.

5. Dargay, J., D. Gately, and M. Sommer. "Vehicle Ownership and Income Growth, Worldwide: 1960-2030." *Energy Journal*, 2007, 28(4).

6. Holzer, H., K. Ihlanfeldt, and D. Sjoquist. "Work, Search, and Travel Among White and Black." *Journal of Urban Economics*, 1994, 25: pp. 320-345.

7. Raphael, S., et al. *Can Boosting Minority Car Ownership Rates Narrow Inter-racial Employment Gaps?* 2001, Washington, D.C.: The Brookings Institution.

8. UK Social Exclusion Unit. *Making the Connections: Final Report on Transport and Social Exclusion*. [Report] 2003; cited 11/1/2010; available from: www.lancashire.gov.uk/corporate/web/viewdoc.asp?id=42633.

9. Chapple, K. "Time to Work: Job Search Strategies and Commute Time for Women on Welfare in San Francisco." *Journal of Urban Affairs*, 2001, 23: pp. 155-176.

10. Ferdous, N., et al. "A comprehensive analysis of household transportation expenditures relative to other goods and services: An application to United States consumer expenditure data." *Transportation*, 37(3): pp. 363-390.

11. Surface Transportation Policy Project. *Transportation Costs on the American Dream*. [Report] 2003; cited 12/1/2010; available from: http://www.transact.org/library/decoder/american_dream.pdf.

12. Bureau of Labor Statistics. *2009 Consumer Expenditure Survey*. 2010; cited 3/1/2011; available from: ftp://ftp.bls.gov/pub/special.requests/ce/standard/2009/quintile.txt.

13. Blumenberg, E. "Transportation Costs and Economic Opportunity Among the Poor." *Access*, 2003, 23: pp. 40-41.

14. Cain, A. and P. Jones. "Does Urban Road Pricing Cause Hardship to Low-Income Car Drivers." *Transportation Research Record*, 2008, 2607: pp. 47-55.

15. Venter, C. and R. Behrens. "Transport Expenditure: Is the 10% Policy Benchmark Appropriate?" In *Proceedings of the 24th South African Transport Conference*. 2005, Pretoria, South Africa.

16. Victoria Transport Policy Institute. *Transportation Affordability: Evaluation and Improvement Strategies*. [Report] 2010; cited 10/10/2010; available from: http://www.vtpi.org/affordability.pdf.

17. Brookings Institution. *The Affordability Index: A New Tool for Measuring the True Affordability of a Housing Choice*. [Report] 2006; 9/1/2010; available from: http://www.brookings.edu/metro/umi/20060127_affindex.pdf.

18. Jones, P., et al. *Understanding Travel Behavior*. 1983, Aldershot, England: Gower Press.

19. Clifton, K. and K. Lucas. "Examining the Empirical Evidence of Transport Inequality in the US and UK." *Running on Empty: Transport, Social Exclusion and Environmental Justice*. 2004, Bristol, United Kingdom: The Policy Press.

20. Dodson, J., B. Gleeson, and N. Sipe. *Transport Disadvantage and Social Status: A Review of Literature and Methods*. 2004, Queensland, Australia: Griffith University.

21. Giuliano, G. "Low Income, Public Transit, and Mobility." *Transportation Research Record*, 2005, 1927: pp. 63-70.

22. Jones, P., P. Nijkamp, and S. Reichman. *Mobility and the Individual in Western Industrial Society*, in *Transportation Planning in a Changing World*. 1987, Aldershot, England: Gower Press. pp. 29-47.

23. Fletcher, C., S. Garasky, and R. Nielsen. "Transportation Hardship: Are You Better Off with a Car?" *Journal of Family and Economic Issues*, 2005, 26(3): pp. 323-343.

24. Gleeson, B. and B. Randolph. *A New Vision for Western Sydney*. 2002, New South Wales: University of Western Sydney.

25. Ryan, J. and G. Han. "Vehicle Ownership Model Using Family Structure and Accessibility: Application to Honolulu, Hawaii." *Transportation Research Record*, 1999, 1676: pp. 1-10.

26. Evans, A. "The Prediction of Car Ownership: A Comment." *Journal of Transport Economics and Policy*, 1970, 4: pp. 89-106.

27. Cervero, R. and C. Radisch. "Travel Choices in Pedestrian Versus Automobile Oriented Neighborhood." *Transport Policy*, 1996, 3: pp. 127-141.

28. Handy, S. "Regional Versus Local Accessibility: Implications for Nonwork Travel." *Transportation Research Record*, 1993, 1400: pp. 58-66.

29. Handy, S.L. "Understanding the link between urban form and nonwork travel behavior." *Journal of Planning Education and Research*, 1996, 15(3): pp. 183-198.

30. Handy, S. "Understanding the Link between Urban Form and Travel Behavior." In *74th Annual Meeting of the Transportation Research Board*. 1995, Washington, D.C.

31. Cervero, R. and K. Knockelman. "Travel Demand and the 3Ds: Density, Diversity, and Design." *Transportation Research Part D: Transport and Environment*, 1997, 2: pp. 199-219.

32. Blumenburg, E. and P. Ong. "Job Accessibility and Welfare Usage: Evidence from Los Angeles." *Journal of Policy Analysis and Management*, 1998: pp. 639-657.

33. Ong, P. "Work and Car Ownership Among Welfare Recipients." *Social Work Research*, 2006, 20: pp. 255-267.

34. O'Regan, K. and J. Quigley. "Where Youth Live: Effects of Urban Space on Employment." *Urban Studies*, 1998, 35: pp. 1187-1205.

35. Cullinane, S. and K. Cullinane. "Car Dependence in a Public Transport Dominated City: Evidence from Hong Kong." *Transportation Research Part D: Transport and Environment*, 2003, 8: pp. 129-138.

36. Schor, J. *The Overspent American: Upscaling, Downshifting, and the New Consumer*. 1998, New York: Basic Books.

37. Mitric, S. and R. Carruthers. *The Concept of Affordability of Urban Public Transport Services for Low-Income Passengers*. [Report] 2005; cited 10/1/2010; available from: http://siteresources.worldbank.org/INTURBANTRANSPORT/Resources/affordability_upt.pdf.

38. Golub, A. "Welfare and Equity Impacts of Gasoline Price Changes under Different Public Transportation Service Levels." *Journal of Public Transportation*, 2010, 13(3): pp. 1-21.

39. Cervero, R. "Transit Pricing Research: A Review and Synthesis." *Transportation*, 1990, 17: pp. 117-139.

40. Deka, D. "Transit Availability and Automobile Ownership: Some Policy Implications." *Journal of Planning Education and Research*, 2002, 21(3): pp. 285-300.

41. Holtzclaw, J., et al. "Location Efficiency: Neighborhood and Socio-Economic Characteristics Determine Auto Ownership and Use-Studies in Chicago, Los Angeles and San Fancisco." *Transportation Planning and Technology*, 2002, 25: pp. 1-27.

42. Krizek, K. "Transit Supportive Home Loans: Theory, Application, and Prospects for Smart Growth." *Housing Policy Debate*, 2003, 14: pp. 657-677.

43. Fan, Y., A. Khattak, and D. RodrÃguez. "Household Excess Travel and Neighbourhood Characteristics." *Urban Studies*, 2011, 48(6): pp. 1235-1253.

44. Kane, M. *Better Connections: Linking Minnesotans with Low Income and Limited Transportation Options to Jobs and Other Important Destinations*. 2009, St. Paul, MN: Growth and Justice.

45. Metropolitan Council. *Travel Behavior Inventory*. 2000; cited 9/1/2010; available from: http://www.metrocouncil.org/planning/transportation/TBI_2000.htm.

46. Metropolitan Council. *2030 Transportation Policy Plan*. 2004; cited 9/1/2010; available from: http://www.metrocouncil.org/planning/transportation/tpp/2004/summary.htm.

47. Metropolitan Council. *2030 Regional Development Framework*. 2010; cited 3/1/2011; available from: http://www.metrocouncil.org/planning/framework/documents.htm.

48. Minnesota Department of Transportation. *Greater Minnesota Transit Plan 2010-2030*. 2010; cited 3/1/2011; available from: http://www.dot.state.mn.us/transit/transitplan/plan.html.

49. Krizek, K., A. El-Geneidy, and K. Thompson. "A Detailed Analysis of How an Urban Trail System Affects Cyclists' Travel." *Transportation*, 2007, 34(5): pp. 611-624.

50. Eggert, A. *Nice Ride program tops first-year goals*. 2010; cited 1/15/2011; available from: http://www.mndaily.com/2010/11/10/nice-ride-program-tops-first-year-goals.

51. Metropolitan Council. *Guide for Transit Oriented Development*. 2010; cited 1/15/2011; available from: http://www.metrocouncil.org/planning/tod/tod.htm.

52. Goldberg, H. *State and County Supported Car Ownership Programs Can Help Low-Income Families Secure and Keep Jobs*. 2001, Washington, D.C.: Center on Budget and Policy Priorities.

53. Minnesota Department of Administration. *Minnesota population change by metropolitan area 2000-2010*. 2010; cited 4/1/2011; available from: http://www.mn2010census.org/resource.html?Id=31949.