FHWA/IN/JTRP-2008/19

Final Report

**ALTERNATIVE LAND USE PATTERNS TO
MINIMIZE CONGESTION**

*Volume 3
Empirical Study of Mixed Land Use
Traditional Neighborhoods*

**Li Jin
Jon Fricker**

December 2008

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Volume 3

Empirical Study of Mixed Land Use Traditional Neighborhoods

by

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Project No. C-36-70G

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Indiana Department of Transportation
and the Federal Highway Administration
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The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views of the Federal Highway Administration and the Indiana Department of Transportation. This report does not constitute a standard, a specification, or a regulation.

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ABSTRACT

Urban sprawl creates serious traffic congestion. Alternative land use patterns may be the best solution. New Urbanists claim that, by placing frequently-visited sites within walking distance of homes and creating a pleasant walking environment, people are more willing to choose non-motorized transportation mode to do such activities.

Part I of this study investigated the ability of travel demand models to estimate the impacts of alternative land use patterns. Part II conducted an economic viability analysis for a mixed land use neighborhood and collected land use preferences at meetings of neighborhood associations. The objective in Part III is to evaluate the feasibility of implementing mixed land use neighborhood, based upon public acceptance, actual impacts on travel behavior and observed trip making patterns. Two mailback surveys and three intercept surveys were conducted and analyzed for this report.

In this study, the statistical analyses of the two mailback surveys have shown that a resident's non-motorized mode travel share is strongly related to his/her home-to-store trip distance. However, a resident's shopping frequency at neighborhood stores is not related to his/her home-to-store trip distance. Mixed land use may not lead to fewer vehicle trips, if the trips to "neighborhood stores" that are close to home or work are made by automobile as part of a trip chain.

Neighborhood stores in the Meridian-Kessler neighborhood attract both residents and non-resident customers. Because an increase in traffic to neighborhood stores could worsen the environment for a neighborhood's residents, the size, type and location of neighborhood stores in a mixed land use neighborhood need to be managed carefully. Neighborhood stores can be located along the arterial streets that surround the neighborhood, not at the center of the neighborhood. This arrangement may not adhere to the New Urbanist sense of "place", but it offers the neighborhoods reduced vehicular traffic and the neighborhood businesses increased exposure to non-neighborhood potential customers.

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Part I of this study investigated the ability of travel demand models to estimate the impacts of alternative land use patterns. Part II conducted an economic viability analysis for a mixed land use neighborhood and collected land use preferences at meetings of neighborhood associations. The objective in Part III is to evaluate the feasibility of implementing mixed land use neighborhood, based upon public acceptance, actual impacts on travel behavior and observed trip making patterns. Two mailback surveys and three intercept surveys were conducted and analyzed for this report.

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Neighborhood stores in the Meridian-Kessler neighborhood attract both residents and non-resident customers. Because an increase in traffic to neighborhood stores could worsen the environment for a neighborhood's residents, the size, type and location of neighborhood stores in a mixed land use neighborhood need to be managed carefully. Neighborhood stores can be located along the arterial streets that surround the neighborhood, not at the center of the neighborhood. This arrangement may not adhere to the New Urbanist sense of "place", but it offers the neighborhoods reduced vehicular traffic and the neighborhood businesses increased exposure to non-neighborhood potential customers.

CHAPTER 1. NEIGHBORHOOD LAND USE PATTERNS

1.1 Background and Motivation for this Research

The term *urban sprawl* describes development that is dispersed and auto-dependent. Land uses are separated, making it impossible to walk to most destinations. Low-density residential development creates traffic congestion and pollution, increases fuel use and threatens open space, and makes it more difficult to provide public services. (Tirado 2001) Land use patterns based on New Urbanist principles offer alternatives to the urban sprawl. The three most important features of New Urbanism neighborhood land use trend are:

1. High density or compact development
2. Mixed land use
3. Interconnected, walkable community

Swift (2005) specified fifteen New Urbanist neighborhood design features. Among them are:

1. The community has a discernible center. This is often a plaza, square or green, and sometimes a busy or memorable intersection. A transit shop should be located at the center.
2. Most dwellings are within a five-minute walk (a quarter mile) from the center. Streets are designed for walking and cycling, with sidewalks on both sides, bike lanes where needed, good crossings, traffic calming features used to control motor vehicle traffic speeds, and other features to encourage non-motorized travel.
3. There are places to work within and adjacent to the neighborhood, including shops, office buildings, and live-work units.
4. There are shops sufficiently varied to meet common household needs, such as convenience stores, a post office, a bank machine, and a gym.
5. A small ancillary building should be permitted within the backyard of house. It may be used as a rental apartment, or as a place to work.
6. There should be an elementary school close enough so that most children can walk from

their dwellings. The distance should not be more than one mile.

7. There are parks, trails and playgrounds near every dwelling. This distance should be not more than one-eighth of a mile.

8. Thoroughfares are relatively narrow and shaded by rows of trees that slow traffic and create an appropriate environment for pedestrian and bicyclist.

These features of a New Urbanist neighborhood may change the travel modes that residents choose to use during their everyday activities. People can go shopping and perform other personal activities by walking or bicycling. Their children can walk to school and parks. Proponents of New Urbanism design claim that walkable communities reduce negative environmental consequences and foster stronger communities through improved social interaction.

Many ideas behind New Urbanism trend are not new. See Figure 1.1. In the suburban sprawl development in the upper half of the figure, the mall, apartments, houses, and school are connected only by the main road. In the traditional (mixed land use) neighborhood in the bottom of the figure, there is greater connectivity and possibilities for non-motorized travel modes.

Figure 1.1: A comparison of traditional neighborhood and suburban sprawl

Source: Duany and Plater-Zyberk (1992)

Neo-traditional neighborhood design has been the focus of numerous research projects in recent years. Handy (1992) found that the effectiveness of neo-traditional development at reducing non-work travel is ambiguous, based on case studies of four communities within the San Francisco Bay Area. Frank and Pivo (1994) found that the percent of walking and transit trips had the highest linear relationship with density for shopping trips, while the land-use mix was not found to be significantly correlated with the mode choices. Cervero and Kockelman (1997) constructed a series of variables to measure, roughly, land use mix. They found that a compact, mixed-use, and pedestrian-friendly design can lessen vehicle trips, reduce VMT per capita, and encourage non-motorized travel, not only for non-work travel, but also for work trips. Based on the data presented in McCormack et al. (2001), mixed land use neighborhood residents travel 29 percent fewer kilometers than residents in adjacent areas and 49 percent fewer kilometers than residents in suburban areas. Bose and Fricker (2001) used travel demand modeling software to show how much non-work trip lengths can be reduced (in terms of both travel time and distance) when a Euclidean (separated land use) development is transformed into a neighborhood that has New Urbanist characteristics. Travel research has determined that trip frequencies, destination choices, mode choices, departure times, and trip chaining are all affected by density and mixed land use. (Sanderson 1999)

Urban form can be measured on spatially aggregated units (such as the city or urban-suburban level) or on much more disaggregated units (such as the neighborhood level). (Rajamani et al. 2003) Similarly, analysis can be conducted for a group of individuals or at the individual level. Four combinations of geographic scale and level of analysis are possible. This research described in this report will be on the neighborhood scale and the microscopic level. The level of analysis will focus on individual personal behavior.

New Urban News's benchmark survey (Steuteville 2004), completed in December, 2003, listed 648 neighborhood-scale New Urbanism communities in the United States. This was an increase of 176 from the year before. The New Urbanist communities listed for included Indiana Beachwalk in Michigan City, Indiana, Coffee Creek Center in Chesterton, Indiana, and the Village of West Clay in Carmel, Indiana.

Because the New Urbanism neighborhoods in Indiana were not fully developed, existing neighborhoods were identified that either (a) contained some of the traditional or New Urbanist characteristics or (b) could be easily converted into a New Urbanist neighborhood. In one

particular mixed land use neighborhood, “commercial nodes” are located at intersections a few blocks apart, surrounded by residences at typical urban density. This is a neighborhood that developed more than 100 years ago, yet the mixed land use resembles the traditional principles that many urban planners want to recapture in new developments. This type of development would provide people with an alternative to the sprawling residential-only suburban neighborhoods that are located at driving distance from large shopping malls.

The objective of this research is to evaluate the feasibility of implementing mixed land use neighborhood design, based upon public acceptance and the actual impacts on travel behavior and observable trip making. (Bose and Fricker 2001) In Part III of this research study, one real mixed land use neighborhood (the Meridian-Kessler neighborhood in Indianapolis) and one “semi-mixed” land use neighborhood (the St. Lawrence-McAllister neighborhood in Lafayette) were adopted for case studies. A mail back survey in the two areas and intercept surveys in the Meridian-Kessler neighborhood were carried out. The results were analyzed to evaluate the degree to which various aspects of traditional neighborhood design were acceptable to those individuals surveyed.

1.2 Key Research Questions

The mailback survey was designed to answer questions such as:

1. Does a mixed land use neighborhood make people more likely to choose non-motorized travel modes?
2. To what extent do people living a mixed land use neighborhood shop at the neighborhood stores?
3. Does the frequency of shopping at neighborhood stores depend upon the distance from home to store, vehicle availability, walking environment, age, sex, or other independent variables? Does the choice of mode for trips to neighborhood stores depend on any of these factors?
4. What proportion of people prefer a mixed land use neighborhood pattern? What is the type of stores do people want in their mixed land use neighborhood?
5. Are there any significant differences in the frequency of shopping at neighborhood stores and the use of non-motorized travel modes for the residents in the two case study areas?

6. To what extent did people who live in a mixed land use neighborhood choose to do so because they prefer mixed land uses? What changes would residents like to see in their mixed land use neighborhood?

7. What are the best attributes of the two case study neighborhoods, in the opinion of the residents? Why do residents (not) shop at neighborhood stores? What would make the residents shop the neighborhood stores more often?

In the "customer intercept survey" survey, shoppers were asked questions as they left neighborhood stores. The main research questions to be answered were:

1. To what extent are the businesses at this intersection supported by the neighborhood's residences?
2. To what extent do the businesses' customers live outside the neighborhood?
3. Are customers who live close to these businesses more likely to use travel modes other than automobiles?

1.3 Research methodology

To understand residents' travel behavior in a mixed land use neighborhood, appropriate surveys can be helpful. The basic steps in conducting a survey include:

1. Determining a sampling methodology. The sample should be representative of the people who are potentially affected by the action.
2. Determining the type of survey instrument (mail, telephone, in-person interview, etc.).
3. Designing the survey instrument.
4. Implementing the survey.
5. Analyzing the survey results.

Intercept and mailback surveys were used in this research study.

In this study, the intercept survey involved interviewing shoppers as they left businesses at a commercial node in the Meridian Kessler neighborhood. By "intercepting" persons in this way, a reasonable sample of shoppers could be created, regardless of their residential locations. The intercept survey was conducted on several different days. The interview consisted of 4 questions (see Appendix A) designed to determine the origin, frequency, travel mode, and reason(s) for shopping trips to the neighborhood's businesses. Although the survey results apply only to the group of people who were interviewed on certain days at the survey locations, it is possible to

begin to develop an understanding of traveler choices. (Nardi 2003, Orient Pacific undated).

The mailback surveys used this research gave each resident an equal opportunity to provide information. In the Meridian Kessler neighborhood, the survey was placed in a quarterly newsletter published by the neighborhood association. In the St. Lawrence McAllister neighborhood, members of the neighborhood association distributed the survey to each household in the neighborhood. In designing mailback survey, both "revealed preference" survey and "stated preference" questions were included.

1. "Revealed preference" questions ask for actual existing travel behavior.
2. "Stated preference" questions try to uncover attitudes and hypothetical choices.
 - A. "Attitudinal" surveys ask respondents directly how they would respond to various actions (e.g., Would they use non-motorized travel mode if mixed land use neighborhood design were available?) or ask them to rate or rank their preferences for various improvements. Attitudinal surveys are relatively easy to design and implement and have been widely used to estimate the potential impacts of bicycle and pedestrian improvements and to determine relative preferences for such improvements. However, attitudinal surveys often significantly overestimate the response to a bicycle or pedestrian improvement, because people tend to be more likely to state that they will change their behavior than to actually do so. Attitudinal surveys tend to be better suited for evaluating relative preferences and for estimating the maximum possible response to an action, rather than predicting actual shifts in travel demand.
 - B. "Hypothetical choice" overcomes many of the biases of attitudinal surveys by requiring respondents to make choices between hypothetical alternatives with varying attributes. Hypothetical choice surveys are generally used to develop discrete choice models and to estimate the relative importance of each attribute (time, cost, presence of bike lanes, etc.) in common terms. While hypothetical choice surveys, combined with discrete choice modeling, are becoming more widely used in non-motorized travel analysis, they have the disadvantage of requiring considerable time and expertise to implement. The choice of alternatives to be presented to each respondent must be made carefully to provide the desired relationships between the characteristics of hypothetical alternatives and the probabilities of choosing each

alternative. (FHWA 1999)

In this research, attitudinal survey questions were used because the creation of plausible discrete mode choice models would have involved a survey so long as to discourage all but the most determined neighborhood residents from completing it.

1.4 Existing Models and Literature Review

Cervero (1988) found that mixed land use reduces motorized travel and congestion levels in two key ways. First, a given amount of floor space spread among multiple activities will normally lead to fewer trips than the same floor space devote to a single use. Second, more travel is taken by foot and bicycle, particularly before noon. And because workers could work nearby, some motorized travel during the morning and evening could be replaced by walk or bicycle trips.

Handy (1992) determined that the effectiveness of neo-traditional development at reducing non-work travel is ambiguous, based on case studies of four communities within the San Francisco Bay Area.

A neo-traditional development community includes a mixed-use core within a walking distance of most residences. Employment centers are also included in the design, so the residents could live and work within the development. Designers want to create a sense of community by providing public spaces and civic centers. Also, a pedestrian-friendly environment are created, with narrower streets, wider sidewalks, and more street trees. The general layout abandons curvilinear streets and cul-de-sacs in favor of a rectilinear grid.

Neo-traditional development communities are not like the typical suburban development, where land uses are strictly segregated and widely separated. Neo-traditional land uses are better mixed, connections between residential and commercial areas are more thoughtfully designed, and many daily needs are provided for within the community itself. The intent is to increase the variety of activities within the local area and the access to them.

Handy used two types of accessibility (regional accessibility and local accessibility) to measure whether the travel pattern is influenced by the community character and region. By improving local accessibility, the hope is that more local trips will be made by walking instead of driving and the number of regional trips taken will be reduced.

Using existing data from the regional planning agencies, Handy identified four communities

that had with different combinations of regional accessibility and local accessibility levels. (See the 2 x 2 matrix in Table 1.1.) A telephone survey of 100 residents in each area was conducted, focusing on types of trips, frequency of trips to local commercial areas or to regional shopping centers, trip lengths, and the mode of travel used.

Table 1.1 Levels of Local and Regional Accessibility			
		Regional Accessibility Level	
		High	Low
Local Accessibility Level	High	Case study area 1	Case study area 2
	Low	Case study area 3	Case study area 4

Handy wanted to answer two questions:

1. Are higher levels of local accessibility associated with more walking trips rather than driving trips?
2. Are higher levels of local accessibility associated with fewer trips to regional centers?

The surveys revealed that appropriately designed and well-integrated local commercial areas will in fact be used by local residents. The question is, whether the walking trips are substitutes for trips that would otherwise be taken by car (to either a local center or a regional center) or do people who value the option to walk to commercial arrears intentionally choose to live in such areas where the walking option is available. Also, Handy found that, for walking trips to commercial centers, high local accessibility, in the form of a nearby downtown, clearly adds to the options available to residents, but it is not clear whether it reduces the amount of travel to regional centers. Her conclusion is that, although residents are significantly more likely to make walking trips to nearby commercial areas, it could not be determined (a) whether these walking trips replace driving trips or (b) were made in addition to trips to regional centers.

Ewing et al. (1994) found that there is an inverse relationship between the accessibility and VHT per person after analyzing the 1600-record travel survey database from Palm Beach County, Fla. VHT does not reflect accessibility to the extent that one might expect. For example, if A has the 1/10th the accessibility of B, it generates only two-thirds more VHT.

Frank and Pivo (1994) found that the percent of walking and transit trips had the highest

linear relationship with density for shopping trips, while land use mix was not found to be significantly correlated with the mode choices (car, transit, and walking) for shopping trips. The authors began with the concept that both urban form factors (land use mix and density) and non-urban form factors (income, gender, age, and level of service) will affect travel behavior. They used non-urban-form factors as control variables and compared the different urban form factors' influence on travel behavior with the same non-urban form variables. Census tracts with different levels of land use mix and densities were compared to test for the differences in the proportions of single-occupant vehicles, transit, and walking trips that originated and ended in those tracts.

Cervero (1996) investigated how the presence of mixed land use in a neighborhood affects the commuting choices of the residents by using data from the 1985 American Housing Survey. Cervero concluded that, within 300 feet of one's residence, grocery stores and other customer services could encourage mass transit, walking and bicycling, controlling for factors such as residential densities and vehicle ownership levels. When retail shops are more than 300 feet from residences, they tend to encourage use of the car mode. Residential densities exert a stronger influence on motorized mode choices than do levels of land use mix. For non-motorized mode choice, the presence or absence of neighborhood shops have more influence than do residential densities.

Cervero also measured vehicle ownership and commute distance by multiple linear regression models. The research also showed that the proximity of mixed-use development matters greatly. If retail shops are within 300 feet of dwelling units, workers are more likely to commute to work by transit, foot, or bicycle. Beyond this distance, mixed use activities appear to induce commuting by auto. This could be because of the ability to efficiently link work and shopping trips by automobile, where retail activities are beyond easy walking distance of one's home. Cervero found that mid-high neighborhood density and mixed land use tend to reduce vehicle ownership and was associated with shorter commute distance.

Cervero concluded that mixed land use is likely to have a significant impact on non-work travel, especially for shopping trips. Unfortunately, there was no database that contained suitable land use and non-work travel data. Usually there are not enough trip records for any one neighborhood to study how land use environments affect non-work travel at a disaggregate level. Obtaining suitable data for studying how densities and land use mixtures shape non-work travel

behavior remains a significant challenge.

Steiner (1996) was interested in the existing mixed-use, medium-density neighborhood that has established retail centers. This is the first study to consider the patterns of use and accessibility to shopping in neighborhoods. Six shopping areas were considered. Steiner found that the most important variable in the decision to walk is the distance from home to the shopping area. Walk shares from 10% to about 40% of respondents in various shopping areas. Almost all of the non-residents drive to the shopping area, and non-residents are less frequent shoppers and make more complex trip chains on their trips.

Cervero and Kockelman (1997) constructed a series of variables to measure urban “diversity” (land use mix). They used travel data, personal data and household data from Bay Area travel survey diaries. Dependent variables were vehicle miles traveled (VMT) by personal vehicles, and mode choice. It was found that a compact, mixed-use, and pedestrian-friendly design can lessen vehicle trips, reduce VMT per capita, and encourage non-motorized travel, not only for non-work travel, but for work trips as well. A *dissimilarity index* of spatial mixing proved to be a more powerful predictor and measure of diversity than the *entropy index* of land use heterogeneity.

Kitamura et al. (1997) examined the effects of land use and attitudinal characteristics on travel behavior for five diverse San Francisco Bay Area neighborhoods. The authors found that the measures of residential density, public transit accessibility, mixed land use, and the presence of sidewalks are significantly associated with trip generation by mode and modal split. The attitudes variables are more strongly associated with travel than land use characteristics. Attitude statements relating to urban life were analyzed and grouped into eight categories: pro-environment, pro-transit, suburbanite, automotive mobility, time pressure, urban villager, TCM, and workaholic. The authors suggest that land use policies promoting higher densities and mixtures may not alter travel demand materially unless residents’ attitudes are also changed.

It could be argued that certain types of land use patterns attract residents with certain demographic and socio-economic attributes, attitudes and values, and that attributes of residents are the true determinants of their travel behavior. For example, high density often attracts residents with lower incomes and lower automobile ownership levels. It is unclear how effective and desirable a high-density land use policy would be in changing travel patterns.

Kitamura et al. suggest that lifestyle choices are relevant to the selection of the neighborhood

and travel behavior. The approach taken in their study was to collect micro-scale land use, roadway network, and public transit information in a set of carefully selected neighborhoods. This information was integrated with demographic, socio-economic, attitudinal, and travel behavior through mailback surveys from households in the five neighborhoods. The resulting database was used in multivariate statistical analyses to test various hypotheses. It was found that land use characteristics variables could add explanatory power, in addition to the differences of demographic and socio-economics attributes. Differences in the neighborhood characteristics -- in particular, residential density, public transit accessibility, mixed land use, and the presence of sidewalks -- are significantly associated with trip generation by mode and modal split.

The paper then addressed the possibility that the true determinant of travel differences is people's attitude. When attitudinal factors are highly correlated with land use characteristics, the difference in travel demand and mode split may be caused by attitudinal factors, not by land use policy. If this is the case, then changing land use characteristics through land use policy will not alter travel behavior, unless either land use policy or resulting land use characteristics can change attitudes.

By adding these factors into the regression model, the authors found that land use variables have their own explanatory power, but it is weaker than the socio-economic and attitude factors. Attitude factors are more strongly, and perhaps more directly, associated with travel demand and mode split than are land use characteristics. Land use policy promoting higher density and mixture may not alter travel demand materially, unless residents' attitudes are also changed. The authors pointed out that it will be important to determine how these attitudes are formed, and how they interact with travel experience.

McCormack et al. (2001) compared travel diaries from mixed land use neighborhoods with diaries from the entire region. They found that mixed land use neighborhood residents travel 28 percent fewer kilometers than residents in adjacent areas and 120 percent fewer kilometers than residents in suburban areas. This paper used a 2-day travel diary and demographic survey of 900 households in 3 mixed land use neighborhood in the greater Seattle, Washington in November 1992. Then this data set was compared with identical countrywide household travel data. The research showed that, the farther that mixed land use neighborhood residents lived from a commercial street, the less likely it was their shopping trips would be on foot and the more likely their shopping trips would be in an automobile. The authors pointed out that person's

characteristics like age, the number of children, the number of adults are the key determinants of travel behavior.

Greenwald et al. (2001) found that local land use variables are significant in determining the probabilities of non-work walking travel. The most important determinant of walking behavior appears to be the trip distance. Shorter distances will promote walking trips for non-work activities.

Rosenbloom et al. (2002) found that, over age 65, women will experience more travel problems than men. They will face worse situations when they do not or cannot drive. The author said that it will be helpful to evaluate the impacts of residential location on the travel pattern of women and men non-drivers.

Hess et al. (2002) found that land use patterns affect the number of automobiles that a household owns. As the land use mix changes from homogeneous to diverse, the probability of owning an automobile decreases by 31 percentage points. Contrary to the conventional opinion that income determines the household's decision to own an automobile, the pedestrian environment, mixed land use, and proximity to transit and light rail will influence automobile ownership decisions.

Sanches et al. (2002) revealed that the presence of mixed land use in origin tracts exerts a positive influence on the option for walking.

Rajamani et al. (2003) analyzed the land use effect on non-work travel by capturing a multitude of urban form measures, including land use mix, accessibility, and other disaggregate measures from the 1995 Portland, Oregon Metropolitan Activity Survey. The results indicated that mixed land uses promote walking behavior for non-work activities. The paper pointed out that flexible zoning could reduce automobile dependence.

A review of the studies described above indicate that most researchers agree that mixed land use development could encourage mass transit, walking and bicycling. However, the effectiveness of mixed land use development in reducing vehicle trips among neighborhood remains to be demonstrated. Part III of this study builds upon the two previous parts to help address that issue.

LIST OF REFERENCES

- Bose, Amica and Jon D. Fricker (2001). "Reverse Engineered Land Use Patterns to Minimize Congestion," *Transportation Research Record* No. 1831, Paper No. 03-2714.
- Cervero, Robert (1988). "Land use Mixing and Suburban Mobility," *Transportation Quarterly*, Vol.42, No.3, pp. 429-446.
- Cervero, Robert (1996). "Mixed land uses and Commuting: Evidence From the American Housing Survey," *Transportation Research Part A*, Vol.30, No.5, pp. 361-377.
- Cervero, Robert and Kara Kockelman (1997). "Travel demand and the 3Ds: Density, Diversity, and Design," *Transportation Research Part D: Transport and Environment*, Volume 2, Issue 3, pp.199-219.
- Duany, Andres and Elizabeth Plater-Zyberk (1992). The Second Coming of the American Small Town. The Wilson Quarterly, Winter, pp. 97-100.
- Ewing, Reid, Padma Haliyur, and G. William Page (1994). "Getting around a Traditional City, a Suburban Planned Unit Development, and Everything in Between," *Transportation Res. Rec.* 1466, pp. 53-62.
- FHWA (1999), "Guidebook on Methods to Estimate Non-Motorized Travel: Overview of Methods" PUBLICATION NO. FHWA-RD-98-165, July.
- Frank, L. and G. Pivo (1994). "Impacts of Mixed Use and Density on Utilization of Three Modes of Travel: Single-Occupant Vehicle, Transit, and Walking," *Transportation Res. Rec.* 1466, pp. 44-52.
- Greenwald, M.J. and M.G. Boarnet (2001) "Built Environment as Determinant of Walking Behavior: Analyzing Nonwork Pedestrian Travel in Portland, Oregon", *Transportation Research Record* 1780, pp. 33-42.
- Handy, Susan (1992). "Regional Versus Local Accessibility: neo-traditional development and its implications for non-work travel," *Built Environment*, Vol.18, No. 4, pp. 253-267.
- Hess, D.B. and P.M Ong. (2002). "Traditional Neighborhoods and Automobile Ownership," *Transportation Research Record* 1805, pp. 35-44.

Kitamura, R., P. L. Mokhtarian and L. Laidet (1997) "A Micro-Analysis of Land Use and Travel in Five Neighborhoods in the San Francisco Bay Area," *Transportation* 24, pp. 125-158.

McCormack, Edward, G. Scott Rutherford, and Martina G. Wilkinson (2001). "Travel Impacts of Mixed Land Use Neighborhoods in Seattle, Washington," *Transportation Research Record* 1780, pp. 25-32.

Nardi, Peter M. (2003). *Doing Survey Research: A Guide to Quantitative Methods*, Pearson Education.

Orient Pacific (undated). "Consumer Intercept Surveys",
<http://www.orientpacific.com/consumer-intercepts.htm>, retrieved 21 December 2006.

Rajamani, Jayanthi, Chandra R. Bhat, Susan Handy, Gerritt Knaap, and Yan Song (2003). "Assessing Impact of Urban Form Measures on Nonwork Trip Mode Choice After Controlling for Demographic and Level-of-Service Effects," *Transportation Research Record* 1831, pp. 158-165.

Rosenbloom, S. and C. Winsten-Bartlett (2002). "Asking the Right Question: Understanding the Travel Needs of Older Women Who Do Not Drive," *Transportation Res. Rec.* 1818, pp. 78-82.

Sanches, S.D.P. and F.S.D. Arruda (2002) "Incorporated Nonmotorized Modes in a Mode Choice Model," *Transportation Res. Rec.* 1818, pp. 89-93.

Sanderson, Marlie (1999). "Development and Application of Integrated Land Use and Transportation Sketch Planning Methods," Gainesville Metropolitan Transportation Planning Organization, <http://www.fhwa.dot.gov/tcsp/fl05.html>, retrieved 20 December 2006.

Steuteville, Robert, (2004). "New Urban neighborhoods make big gains," New Urban News, Volume 9, No. 1, <http://www.newurbannews.com/SurveyStoryJan04.html>, retrieved 05 February 2007.

Steiner, Ruth Lorraine. "Traditional Neighborhood Shopping Districts: Patterns of Use and Modes of Access," Doctor's Thesis submitted to the City and Regional Planning Department, University of California at Berkeley, 1996.

Swift, Peter (2005). "New Urbanism: Clustered, Mixed-use, Multi-Modal Neighborhood Design," Online TDM Encyclopedia, Victoria Transport Policy Institute, May 9, 2005.
<http://www.vtpi.org/tdm/tdm24.htm>, retrieved 20 December 2006.

Tira, Jessica (2001). *Smart Growth Advances Nationally*, Special Report, NewUrbanism.org ,
<http://www.newurbanism.org/newurbanism/smartgrowth.html>, retrieved 20 December 2006.

located at the intersections of 49th Street and College Avenue, 52nd and College, 54th and College, and 49th and Pennsylvania Street. Figure 2.2 shows photos of one of the commercial nodes in the Meridian-Kessler neighborhood. These commercial intersections have survived as commercial locations for more than 100 years. They are surrounded by residences on compact lots, which make the Meridian-Kessler neighborhood one example of "mixed land use".

Figure 2.2: The commercial node at 49th and College. Photos by Jon D. Fricker

The Meridian-Kessler neighborhood has the following characteristics:

1. Mixed land use
2. Racially and socio-economically diverse
3. A variety of housing types
4. A sense of community

See the census data in the box to the right.

Total Population: 13762	Hispanic: 186
Persons Per Acre: 9.4	Hispanic Origin: 1.4%
-Males: 6621	
-Females: 7142	Age 0 to 5: 950
Total Households: 5709	Age 5 to 17: 2391
White: 8972	Age 18 to 21: 467
Non-white: 4790	Age 22 to 44: 5646
Non-white: 34.8%	Age 45 to 64: 3142
-Black: 4400	Age 65 and Older: 1166
-American Indian & Alaskan Native: 21	Total Dwelling Units: 6115
-Asian: 65	-Occupied Units: 5709
-Hawaiian & Pacific Islander: 2	-Vacant Units: 406
-Other: 57	
One Race: 13518	
Two Races: 245	

Source: Indianapolis 2006

A mailback survey form (Appendix B) was put in the Meridian-Kessler neighborhood newsletter in December, 2004. All neighborhood residents got the newsletter and had the opportunity to complete the survey. Sixty-seven survey forms were completed and returned by mail.

2.2 Mailback survey descriptive statistics

Figures 2.3 to 2.9 show graphs of descriptive statistics for several factors in the mailback survey. The graphs show that:

- Most residents shop at neighborhood stores an average of 0.5-3.5 times per week.
- Even when shopping at neighborhood stores, almost one-third of the respondents use non-motorized travel modes less than ten percent of the time.
- On a scale of 1 (very easy) to 7 (very difficult), a majority of respondents consider walking accessibility to Meridian-Kessler neighborhood stores to be easy or very easy.
- The most common length of residence was 10-19 years. Among respondents, housing turnover is very low.
- A large percentage of people who returned the survey are in the 40-60 age range.
- About half of the households in the survey sample have two vehicles, with every household having at least one vehicle.
- 77 percent of the respondents were female.

Figure 2.3: Frequency of Shopping at Neighborhood Stores

Figure 2.4: Proportion of trips to neighborhood stores by non-motorized modes

Figure 2.5: Accessibility to neighborhood stores by walking

Figure 2.6: Years living in the Meridian-Kessler neighborhood

Figure 2.7: Age of survey respondent

Figure 2.8: Vehicles in household

Figure 2.9: Respondents by sex

Some basic descriptive statistics are presented in Table 2.1. The mean frequency of shopping at neighborhood stores is 2.57 times per week and the mean proportion of non-motorized travel mode for shopping neighborhood is 0.23. The Pearson Correlation Coefficients are given in Table 2.2. The values in bold font indicate a strong correlation (positive or negative) between the pair of factors involved. For example, as the Walk Accessibility value gets smaller (i.e., better), the Proportion of Trips by Non-Motorized Modes gets larger. See the significant negative correlation of -0.4335 in Table 2.2.

Table 2.1: Meridian-Kessler mailback survey simple statistics

Variable Name	Mean	Std Dev	Minimum	Maximum	Valid Cases
shopfreq	Neighborhood stores shopping frequency (times per week)				
	2.57	1.97	0.25	10.00	60
nmtpro	Proportion of trips using non-motorized travel mode when shopping at neighborhood stores				
	0.23	0.25	0.00	0.90	59
waccess	Walk accessibility to neighborhood stores (1 = very easy, 7 = very difficult)				
	2.51	1.69	1.00	7.00	62
yrsnhd	Years living in the Meridian-Kessler neighborhood				
	21.82	15.20	2.00	77.00	64
age	Age in years				
	52.40	13.70	27.00	86.00	63
hhsz	Number of household members				
	2.56	1.20	1.00	7.00	63
hhdlic	Number of driver's licenses in household				
	1.96	0.76	1.00	5.00	57
hhvehs	Number of vehicles in household				
	2.16	0.89	1.00	4.00	64
dummy_sex	Dummy variable for sex (1 if female, 0 if male)				
	0.77	0.43	0.00	1.00	64

Table 2.2: Sample correlation between survey variables

Pearson Correlation Coefficients									
	shopfreq	nmtpro	waccess	yrsnhd	age	hhsz	hhdlic	hhvehs	dummy_sex
shopfreq	1.0000	-0.057	-0.2254	0.0863	0.1009	-0.1079	-0.0186	0.0364	-0.0469
nmtpro	-0.0570	1.0000	-0.4335	-0.1594	-0.1310	-0.0080	-0.1181	-0.1838	-0.0006
waccess	-0.2254	-0.4335	1.0000	0.1484	0.1413	0.1418	0.2696	-0.0063	-0.0872
yrsnhd	0.0863	-0.1594	0.1484	1.0000	0.7830	-0.1751	0.0191	0.0284	0.0643
age	0.1009	-0.1310	0.1413	0.7830	1.0000	-0.3363	-0.0974	-0.1136	0.0521
hhsz	-0.1079	-0.0080	0.1418	-0.1751	-0.3363	1.0000	0.7599	0.4659	-0.1146
hhdlic	-0.0186	-0.1180	0.2696	0.0191	-0.0974	0.7599	1.0000	0.6320	-0.2542
hhvehs	0.0364	-0.1838	-0.0063	0.0284	-0.1136	0.4659	0.6320	1.0000	-0.068
dummy_sex	-0.0469	-0.0006	-0.0872	0.0643	0.0521	-0.1146	-0.2542	-0.0688	1.0000

Figure 2.10 is the graph of the scatter plot matrix. A scatter plot matrix shows relationships among several variables taken two at a time. Scatter plot matrices can reveal a wealth of information which includes dependencies, clusters, and outliers (SAS, 2006). In this scatter plot matrix, the variables “years living in neighborhood” and “age” have a strong linear correlation, as might be expected. “Household members” and “household driver’s licenses” also have a clear linear correlation. Other variables’ relationships are not so clearly evident in the scatter plot matrix.

Figure 2.10: Scatter plot matrix

In the following sections, several potential output variables will be discussed in relation to possible causal variables, as reflected in the responses to the mailback survey.

2.3 Proportion of travel by non-motorized modes

The first dependent variable to be analyzed is the proportion of trips made by a non-motorized travel mode when a person shops at neighborhood stores.

2.3.1 Linear regression with one explanatory variable

After trying different independent variables in simple linear and polynomial regression analyses, three variables -- the weighted distance from the resident's home to the neighborhood stores (*averd*), walk accessibility to neighborhood stores (*wacess*), and a person's physical limitation for walking (*walklim*) -- were found to have the most explanatory power among all the explanatory variables that were tested.

(1) The weighted distance from the resident's home to the neighborhood stores is indicated by the independent variable *averd*. The home location of each survey respondent was geocoded on a map of the Meridian-Kessler neighborhood using geographic information systems (GIS) software. See Figure 2.11. The distance from home to each commercial node was then

Figure 2.11: Geocoded home locations in the Meridian-Kessler neighborhood

measured using GIS. Because the distance from a person's home address to each of the four commercial nodes is different, a weighted distance from each resident's home to the neighborhood stores he/she patronizes was calculated, using the answer to question 1: "Which shopping area in the Meridian-Kessler neighborhood do you shop at the most?" For example, if one respondent chose 49th and Pennsylvania and 52nd and College as the answers to question 1, then the average distance from his/her home is:

$$\text{average distance} = \frac{\text{distance to 49th\&Pennsylvania} + \text{distance to 52nd\&College}}{2}$$

If another respondent chose 49th and Pennsylvania, 52nd and College and 52th and College as the answers to question 1, then the average distance from his/her home is computed as:

$$\text{average distance} = \frac{\text{distance to 49th\&Pennsylvania} + \text{distance to 52nd\&College} + \text{distance to 54th\&College}}{3}$$

Figure 2.12 shows the simple linear and polynomial regression fits.

Figure 2.12 Simple Linear Regression, quadratic, and cubic polynomial fits for $\text{nmtpro} \times \text{averd}$

The simple linear regression (SLR) fit equation is: $\text{nmtpro} = 0.5388 - 0.4224 \times \text{averd}$, with an R-squared value of 0.3716. The SAS output for the SLR is shown below.

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.26922	1.26922	31.93	<.0001
Error	54	2.14632	0.03975		
Corrected Total	55	3.41554			
Root MSE		0.19937	R-Square	0.3716	
Dependent Mean		0.24107	Adj R-Sq	0.3600	
Coeff Var		82.69978			

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.53877	0.05903	9.13	<.0001
averd	1	-0.42241	0.07475	-5.65	<.0001

The nonlinear curves in Figure 2.12 show the best second- and third-order polynomial fits. This suggests that some nonlinear relationship is the best fit. The second-order polynomial fit equation is: $nmtpro = 0.7126 - (0.9796 \cdot averd) + (0.3509 \cdot averd_square)$, with $R\text{-squared} = 0.4130$. The variable *averd_square* in the equation above and in the SAS output below is equivalent to $averd^2$.

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1.41065	0.70532	18.65	<.0001
Error	53	2.00489	0.03783		
Corrected Total	55	3.41554			
Root MSE		0.19449	R-Square	0.4130	
Dependent Mean		0.24107	Adj R-Sq	0.3909	
Coeff Var		80.67920			

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.71259	0.10676	6.67	<.0001
averd	1	-0.97959	0.29725	-3.30	0.0018
averd_square	1	0.35089	0.18148	1.93	0.0585

In all three fits, the tendency to use non-motorized modes decreases as the average distance to the neighborhood stores increases. As *averd* approached one mile, *nmtpro* was getting close to zero.

(2) Walking accessibility to neighborhood stores is indicated by the independent variable *wacess*. The value of this variable is determined from the survey question: “How easy is it for you to walk to the commercial intersection(s)?” The respondents chose a number from 1 (very easy walking accessibility) to 7 (very difficult). The dependent variable is still *nmtpro*, the proportion of trips made by a non-motorized travel mode when a person shops at neighborhood stores.

Figure 2.13 shows the simple linear and polynomial regression fits.

Figure 2.13: SLR, quadratic, and cubic polynomial fits for $nmtpro \times wacess$

The SLR fit equation is: $nmtpro = 0.3891 - (0.0634 \times wacess)$, with $R\text{-squared} = 0.1879$.

The SAS output for SLR is:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.66616	0.66616	13.19	0.0006
Error	57	2.87892	0.05051		
Corrected Total	58	3.54508			
Root MSE					
Dependent Mean		0.22474	R-Square	0.1879	
Coeff Var		0.23051	Adj R-Sq	0.1737	
		97.49685			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.38912	0.05257	7.40	<.0001
wacess	1	-0.06344	0.01747	-3.63	0.0006

The second and third order polynomial fits are not much different from the simple linear fit in Figure 2.13. For all fits, the tendency to use non-motorized travel modes decreases as walking accessibility worsens. When $wacess > 4$, walk accessibility is not good and non-motorized travel is highly unlikely. Because bicycle use is rare among survey respondents, walking is the principal non-motorized mode.

(3) A person's physical limitation for walking is indicated by the independent variable *walklim*. The value of this variable is determined from the survey question: "Please give a brief explanation how easy it is for you to walk to the commercial intersection(s)." If a resident indicated that he/she has some physical limitation about walking, this variable *walklim* was set to 1; otherwise, it was set to zero. Figure 2.14 shows the simple linear fit for *nmtpro* vs. *walklim*.

Figure 2.14: SLR fit for *nmtpro*walklim***

The SLR fit equation is: $nmtpro = 0.25 - (0.225 * walklim)$, with $R\text{-squared} = 0.054$. The SAS output for SLR is:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.18853	0.18853	3.20	0.0792
Error	56	3.30250	0.05897		
Corrected Total	57	3.49103			
		Root MSE	0.24284	R-Square	0.0540
		Dependent Mean	0.23448	Adj R-Sq	0.0371
		Coeff Var	103.56583		
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.25000	0.03305	7.57	<.0001
walklim	1	-0.22500	0.12584	-1.79	0.0792

2.3.2 Multiple linear regression

The four independent variables used in the previous section's simple regression analysis – *averd*, *averd_square*, *waccess*, and *walklim* -- were used in a multiple linear regression analysis with *nmtpro* as the dependent variable. The resulting SAS output is as follows:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	1.60193	0.40048	11.26	<.0001
Error	51	1.81361	0.03556		
Corrected Total	55	3.41554			
Root MSE					
Dependent Mean		0.18858	R-Square	0.4690	
Coeff Var		0.24107	Adj R-Sq	0.4274	
		78.22410			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.75820	0.10676	7.10	<.0001
<i>averd</i>	1	-1.03982	0.29041	-3.58	0.0008
<i>averd_square</i>	1	0.41287	0.17846	2.31	0.0248
<i>waccess</i>	1	-0.01137	0.02010	-0.57	0.5740
<i>walklim</i>	1	-0.19744	0.10830	-1.82	0.0742

The variable *waccess* is not significant (P-value is 0.5740) because of multicollinearity. The correlation matrix is:

Pearson Correlation Coefficients			
Prob > r under H0: Rho=0			
Number of Observations			
	<i>averd</i>	<i>waccess</i>	<i>walklim</i>
<i>averd</i>	1.00000	0.54914	0.05555
	58	<.0001	0.6788
		58	58
<i>waccess</i>	0.54914	1.00000	0.31109
	<.0001		0.0155
	58	62	60
<i>walklim</i>	0.05555	0.31109	1.00000
	0.6788	0.0155	
	58	60	60

Variables *averd* and *waccess* are strongly correlated; so are *walklim* and *waccess*. If people live farther away from the neighborhood stores, they are more likely to view walk accessibility to those stores as difficult. A person's physical limitation for walking is also related to poor walking accessibility to neighborhood stores. The multiple linear regression analysis suggests that the best variables to explain the variable *nmtpro* are *averd*, *averd_square*, and *walklim*.

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	1.59055	0.53018	15.11	<.0001
Error	52	1.82499	0.03510		
Corrected Total	55	3.41554			
Root MSE		0.18734	R-Square	0.4657	
Dependent Mean		0.24107	Adj R-Sq	0.4349	
Coeff Var		77.71100			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.74605	0.10389	7.18	<.0001
averd	1	-1.04973	0.28798	-3.65	0.0006
averd_square	1	0.40196	0.17625	2.28	0.0267
wal kl im	1	-0.22242	0.09824	-2.26	0.0278

Figure 2.15 shows the residual plot against predicted value, which suggests the absence of constant variance. Therefore, the weighted least square method is implemented.

Figure 2.15: Residual plot with predicted value

The weight for the weighted least square method is obtained by the fitted values from the standard deviation regressed function. (Kutner et al. 2004) The resulting SAS output is:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	63.49765	21.16588	13.67	<.0001
Error	52	80.53183	1.54869		
Corrected Total	55	144.02948			
Root MSE					
Dependent Mean		1.24446	R-Square	0.4409	
Coeff Var		0.16013	Adj R-Sq	0.4086	
		777.16830			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.71873	0.12388	5.80	<.0001
averd	1	-0.98043	0.29628	-3.31	0.0017
averd_square	1	0.35706	0.16320	2.19	0.0332
walklim	1	-0.13324	0.08894	-1.50	0.1402

Based on these analyses of the Meridian-Kessler neighborhood mailback survey responses, the final multiple regression model for predicting the variable *nmtpro* is: $nmtpro = 0.7187 - (0.9804 \cdot averd) + (0.3571 \cdot averd^2) - (0.1332 \cdot walklim)$. From this model, if person doesn't have a walk limitation problem (making *walklim*=0), when his/her home distance to stores increases from 0.5 to 1 mile, his/her non-motorized mode share will decrease from 0.3178 to 0.0953.

2.3.3 Accounting for preferences

In mailback survey question 10, "What is the reason you live in the Meridian-Kessler neighborhood?", a small portion of people chose shopping convenience or walkability as the reason for their home location choice. A t-test was applied to compare the means of variable *nmtpro* between two groups. One group is made up of people who state that shopping convenience or walkability is the reason for their living in the M-K neighborhood. The people in other group choose reasons other than shopping convenience or walkability. The SAS output below shows that the difference in the means of the two groups is not statistically different from 0 at a significant level $\alpha = 0.05$.

The TTEST Procedure

Statistics								
Variable	walkorshop_pre	N	Lower CL Mean	Mean	Upper CL Mean	Lower CL Std Dev	Std Dev	Upper CL Std Dev
nmtpro	N	48	0.1396	0.2083	0.2771	0.1972	0.2369	0.2967
nmtpro	Y	11	0.1394	0.3273	0.5151	0.1954	0.2796	0.4907
nmtpro	Diff (1-2)		-0.283	-0.119	0.045	0.207	0.2449	0.2998

T-Tests

Variable	Method	Variances	DF	t Value	Pr > t
nmtpro	Pooled	Equal	57	-1.45	0.1517
nmtpro	Satterthwaite	Unequal	13.5	-1.31	0.2129

Equality of Variances

Variable	Method	Num DF	Den DF	F Value	Pr > F
nmtpro	Folded F	10	47	1.39	0.4253

Therefore, even for the people who state that neighborhood stores or walkability is their reason to live in Meridian-Kessler neighborhood, these people don't have a statistically significant higher proportion of non-motorized mode use when shopping neighborhood stores, compared with other people who don't state that neighborhood stores or walkability is the reason for living there.

To further test the multiple linear regression results in Section 2.3.2, the respondents in the survey sample who chose shopping convenience or walkability as the reason of residential location choice were removed. After running regression in the remaining survey sample, the independent variables *averd*, *averd_square*, and *walklim* could also explain *nmtpro*, which is the proportion of non-motorized travel mode when a person shops the neighborhood stores. The SAS output for the remaining sample is as follows:

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	1.10346	0.36782	10.62	<.0001
Error	43	1.48888	0.03463		
Corrected Total	46	2.59234			
Root MSE		0.18608	R-Square	0.4257	
Dependent Mean		0.21277	Adj R-Sq	0.3856	
Coeff Var		87.45669			

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.68526	0.11054	6.20	<.0001
averd	1	-0.95002	0.29570	-3.21	0.0025
averd_square	1	0.36084	0.17943	2.01	0.0506
walklim	1	-0.19340	0.11379	-1.70	0.0964

Therefore, even in the sample of people who don't think that nearby shop stores or walk environment is the reason of their residential location choice, the distance from their homes to neighborhood shopping stores can also explain their non-motorized mode share. Distance is the most important explanatory factor for non-motorized travel mode share, not a person's lifestyle when choosing a mixed land use neighborhood, because of a specific preference for shopping nearby and walking easily. Building a mixed land use neighborhood can encourage residents who live within walking distance of neighborhood stores to choose non-motorized travel modes when they shop at those stores.

This finding gives evidence that New Urbanism promote a higher non-motorized mode share by placing shopping areas within walking distances.

2.4 Frequency of Shopping at Neighborhood Stores

In order to investigate (and explain) the frequency with which people shop at neighborhood stores, another regression analysis was conducted. The dependent variable is *shopfreq*, which is the frequency per week that people shop at neighborhood stores. By trying different independent variables in the regression analysis, two variables, when used together, were found to have the most explanatory power. The variables are *weighted distance from the resident's home to the neighborhood stores* (*averd*) and *walking accessibility* (*wacess*). However, *averd* by itself can't explain *shopfreq*.

(1) The independent variable *averd* represents the weighted average distance from the resident's home to the neighborhood stores. The SAS output for a SLR analysis of *shopfreq* vs. *averd* is:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.67497	1.67497	0.55	0.4616
Error	55	167.59038	3.04710		
Corrected Total	56	169.26535			
Root MSE		1.74559	R-Square	0.0099	
Dependent Mean		2.45614	Adj R-Sq	-0.0081	
Coeff Var		71.07061			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	2.12945	0.49761	4.28	<.0001
averd	1	0.47174	0.63627	0.74	0.4616

The independent variable *avrd* is not significant in explaining *shopfreq*, because the p-value is 0.4616. Figure 2.16 shows that there is no obvious relationship between *shopfreq* and *avrd*.

Figure 2.16: Scatter plot for shopfreq*avrd

(2) Walking accessibility to neighborhood stores is indicated by the independent variable *wacess*. The value of this variable is determined from the survey question: “How easy is it for you to walk to the commercial intersection(s)?” The respondents chose a number from 1 (very easy walking accessibility) to 7 (very difficult). The dependent variable is still *shopfreq*, the frequency per week with which people shop at neighborhood stores

Figure 2.17 shows the simple linear and polynomial regression fits. The SLR fit equation is: $\text{shopfreq} = 3.2122 - (0.2644 * \text{wacess})$, with R-square = 0.0508. The SAS output for the SLR model is:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	11.57094	11.57094	3.10	0.0834
Error	58	216.28739	3.72909		
Corrected Total	59	227.85833			
Root MSE					
Dependent Mean		1.93109	R-Square	0.0508	
Coeff Var		2.56667	Adj R-Sq	0.0344	
		75.23712			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	3.21219	0.44322	7.25	<.0001
wacess	1	-0.26438	0.15009	-1.76	0.0834

Figure 2.17: SLR, quadratic, and cubic polynomial fits for $\text{shopfreq} \times \text{wacess}$

The second- and third-order polynomial fits don't improve the model by checking the adjusted R-square.

(3) Using both independent variables, *wacess* and *averd*, after applying multiple linear regression, the SAS results are:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	26.78216	13.39108	5.08	0.0096
Error	54	142.48319	2.63858		
Corrected Total	56	169.26535			
Root MSE		1.62437	R-Square	0.1582	
Dependent Mean		2.45614	Adj R-Sq	0.1270	
Coeff Var		66.13506			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	2.44658	0.47433	5.16	<.0001
wacess	1	-0.48832	0.15830	-3.08	0.0032
averd	1	1.69004	0.71172	2.37	0.0212

Figure 2.18 shows the residual plot against predicted value, which suggests that constant variance may not exist. Therefore, the weighted least square method is implemented.

Figure 2.18: Residual plot with predicted value

The weight for the weighted least square method is obtained by the fitted values from the standard deviation regressed function. (Kutner et al. 2004) The result from SAS output is:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	23.21357	11.60678	6.82	0.0023
Error	54	91.92317	1.70228		
Corrected Total	56	115.13673			
	Root MSE	1.30471	R-Square	0.2016	
	Dependent Mean	2.08245	Adj R-Sq	0.1720	
	Coeff Var	62.65298			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	2.16372	0.40369	5.36	<.0001
waccess	1	-0.43715	0.13117	-3.33	0.0016
averd	1	1.93733	0.63226	3.06	0.0034

Based on the Meridian-Kessler neighborhood mailback survey, the final multiple regression model for predicting variable *shopfreq* is:

$$\text{shopfreq} = 2.1637 - (0.4372 * \text{waccess}) + (1.9373 * \text{averd})$$

The sign for *waccess* is reasonable; the sign for *averd* is not. It turns that a high positive correlation between *waccess* and *averd* exists. The correlation matrix is:

Pearson Correlation Coefficients		
Prob > r under H0: Rho=0		
Number of Observations		
	waccess	averd
waccess	1.00000	0.54914
	62	<.0001
		58
averd	0.54914	1.00000
	<.0001	
	58	58

Based on the regression, improving walk accessibility to neighborhood stores could encourage shopping frequency at neighborhood stores. The average distance from a resident's home to neighborhood stores does not by itself explain shopping frequency at neighborhood stores.

2.5 Other neighborhood attributes

In answering the Meridian-Kessler neighborhood mailback survey question 5: “Why do you shop at the neighborhood stores?”, most respondents chose “close to home/work” as the answer. Figure 2.19 shows all answers by the respondents.

Figure 2.19: Reasons for shopping at neighborhood stores

For the Meridian-Kessler neighborhood mailback survey question 8: “What would cause you to shop in the Meridian-Kessler neighborhood more often?”, most respondents chose “good grocery stores” as the answer. Figure 2.20 shows all answers by respondents.

Figure 2.20: Changes wanted by respondents

In answering the Meridian-Kessler neighborhood mailback survey question 10: “Why do you choose to live in the Meridian-Kessler neighborhood?”, most respondents chose “small town environment, neighborhood feeling” as the answer. Figure 2.21 shows all answers by respondents.

Figure 2.21: Reasons for living in the Meridian-Kessler neighborhood

2.6 Summary

Although most respondents to the mailback survey were in the 40-60 age range, the home location of the respondents and information such as vehicles per household indicated a fairly wide range of economic conditions. Whether or not a person claimed to have chosen to move into (or stay in) the Meridian-Kessler neighborhood because of the presence of shopping nearby, the likelihood of shopping in the neighborhood or using non-motorized transportation to do so was about the same.

The mailback survey results indicated that the distance from a resident's home address to neighborhood stores is a major factor in the decision whether to use a non-motorized travel mode choice for shopping trips. The frequency of shopping at neighborhood stores could not be significantly explained by the average distance from home to the stores. However, when the average distance and accessibility for walking are used together to explain neighborhood store shopping frequency, they are both significant. The reason is that there is high correlation between these two factors.

Most residents in Meridian-Kessler value a neighborhood that has a "small town environment, neighborhood feeling". Adding "good grocery stores" would be the best way to get residents to shop more in the neighborhood.

LIST OF REFERENCES

- IndyStar.Com (2006). "Meridian-Kessler has diverse heritage",
<http://www2.indystar.com/community/profiles/meridiankessler.html>, retrieved 23 December 2006.
- Indianapolis, City of (undated). "Demographic Characteristics of Registered Organization Areas", Department of Metropolitan Development, Division of Planning,
<http://www.indygov.org/NR/rdonlyres/ezqmypiemx53exkbuwb2ri3nkv357rqubcfjtzsmsojhpriht2zbwliyexhmcethhb3x7yv63pqf4l4vzev7swv6stb/2000nhooddemo.pdf>, retrieved 25 December 2006.
- SAS. (2006). "SAS/INSIGHT User's Guide",
<http://www.sussex.ac.uk/its/help/guides/sas/insight/chap5/sect3.htm>, retrieved 5 February 2006.

Michael H Kutner, Christopher J. Nachtsheim, John Neter, William Li (2004). “Applied Linear Statistical Models”, McGraw-Hill/Irwin.

CHAPTER 3. MAILBACK SURVEY IN THE ST. LAWRENCE-MCALLISTER NEIGHBORHOOD

3.1 Introduction to the St. Lawrence-McAllister Neighborhood

The St. Lawrence-McAllister neighborhood is bounded by Greenbush Street, 15th Street, Schuyler Avenue, US 52, and Erie Street (see Figure 3.1). In 1889, construction of the Monon Shops began along the west side of McDoel Avenue in Figure 3.1. The Monon Shops were a hub and servicing station for the coal and steam-powered locomotives that utilized the railroad route that stretched from Louisville, Kentucky to Chicago, Illinois. In 1889, the neighborhood shown in Figure 3.1 was annexed by the City of Lafayette.

Figure 3.1: The St. Lawrence-McAllister neighborhood location map

The St. Lawrence-McAllister neighborhood is described as well maintained, appealing, safe, and clean; where families have pride in their homes and a sense of community by helping their neighbors, getting to know one another, encouraging and promoting long-term residency, and working with neighbors, local government, businesses, and community institutions to improve the neighborhood (City of Lafayette undated). Other descriptive data are shown in Table 3.1.

Table 3.1 Data for St. Lawrence-McAllister Neighborhood

Census Data 2000	
Population	2825
Percent White	92%
Percent Minority	8%
Incomes Below 80% Median	57%
Households	1245
Vacancy Rate	4%

Market Square, a shopping center that has recently lost several major stores, is located just beyond the southeast corner of the neighborhood. The intersection of 15th and Schuyler Avenue is a significant potential commercial gateway to the neighborhood. The intersection of Schuyler and Sagamore Parkway North is the site of some commercial expansion. The development and changes in these nearby businesses can affect the neighborhood's environment by generating greater traffic flow in the area. An analysis of the possible travel patterns in this neighborhood would help evaluate the impacts of nearby business changes.

The mailback survey form (Appendix B) was put in the St. Lawrence-McAllister neighborhood newsletter in February 2004. All neighborhood residents receive the newsletter. Fifty-three survey forms were completed and returned by residents.

3.2 Mailback survey descriptive statistics

Figures 3.2 to 3.8 show graphs of descriptive statistics from the mailback survey results for the St. Lawrence-McAllister neighborhood.

Most people shop at Market Square 2-10 times per month. See Figure 3.2.

Figure 3.2 Frequency of shopping at Market Square

Most people never choose a non-motorized travel mode for shopping trips.

Figure 3.3 Distribution of non-motorized mode shares

Large percentage of people who filled out the mailback survey form were ages 40-70.

A

Figure 3.4 Age of survey respondent

Most households have two vehicles and two people. See Figures 3.5 and 3.6.

Figure 3.5 Vehicles in household

Figure 3.6 Household size

Most respondents have lived in St. Lawrence-McAllister neighborhood for 0-9 years.

Figure 3.7 Years living in the St. Lawrence-McAllister neighborhood

Seventy-five percent of the respondents to the St. Lawrence-McAllister mailback survey were women.

Figure 3.8 Respondents by sex

Some basic descriptive statistics are presented in Table 3.1. The mean frequency of shopping at Market Square is 6.91 times per month. The mean proportion of using a non-motorized travel mode for shopping at neighborhood stores is 0.06.

Table 3.1: Simple statistics for St. Lawrence-McAllister mailback survey

Variable Name	Mean	Std Dev	Minimum	Maximum	Valid Cases
shopfreq	Market Square shop frequency (times per month)				
	6.91	6.73	0.00	40.00	53
nmtpro	Proportion of non-motorized travel mode when shop neighborhood stores				
	0.06	0.13	0.00	0.50	53
yrsnhd	Years living in the Meridian-Kessler neighborhood				
	27.83	25.25	1.00	85.00	53
age	Ages in years				
	57.28	18.03	24.00	90.00	53
hhsz	Number of household members				
	2.04	0.73	1.00	4.00	53
hhvehs	Number of vehicles in household				
	1.88	0.90	0.00	4.50	53
dummy_sex	Dummy variable for sex (1 if female, 0 if male)				
	0.76	0.43	0.00	1.00	51

Although the St. Lawrence neighborhood is about the same age as the Meridian-Kessler neighborhood, relationship of the residences to the businesses have been quite different. In

Meridian-Kessler, the commercial businesses came first, and homes were built around the commercial nodes. The St. Lawrence-McAllister neighborhood developed in response to the Monon Shops, a major employment center a few blocks to the northwest. Businesses came soon thereafter, but scattered along the edges of the neighborhood. Competition from Market Square forced some neighborhood businesses to close. In turn, Market Square and other stores nearby are feeling pressure from a large (and growing) Tippecanoe Mall three miles to the southeast, along with several large discount stores.

The Pearson Correlation Coefficients are given in Table 3.2.

Table 3.2: Sample correlation between survey variables

Pearson Correlation Coefficients Prob > r under H0: Rho=0 Number of Observations							
	nmtpro	shopfreq	yrsnhd	age	hhsi ze	hhvehs	dummy_sex
nmtpro	1.000 53	0.267 0.054 53	-0.014 0.923 53	0.023 0.872 53	0.194 0.164 53	0.090 0.520 53	-0.212 0.134 51
shopfreq	0.267 0.053 53	1.000 53	-0.087 0.536 53	0.189 0.176 53	-0.015 0.916 53	0.180 0.198 53	-0.191 0.179 51
yrsnhd	-0.014 0.923 53	-0.087 0.536 53	1.000 53	0.743 <.0001 53	-0.199 0.154 53	-0.124 0.378 53	-0.127 0.376 51
age	0.023 0.872 53	0.189 0.176 53	0.743 <.0001 53	1.000 53	-0.305 0.026 53	-0.304 0.027 53	-0.140 0.330 51
hhsi ze	0.194 0.165 53	-0.015 0.916 53	-0.199 0.154 53	-0.305 0.026 53	1.000 53	0.501 0.0001 53	0.109 0.445 51
hhvehs	0.090 0.520 53	0.180 0.198 53	-0.124 0.378 53	-0.304 0.027 53	0.501 0.000 53	1.000 53	-0.053 0.710 51
dummy_sex	-0.212 0.135 51	-0.191 0.179 51	-0.127 0.376 51	-0.139 0.329 51	0.109 0.448 51	-0.053 0.710 51	1.000 51

Figure 3.9 is the graph of scatter plot matrix. A scatter plot matrix shows relationships among several variables taken two at a time (SAS, 2006). In this scatter plot matrix, the variables *years living in the neighborhood* and *age* have a strong linear correlation. *Household members* and *household vehicles* also have linear correlation. Other variables do not show strong relationships in the scatter plot matrix.

In the following sections, several potential output variables will be discussed in relation to possible causal variables, as reflected in the responses to the mailback survey.

Figure 3.9: Scatter Plot Matrix

3.3 Proportion of travel by non-motorized modes

The first dependent variable to be analyzed is the proportion of trips made by a non-motorized travel mode when a person shops at neighborhood stores.

3.3.1 Linear regression with one explanatory variable

For the respondents who shop at Market Square at least once per month, simple linear regression models were applied to predict the non-motorized share. The dependent variable represents the proportion of trips made by non-motorized travel modes when a person shops at the neighborhood stores. After trying different independent variables in simple linear and polynomial regression analyses, two variables -- the distance from the resident's home to Market Square (*averd*) and dummy (or indicator) variables for sex (*dummy_sex*) -- were found to have adequate explanatory power.

(1) The weighted distance from the resident's home to the neighborhood stores is indicated by the independent variable *averd*. The home location of each survey respondent was geocoded on the map of the St. Lawrence-McAllister neighborhood using GIS software. See Figure 3.10. Then the distance from each home location to Market Square was measured.

Figure 3.10: Geocoded home locations on St. Lawrence-McAllister neighborhood map

Figure 3.11 shows the simple linear and polynomial regression fits. The simple linear regression (SLR) fit equation is: $\text{nmtpro} = 0.1908 - 0.2647 \cdot \text{averd}$, with an R-squared value of 0.1395. The P-value for *averd* is 0.0097.

Figure 3.11 SLR, quadratic, and cubic polynomial fits for $\text{nmtpro} \cdot \text{averd}$

The SAS output for the SLR is shown below.

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.12671	0.12671	7.29	0.0097
Error	45	0.78180	0.01737		
Corrected Total	46	0.90851			

Root MSE	0.13181	R-Square	0.1395
Dependent Mean	0.06383	Adj R-Sq	0.1203
Coeff Var	206.49973		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.19075	0.05078	3.76	0.0005
averd	1	-0.26472	0.09802	-2.70	0.0097

The nonlinear curves in Figure 3.11 show the best second- and third-order polynomial fits. This suggests that some nonlinear relationship may be the best fit. The second-order polynomial

fit equation is: $nmtpro = 0.3338 - (0.9362 \cdot averd) + (0.6667 \cdot averd_square)$, with R-squared = 0.1752. The variable $averd_square$ in the equation above and in the SAS output below is equivalent to $averd^2$.

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.15916	0.07958	4.67	0.0144
Error	44	0.74935	0.01703		
Corrected Total	46	0.90851			
Root MSE					
Dependent Mean		0.13050	R-Square	0.1752	
Coeff Var		0.06383	Adj R-Sq	0.1377	
		204.45282			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.33377	0.11516	2.90	0.0058
averd	1	-0.93617	0.49600	-1.89	0.0657
averd_square	1	0.66671	0.48297	1.38	0.1744

(2) The independent variable *dummy_sex* is a dummy variable. If the respondent is a female, *dummy_sex* = 1; if male, *dummy_sex* = 0. The dependent variable is still *nmtpro*, the proportion of trips made by a non-motorized travel mode when a person shops at neighborhood stores. Figure 3.12 shows the simple linear fit.

Figure 3.12 SLR fit for $nmtpro \cdot dummy_sex$

The SLR fit equation is: $nmtpro = 0.1182 - (0.0711 \cdot dummy_sex)$, with the R-squared of the simple linear regression = 0.0466. The SAS output for the SLR fit is:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.04204	0.04204	2.10	0.1546
Error	43	0.86107	0.02002		
Corrected Total	44	0.90311			
		Root MSE	0.14151	R-Square	0.0466
		Dependent Mean	0.06444	Adj R-Sq	0.0244
		Coeff Var	219.58334		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.11818	0.04267	2.77	0.0082
dummy_sex	1	-0.07112	0.04909	-1.45	0.1546

According to the survey results, a female is less likely to choose a non-motorized travel mode to go shopping at Market Square.

3.3.2 Multiple linear regression

The three independent variables used in the previous section's simple regression analysis – *averd*, *averd_square*, and *dummy_sex* -- were used in a multiple linear regression analysis with *nmtpro* as the dependent variable. The resulting SAS output is as follows:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	0.17995	0.05998	3.40	0.0265
Error	41	0.72316	0.01764		
Corrected Total	44	0.90311			
		Root MSE	0.13281	R-Square	0.1993
		Dependent Mean	0.06444	Adj R-Sq	0.1407
		Coeff Var	206.08150		
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.34129	0.11859	2.88	0.0063
<i>averd</i>	1	-0.80246	0.54054	-1.48	0.1453
<i>averd_square</i>	1	0.53497	0.52400	1.02	0.3133
<i>dummy_sex</i>	1	-0.05007	0.04862	-1.03	0.3091

Variables *averd_square* and *dummy_sex* are not significant. By using variables *averd* and *dummy_sex* to explain variable *nmtpro*, the SAS output is as follows:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.16157	0.08078	4.58	0.0159
Error	42	0.74154	0.01766		
Corrected Total	44	0.90311			
Root MSE		0.13287	R-Square	0.1789	
Dependent Mean		0.06444	Adj R-Sq	0.1398	
Coeff Var		206.18524			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	0.23736	0.06085	3.90	0.0003
avrd	1	-0.26011	0.09997	-2.60	0.0128
dummy_sex	1	-0.06581	0.04614	-1.43	0.1612

Therefore, based on the St. Lawrence-McAllister neighborhood mailback survey, the final multiple regression model for predicting variable *nmtpro* is:

$$nmtpro = 0.2374 - (0.2601 * avrd) - (0.0658 * dummy_sex)$$

From this model, when the distance from a male's home to stores increases from 0 to 0.5 mile, his non-motorized mode share will decrease from 0.2374 to 0.1074.

3.4 Frequency of Shopping at Market Square

In order to predict the frequency with which people shop at Market Square, another regression model was applied. The dependent variable is *shopfreq*, which represents how often per month survey respondents shop at Market Square. After trying different independent variables in a regression analysis, none of the variables were found to explain the dependent variable.

The independent variable *avrd* represents the distance from a resident's home to Market Square. The SAS output for a SLR analysis of *shopfreq* vs. *avrd* is:

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	40.51236	40.51236	0.93	0.3397
Error	49	2135.07588	43.57298		
Corrected Total	50	2175.58824			
Root MSE		6.60098	R-Square	0.0186	
Dependent Mean		6.70588	Adj R-Sq	-0.0014	
Coeff Var		98.43571			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	8.78498	2.34598	3.74	0.0005
avrd	1	-4.36032	4.52203	-0.96	0.3397

The independent variable *averd* is not significant in explaining *shopfreq*, because the P-value is 0.3397. Figure 3.13 shows that there is no obvious relationship between *shopfreq* and *averd*.

Figure 3.13: Scatter plot for shopfreq*averd

The distance from home to neighborhood shopping could not explain shopping frequency in St. Lawrence-McAllister.

3.5 Other neighborhood attributes

In answering the St. Lawrence-McAllister neighborhood mailback survey question 4: “Why do you shop at locations you chose in questions 1-3?”, most respondents chose “close to home/work” as the answer. Figure 3.14 shows all answers by respondents.

Figure 3.14: Reasons for shopping at locations

For the St. Lawrence-McAllister neighborhood survey question 8: “What type of stores would you like to have in the SLMA neighborhood?”, most respondents chose “good grocery stores” as the answer. Figure 3.15 shows all answers by respondents.

Figure 3.15: Types of stores wanted by respondents

In answering the St. Lawrence-McAllister Neighborhood survey question 10: “Why do you choose to live in the St. Lawrence-McAllister Neighborhood?”, most respondents chose “safe and quiet environment, neighborhood feeling” as the answer. Figure 3.16 shows all answers by respondents.

Figure 3.16: Reasons for living in the St. Lawrence-McAllister neighborhood

The result of the mailback survey in the St. Lawrence-McAllister neighborhood was similar to the result of the mailback survey in the Meridian-Kessler neighborhood. We also found that the distance from the home address to the neighborhood stores is a major factor in non-motorized travel mode choice. The neighborhood store shopping frequency could not be significantly explained by the average distance from the home to the stores.

Most residents in the St. Lawrence-McAllister neighborhood want a neighborhood which has “safe and quiet environment, neighborhood feeling”. They also prefer “good grocery stores” that are “close to home/work”.

LIST OF REFERENCES

City of Lafayette, CDBG Target Area Organized Neighborhoods, p. 7,
<http://www.lafayette.in.gov/Content/global/File/plan/APPENDIX%20K.pdf>, retrieved 25 December 2006.

SAS. (2006). “SAS/INSIGHT User's Guide”,
<http://www.sussex.ac.uk/its/help/guides/sas/insight/chap5/sect3.htm>, retrieved 5 February 2006.

CHAPTER 4. INTERCEPT SURVEYS IN THE MERIDIAN-KESSLER NEIGHBORHOOD

4.1 Intercept surveys at a commercial node

Four “commercial nodes” in the Meridian-Kessler neighborhood are at 49th Street and College Avenue, 52nd and College, 54th and College, and 49th and Pennsylvania Street. There is a wide variety of stores at these four commercial nodes. Appendix D has a diagram that shows the stores at 54th Street and College Avenue.

Intercept surveys were conducted at 54th Street and College Avenue on three different dates:

- Thursday, November 4, 2004 from 9:10-10:10am, cool and light rain
- Tuesday, August 2, 2005 from 12:00-1:30pm, sunny and hot
- Monday, October 10, 2005 from 4:30-6:00pm, partly cloudy and pleasant

During each intercept survey, a modest number of shoppers were interviewed as they left stores at 54th Street and College. The interview consisted of a few questions designed to determine the origin of the shopper, the frequency of shopping visits, and the reason for shopping at that location. (See Appendix A for a copy of the survey instrument.) Other variables, such as the age and sex of the shopper, and the mode of travel used, could normally be observed by the interviewer. Despite the small number of persons interviewed, because of the variety of day-of-week, time-of day, and season, a good picture of the customers and their behaviors can be inferred.

4.2 Intercept survey analysis

4.2.1 The first intercept survey results

During the November 4, 2004 intercept survey, 21 persons answered questions. Table 4.1 and Figure 4.1 summarize the results of the first intercept survey. The walk trip of more than three miles was actually made from a nearby business, where the person works. It is more than 3 miles to that person’s home.

Table 4.1 Summary of the first intercept survey

Radial distance from origin to 54th & College (miles)	Number of people interviewed (percent)	Travel mode	Average shopping frequency (times per week)
0.00-0.50	8 (38.10%)	6 by walk, 2 by auto	6.64
0.50-1.00	3 (14.29%)	1 by walk, 2 by auto	4.83
1.00-1.50	3 (14.29%)	3 by auto	3.17
1.50-2.00	0	-	-
2.00-2.50	2 (9.52%)	2 by auto	3.50
2.50-3.00	2 (9.52%)	2 by auto	3.63
3.00-3.50	1 (4.76%)	1 by walk	0.25
3.50-4.00	0	-	-
4.00-4.50	1 (4.76%)	1 by auto	1.00
4.50-5.00	0	-	-
5.00-5.50	0	-	-
5.50-6.00	0	-	-
6.00-6.50	0	-	-
6.50-7.00	1 (4.76%)	1 by auto	5.00
>7.00	0	-	-

Figure 4.1. Distribution of distance to stores in the first intercept survey

Figure 4.2 shows the origins of the trips made to 54th and College by the persons interviewed in the first intercept survey. A “W” mark indicates the origin of a walking trip to 54th and College. “A” stands for a trip by automobile. The walking trips to 54th and College tended to be much shorter than the trips made by automobile.

Figure 4.2: Geocoded trip origins in the first intercept survey

4.2.2 The second intercept survey results

During the August 2, 2005 intercept survey, 20 persons answered questions. Table 4.2 and Figure 4.3 summarize the results of the second intercept survey. The walk trip of more than 2 miles was made by a visitor to Indianapolis who misjudged the distance from his host's home to 54th and College.

Table 4.2 Summary of the second intercept survey

Radial distance from origin to 54th & College (miles)	Number of people interviewed (percent)	Travel mode	Average shopping frequency (times per week)
0.00-0.50	2 (10%)	2 by walk	5.00
0.50-1.00	3 (15%)	2 by walk, 1 by auto	2.00
1.00-1.50	3 (15%)	3 by auto	1.67
1.50-2.00	0	-	-
2.00-2.50	1 (5%)	1 by walk	5.00
2.50-3.00	0	-	-
3.00-3.50	1 (5%)	1 by auto	1.00
3.50-4.00	1 (5%)	1 by bus	5.00
4.00-4.50	0	-	-
4.50-5.00	1 (5%)	1 by auto	1.00
5.00-5.50	4 (20%)	4 by auto	1.59
5.50-6.00	1 (5%)	1 by auto	0.10
6.00-6.50	1 (5%)	1 by auto	2.00
6.50-7.00	0	-	-
>7.00	2 (10%)	2 by auto	1.00

Figure 4.3. Distribution of distance to stores in the second intercept survey

Figure 4.4 shows the origins of the trips made to 54th and College by the persons interviewed in the second intercept survey. This time, two bicycle trips and one bus trip were recorded. As in the first intercept survey, trips by walking (“W”) or bicycle are associated with shorter trips than by automobile (“A”) or bus.

Figure 4.4: Geocoded trip origins in the second intercept survey

4.2.3 The third intercept survey results

During the October 10, 2005 intercept survey, 18 persons answered questions. Table 4.3 and Figure 4.5 summarize the results of the third intercept survey.

Table 4.3 Summary of the third intercept survey

Radial distance from home to 54th & College (miles)	Number of people interviewed (percent)	Travel mode	Average shopping frequency (times per week)
0.00-0.50	4 (22.22%)	2 by walk, 2 by auto	3.75
0.50-1.00	2 (14.29%)	2 by auto	1.13
1.00-1.50	1 (5.56%)	1 by auto	0.5
1.50-2.00	0	-	-
2.00-2.50	1 (5.56%)	1 by auto	1
2.50-3.00	0	-	-
3.00-3.50	1 (5.56%)	1 by auto	0.25
3.50-4.00	0	-	-
4.00-4.50	1 (5.56%)	1 by auto	0.5
4.50-5.00	0	-	-
5.00-5.50	0	-	-
5.50-6.00	1 (5.56%)	1 by auto	2.5
6.00-6.50	1 (5.56%)	1 by auto	0.25
6.50-7.00	0	-	-
>7.00	6	1 by auto	1.11

Figure 4.5. Distribution of distance to stores in the third intercept survey

Figure 4.6 and Table 4.3 show that the only two walking trips to 54th and College were less than 0.5 mile long.

Figure 4.6. Geocoded trip origins in the third intercept survey

4.2.4 All intercept survey results

Table 4.4 and Figure 4.7 summarize the results of all three intercept surveys. More than fifty-one percent of people who shop at 54th Street and College Avenue commercial areas live outside of the Meridian-Kessler neighborhood.

Table 4.4 Summary of all intercept surveys

Radial distance from home to 54th & College (miles)	Number of people interviewed (percent)	Travel mode
0.00-0.50	14 (23.73%)	10 by walk, 4 by auto
0.50-1.00	8 (13.56%)	3 by walk, 5 by auto
1.00-1.50	7 (11.86%)	7 by auto
1.50-2.00	0	-
2.00-2.50	4 (6.78%)	1 by walk, 3 by auto
2.50-3.00	2 (3.39%)	2 by auto
3.00-3.50	3 (5.08%)	1 by walk, 2 by auto
3.50-4.00	1 (1.69%)	1 by bus
4.00-4.50	2 (3.39%)	2 by auto
4.50-5.00	1 (1.69%)	1 by auto
5.00-5.50	4 (6.78%)	4 by auto
5.50-6.00	2 (3.39%)	2 by auto
6.00-6.50	2 (3.39%)	2 by auto
6.50-7.00	1 (1.69%)	1 by auto
>7.00	8 (13.56%)	8 by auto

Figure 4.7 Distribution of distance to stores in all intercept surveys

Figure 4.8 shows geocoded home locations for all three intercept surveys. That the chosen travel mode is strongly associated with travel distance is obvious. More important is the information that the mailback survey of neighborhood residents could not give us: the degree to which businesses at commercial nodes in the Meridian-Kessler neighborhood depend on customers from outside the neighborhood. In Table 4.4 and Figures 4.7 and 4.8, it is clear that

more than half (30 of 59) of the persons interviewed came from more than 1.5 miles away. Without these customers, the businesses would probably not be successful.

Figure 4.8: Geocoded trip origins in the third intercept survey

4.3 The piano store customers zip code data

Some stores at 54th and College get customers who come by on a frequent (even daily) basis – the newsstand and the eating establishments. Other businesses rely on steady customers who stop in on a less frequent basis or on the customer who was just passing by – the florist or the surplus store. One store that fits neither pattern is the piano store. According to its manager, the store does not offer lessons; it relies solely on sales of pianos, sheet music, and supplies. The piano store's manager very kindly provided the zip codes of his customers. As can be seen in

Table 4.5 and Figures 4.9 and 4.10, most of his customers come from outside the Meridian Kessler neighborhood. The manager said that many of his customers used to live in or near the Meridian-Kessler neighborhood. After moving elsewhere, they continue to patronize his business.

Table 4.5 Distribution of distance from home to piano store at 54th and College

Distance from home to piano store (miles)	Number of customers
<5	37
5<D<10	55
10<D<15	42
15<D<20	36
20<D<25	10
25<D<30	3
30<D<35	5
35<D<40	0
40<D<45	3
45<D<50	1
50<D<55	7
55<D<60	2
60<D<65	6
65<D<70	1
70<D<75	0
75<D<80	1
D>80	2

Figure 4.9. Distribution of distance from home to piano store at 54th and College

Figure 4.10. Geocoded piano store customers' home locations by zipcode file

From the piano store zip code file, most people who shop at piano store live outside 5 miles of the Meridian-Kessler neighborhood. All these customers will come to the piano store using a motorized mode.

4.4 Summary

To supplement the mailback survey of residents in the Meridian-Kessler neighborhood, customers at one of the commercial nodes in the neighborhood were interviewed on several different days. The “sidewalk surveys” were intended to determine the extent to which neighborhood stores were patronized by persons who did not live in the neighborhood, while also getting information about neighborhood customers in a format other than the mailback survey.

Two things are apparent: (1) Having stores close to homes encourages walking to the stores and (2) businesses at commercial nodes in the Meridian-Kessler neighborhood depend on customers from outside the neighborhood. The sidewalk survey provided information that the mailback survey of neighborhood residents could not, i.e., more than half (30 of 59) of the persons interviewed came from more than 1.5 miles away. Without these customers, the businesses would probably not be successful. When planning or designing a mixed land use neighborhood, the need for customers from outside the neighborhood must be considered.

CHAPTER 5. SUMMARY OF FINDINGS AND CONCLUSIONS

New Urbanists claim that high-density, mixed land use, and walkable communities will lead to mode shifts and travel reductions. They base their claims on assumptions such as (Steiner, 1996):

- Neighborhood retail stores will attract people who live within walking distance of the shopping area rather than people who live beyond a walking distance.
- Residents will choose to walk and bicycle in large numbers to their neighborhood shopping areas.

If these assumptions are true, the New Urbanist land use concept can be an effective way to reduce automobile trips. After analyzing the data from two mailback and three sidewalk intercept surveys, the key findings are:

- Building a mixed land use neighborhood encourages residents to choose non-motorized travel modes when they shop at neighborhood stores, if the neighborhood stores are within walking distance from their homes. In the Meridian-Kessler neighborhood, where shops are closer to homes, the average non-motorized mode share is 23 percent and shopping frequency at neighborhood stores is 2.57 times per week. In the St. Lawrence-McAllister neighborhood, which has far fewer shops within walking distance, the average non-motorized mode share is 6 percent and the shopping frequency at stores in the nearby shopping center is 1.73 times per week.
- Although the distance from home to neighborhood store does influence the choice of travel mode to shops, there is no evidence that the distance affects the frequency of shopping at neighborhood stores by residents.
- Most respondents want “good grocery stores” in their mixed land use neighborhood.
- In both the Meridian-Kessler and St. Lawrence-McAllister neighborhoods, most people chose “small town, neighborhood feeling, safe and quiet” as the reason for their location choice in the two neighborhoods and choose “close to home/work” as the reason they shop at the neighborhood stores. In Meridian-Kessler, 16.4 percent of mailback survey respondents chose “neighborhood shopping convenience or walkability” as the reason for choosing to live in that neighborhood.
- The combined result of the three sidewalk intercept surveys at a commercial node in the

Meridian-Kessler neighborhood was that 51% of the neighborhood stores' customers live more than 1.5 miles away. The Meridian-Kessler neighborhood stores depend in large part on non-residents as customers.

These findings are discussed in more detail below.

5.1 Comparison of two mailback surveys

The Meridian-Kessler neighborhood has four commercial business intersections located along its north-south axis. The St. Lawrence-McAllister neighborhood has Market Square Shopping Center, located just beyond the southeast corner of neighborhood. The business locations in the Meridian-Kessler neighborhood are better for non-motorized travel, because more residents have good access to the neighborhood stores at a shorter travel distance. The shorter distances encourage non-motorized travel modes, according to the analyses of two mailback surveys and a series of intercept surveys. Non-motorized modes are used 23 percent of the time when residents shop at the Meridian-Kessler neighborhood stores. They are used only 6 percent of the time when St. Lawrence-McAllister residents shop at Market Square.

The average respondent's shopping frequency at Meridian-Kessler neighborhood stores is 2.57 times per week. The average respondent's shopping frequency at the Market Square Shopping Center near the St. Lawrence-McAllister neighborhood is 1.73 times per week.

Table 5.1 shows the average personal and household characteristics of the residents who responded to the mailback surveys in the Meridian-Kessler and St. Lawrence-McAllister neighborhoods.

Table 5.1: Average characteristics of the two neighborhoods studied

	Average years living in neighborhood	Average age	Average household size	Average driver licenses in Household	Average vehicles	Average shop frequency	Average non- motorized mode share
Respondents in the Meridian- Kessler Neighborhood	21.82	52.40	2.56	1.96	2.16	2.57	23%
Respondents in the St. Lawrence- McAllister Neighborhood	27.83	57.28	2.04	-	1.88	1.73	6%

The lowest block group median family income in the Meridian Kessler neighborhood is \$36,477. The highest block group median family income in the Meridian Kessler neighborhood is \$139,852, which is more than 4 times the median income in the St. Lawrence-McAllister neighborhood. See Figure 5.2.

Figure 5.2: Meridian-Kessler neighborhood block group family median income

By analyzing the mailback surveys in both neighborhoods, the distance from a person's home to the neighborhood stores or to Market Square Shopping Center is the most significant variable in explaining the non-motorized travel mode share for the shopping trip. Mode choice is highly correlated with the distance a respondent lives from the shopping area.

The regression result in the Meridian-Kessler neighborhood is:

$$\text{nmtpro} = 0.7187 - 0.9804 * \text{averd} + 0.3571 \text{averd}^2 - 0.1332 \text{walk lim}$$

The regression result in the St. Lawrence-McAllister neighborhood is:

$$\hat{nmtpro} = 0.2374 - 0.2601 * averd - 0.0658 dummy \quad sex$$

Therefore, the longer the distance from the neighborhood store or Market Square shopping center, the less likely a person will choose a non-motorized travel mode when they shop at these locations.

The distance from a person's home to the neighborhood stores or Market Square shopping center is not significant in explaining his/her neighborhood shopping frequency. Improving walk accessibility to neighborhood stores encourages a person's shopping frequency at the neighborhood stores in the Meridian-Kessler neighborhood.

Most respondents chose "close to home/work" as the reason they shop at neighborhood stores, and many respondents want to have "good grocery stores" in the neighborhood. However, groceries are quite heavily auto-oriented. Even people who live close to neighborhood stores are likely to drive to grocery shopping (Steiner, 1996). Therefore, even if a grocery store attracts many nearby residents, such stores will not reduce automobile trips in the area. Most respondents chose "neighborhood feeling, safe and quiet" as the reason for their home location choice. The dilemma for planners is to find the balance between the scale of the shopping area and a quiet neighborhood environment. Good neighborhood stores will attract non-residents to the shopping areas, and almost all of them will use the drive mode. If the neighborhood store is to be of a scale that is consistent with its neighborhood, it may be restricted to a size that is not economically viable. If commercial and retail establishments are to survive primarily from neighborhood customers, the density of the neighborhood must be sufficiently high to sustain such enterprises. (Steiner, 1996)

5.2 Analysis of intercept surveys

More than 50% of the customers interviewed at the commercial nodes in the Meridian Kessler neighborhood were non-residents, according to the results of the three sidewalk intercept surveys conducted there. Ninety-three percent of non-resident respondents drove to the shopping area.

Among those customers interviewed who live within 1 mile of the neighborhood shopping area, 59 percent of them walked and 41 percent of them drove to the businesses. No bus or bicycle travel mode was used within 1 mile. Among those interviewed customers who live within 0.5 miles of the shopping area, 71 percent of them walked. Based on the intercept survey result, travel mode choice is strongly associated with the distance.

5.3 Conclusions

In this study, the statistical analyses of the two mailback surveys have shown that a resident's

non-motorized mode travel share is strongly related to his/her home-to-store trip distance. From the mailback survey result in the Meridian-Kessler neighborhood, when the resident's home distance to neighborhood stores increases from 0.5 to 1 mile, if he/she doesn't have a walk limitation problem, his/her non-motorized mode share will decrease from 0.3178 to 0.0953. From the mailback survey result in the St. Lawrence-McAllister neighborhood, when the distance from a male's home to stores increases from 0 to 0.5 mile, his non-motorized mode share will decrease from 0.2374 to 0.1074. The distance from the resident's home address to the neighborhood stores is a major factor in his/her non-motorized travel mode choice.

A resident's shopping frequency at neighborhood stores is not related to his/her home-to-store trip distance. Neighborhood stores can attract nearby residents and customers from outside the neighborhood. If the travel distance is longer than comfortable walking distance, both residents and non-residents choose automobile as their travel mode when shopping at neighborhood stores. Therefore, simply providing for stores close to neighborhoods will not guarantee a reduction in vehicle trips. The stores may encourage more walking trips than the typical store, but the successful store will attract – in fact, will depend on – customers who live in other neighborhoods. To maximize customers from the neighborhood and customers who walk from their homes, the neighborhood population density would have to be much greater than found in most US neighborhoods. Furthermore, mixed land use may not lead to fewer vehicle trips, if the trips to “neighborhood stores” that are close to home or work are made by automobile as part of a trip chain.

The sidewalk intercept survey results and piano zip code data show that the neighborhood stores in the Meridian-Kessler neighborhood attract both residents and non-resident customers. Because an increase in traffic to neighborhood stores could worsen the environment for a neighborhood's residents, the size, type and location of neighborhood stores in a mixed land use neighborhood need to be managed carefully. Neighborhood stores can be located along the arterial streets that surround the neighborhood, not at the center of the neighborhood. This arrangement may not adhere to the New Urbanist sense of “place”, but it offers the neighborhoods reduced vehicular traffic and the neighborhood businesses increased exposure to non-neighborhood potential customers.

REFERENCE

Steiner, R.L. 1996. *Traditional Neighborhood Shopping Districts: Patterns of Use and Modes of Access*. Doctor's Thesis submitted to the City and Regional Planning Department, University of California at Berkeley.

APPENDIX A

SIDEWALK INTERCEPT SURVEY AT
A COMMERCIAL NODE IN
THE MERIDIAN-KESSLER NEIGHBORHOOD

Survey of customers at commercial nodes in residential areas

Purdue University, Prof. Jon D. Fricker, office 765-494-2205, cell 765-404-2568

Version 14 July 2005

Observer initials: _____; Day and Date: _____

Hello. [Keep name tag visible.] May I ask you four questions about your trip to this business area? [Have permission letter and short project summary available.]

1. [If the person has been observed getting out of a motor vehicle, check that box; otherwise ask Question 1.]

Which travel mode did you use to come to this shopping area?

☐ Automobile (drive/ride) ☐ Walk ☐ Bicycle ☐ Bus

☐ other: (specify)

2. **Where do you live? The intersection nearest to your home will be fine.**

[Reason: To determine customer base for the businesses at this shopping area]

.....

3. **How often do you come to this shopping area?** times per week

4. **And, finally, why do you shop here?** [Check as many as apply. Show person the choices, if that helps.]

☐ close to home/work ☐ on the way to home/work ☐ I like the people here.

☐ I want to support neighborhood business. ☐ easy parking

☐ other: (specify)

Thank you very much. [Results will be given to the Meridian-Kessler Neighborhood Association and the business owners.]

[On diagram below, circle or check the store(s) visited by the person interviewed.]

[Observers check boxes below without asking tripmakers. Guess at age.]

Sex: ☐ Female ☐ Male

Age Group: ☐ Under 18 ☐ 18-34 ☐ 35-54 ☐ 55-70 ☐ over 70

This is an anonymous survey. All data will be treated as confidential. Only totals will be used in the study.

APPENDIX B

MAILBACK SURVEY FOR THE MERIDIAN-KESSLER NEIGHBORHOOD

MKNA

2004 Resident Survey—Trips to Neighborhood Businesses

Dear Resident, We are studying tripmaking in neighborhoods with mixed land uses. This 2-page survey is anonymous, so there is no need to put your name on the form. After completing this survey, please fold it so that the address is showing and mail to: Prof. Jon D. Fricker, School of Civil Engineering, Purdue University, West Lafayette IN 47907-2051. The information gathered in this survey will be summarized and shared with the neighborhood association. Thank you for your help.

Part 1 Shopping Choices

1. Which shopping area(s) in the Meridian-Kessler (M-K) Neighborhood do you shop at the most?

- ☐ 49th&Pennsylvania ☐ 49th&College
☐ 52nd&College ☐ 54th&College
☐ other (specify)

If you seldom or never shop in the M-K Neighborhood, skip Questions 2-7, answer Questions 8-15, then mail in the form.

2. Where do you live? If you do not wish to give your address, just give the cross streets of the intersection nearest your home.

.....

How often do you shop at the intersection(s) you checked in Question 1?
times per week or times per month

4. List the businesses at those intersections that you visit at least once a month.

.....

5. Why do you shop at the intersections you checked in Question 1? (Please check all that apply) ☐ Close to home/work
☐ On the way to home/work ☐ Easy parking
☐ Other reason(s) (specify)

.....

6. For every ten times that you go to shop at those neighborhood intersections, how often do you use each travel mode listed below? (Please put a number in each box, even if it is zero.) ☐ Walk ☐ Bicycle ☐ Drive

Automobile ☐ Ride in Automobile ☐ Bus ☐
 Other (specify)

7. How easy is it for you to walk to the intersection(s) you checked in Question 1? Please circle one number (1 = Very easy through 7 = Very difficult) on the scale below, then give a brief explanation.

Very easy	OK	Very difficult
	1	
	2	
	3	
	4	
	5	
	6	
	7	

Explanation:

.....

8. What would cause you to shop in the M-K neighborhood more often?

.....

MKNA

2004 Resident Survey ----- TRIPS TO NEIGHBORHOOD BUSINESSES

Part 2 Information about resident

9. How many years have you lived in the Meridian-Kessler neighborhood?

10. You chose to live in the M-K neighborhood because

.....

11. What is your age?

12. How many other people live in your household? Please enter a number for each age group in each box below, even if it is "0".

__ age under 6 __ age 6-15
__ age 16-21 __ age 22-49 __ age 50-69 __
age 70+13. How many of your household members have a driver's license?

14. How many motor vehicles does your household own? _ 0 _ 1 _ 2

_ 3 _ more than 3

15. Are you: _ Female? _ Male?

Please add any comments you would like to share with us here.

.....

.....

.....

.....

Thank you for participating in this survey.

Please fold in half, seal with tape, add 37 cents postage, and mail to:

Place
postage
here

Jon D. Fricker
School of Civil Engineering
Purdue University
550 Stadium Mall Drive
West Lafayette IN 47907-2051

APPENDIX C

MAILBACK SURVEY FOR THE
ST. LAWRENCE-MCALLISTER NEIGHBORHOOD

Dear Resident,
As part of our research project on land uses and tripmaking in neighborhoods, we are studying the St. Lawrence McAllister (SLM) Neighborhood. This 2-page survey is anonymous, so there is no need to put your name on the form. After completing this survey, return it to The Neighborhood Association Office, or mail it to Prof. Jon D. Fricker, at Purdue University. The information gathered in this survey will be analyzed and shared with the neighborhood association. The data will be summarized. No individual person will be identified. Thank you in advance for your kind cooperation.

Part 1 Shopping Choices

1. How many times per month do you shop at the following locations? (Place a number in the blank spaces that apply.) ____ Market Square ____

Tippecanoe Mall ____ other (specify)

2. List the businesses at the locations you chose in Question 1 that you visit at least once a month:

3. Where do you shop for groceries?

4. Why do you shop at the locations you checked in Questions 1-3? (*Please check all that apply*) ☐

Close to home/work ☐ On the way to home/work

☐ Easy parking ☐ Other reason(s) (*Specify*)

5. Where do you live? If you do not wish to give your address, just give the cross streets of the intersection nearest your home.

6. For every ten times that you go to shop at the locations you checked in Questions 1-3, how often

7. What types of stores would you like to have in the SLM neighborhood?

8. If such stores were located along Schuyler Avenue between 16th and 20th Streets, would you walk to those stores? Yes No Explain why or why not.

Part 2 Information about resident

9. How many years have you lived in the SLM neighborhood?

10. You choose to live in the SLM neighborhood because

11. What is your age?

12. How many other people live in your household? Please enter a number for each age group in the appropriate box, even if it is "0". ☐

age under 6 ☐ age 6-15 ☐ age 16-21 ☐ age 22-49 ☐ age 50-69 ☐ age 70+

13. How many motor vehicles does your

<p>do you use each travel mode listed below? (Please put a number in each box, even if it is zero.) ☐ Drive Automobile ☐ Ride in Automobile</p> <p>☐ Bus ☐ Walk</p> <p>☐ Bicycle ☐ Other: (Specify) </p>	<p>household own? ☐ 0 ☐ 1 ☐ 2</p> <p>☐ 3 ☐ 4 or more</p> <p>14. Are you: ☐ Female? ☐</p> <p>Male?</p> <p style="text-align: right;">NEXT </p>
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<p>Part 3 Your Neighborhood</p> <p>15. List the THREE best attributes in your neighborhood. </p> <p>16. List THREE changes in your neighborhood that you would like to see </p>	<p>17. If there were a small food store (such as old Sites Market) in your neighborhood and a large grocery store several miles from your home, how many times out of ten food shopping trips would you shop at the neighborhood food store?</p> <p><i>Thank you much for participation in this survey. Please add any comments you would like to share with us here.</i> </p>
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Please return the completed survey to the St. Lawrence McAllister Neighborhood Association, 1937 Maple Street, Lafayette, or fold along the line below, then tape shut, add postage, and mail to Prof. Fricker.

Postage
Here

Jon D. Fricker
 School of Civil Engineering
 Purdue University
 550 Stadium Mall Drive
 West Lafayette IN 47907-2051

APPENDIX D

STORES AT THE 54th STREET AND COLLEGE AVENUE COMMERCIAL NODE IN THE MERIDIAN-KESSLER NEIGHBORHOOD

Daugherty, et al. Hair Salon Citizens Action Coalition A/C sales and service Clockworks → vacant Bokay Florist Northside Newsstand The News Cafe Sam's Middle Eastern Restaurant Chiropractor Brooke's Army-Navy Surplus	C O L L E G E	A V E N U E	Vacant building (Was Atlas Supermarket. Will be razed for Arthur's Fresh Market in 2005. Parking lot had been used by customers of businesses nearby.) Atlas Parking Lot (now barricaded) McNamara's Florist (Opened 5 Nov 04 in former CATH Inc. Coffee House; now vacant)
54 th Street			54 th Street
Moe and Johnny's Restaurant and Coffee House (3 entry doors?)	C O L L E G E	A V E N U E	Jazz CATH Hit City Antiques Kitchen Bakery Studio Piano Merchant Yats Cajun Creole Restaurant