MINETA NATIONAL TRANSIT RESEARCH CONSORTIUM

Measuring Benefits of Transit Oriented Development

MNTRC Report 12-18

MNTRC
MINETA NATIONAL TRANSIT RESEARCH CONSORTIUM

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

MINETA TRANSPORTATION INSTITUTE
LEAD UNIVERSITY OF MNTRC

The Norman Y. Mineta International Institute for Surface Transportation Policy Studies was established by Congress in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). The Institute's Board of Trustees revised the name to Mineta Transportation Institute (MTI) in 1996. Reauthorized in 1998, MTI was selected by the U.S. Department of Transportation through a competitive process in 2002 as a national "Center of Excellence." The Institute is funded by Congress through the United States Department of Transportation's Research and Innovative Technology Administration, the California Legislature through the Department of Transportation (Caltrans), and by private grants and donations.

The Institute receives oversight from an internationally respected Board of Trustees whose members represent all major surface transportation modes. MTI's focus on policy and management resulted from a Board assessment of the industry's unmet needs and led directly to the choice of the San José State University College of Business as the Institute's home. The Board provides policy direction, assists with needs assessment, and connects the Institute and its programs with the international transportation community.

MTI's transportation policy work is centered on three primary responsibilities:

Research

MTI works to provide policy-oriented research for all levels of government and the private sector to foster the development of optimum surface transportation systems. Research areas include: transportation security; planning and policy development; interrelationships among transportation, land use, and the environment; transportation finance; and collaborative labor-management relations. Certified Research Associates conduct the research. Certification requires an advanced degree, generally a Ph.D., a record of academic publications, and professional references. Research projects culminate in a peer-reviewed publication, available both in hardcopy and on TransWeb, the MTI website (http://transweb.sjsu.edu).

Education

The educational goal of the Institute is to provide graduate-level education to students seeking a career in the development and operation of surface transportation programs. MTI, through San José State University, offers an AACSB-accredited Master of Science in Transportation Management and a graduate Certificate in Transportation Management that serve to prepare the nation's transportation managers for the 21st century. The master's degree is the highest conferred by the California State University system. With the active assistance of the California Department of Transportation, MTI delivers its classes over a state-of-the-art videoconference network throughout the state of California and via webcasting beyond, allowing working transportation professionals to pursue an advanced degree regardless of their location. To meet the needs of employers seeking a diverse workforce, MTI's education program promotes enrollment to under-represented groups.

Information and Technology Transfer

MTI promotes the availability of completed research to professional organizations and journals and works to integrate the research findings into the graduate education program. In addition to publishing the studies, the Institute also sponsors symposia to disseminate research results to transportation professionals and encourages Research Associates to present their findings at conferences. The World in Motion, MTI's quarterly newsletter, covers innovation in the Institute's research and education programs. MTI's extensive collection of transportation-related publications is integrated into San José State University's world-class Martin Luther King, Jr. Library.

REPORT 12-18

MEASURING BENEFITS OF TRANSIT ORIENTED DEVELOPMENT

Robert B. Noland, Ph.D.
Kaan Ozbay, Ph.D.
Stephanie DiPetrillo
Shri Iyer

October 2014

A publication of

Mineta National Transit Research Consortium

College of Business
San José State University
San José, CA 95192-0219

DISCLAIMER STATEMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. CA-MNTRC-14-1142 FHWA-NJ-2014-014	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Measuring Benefits of Transit Oriented Development		**5. Report Date** October 2014 **6. Performing Organization Code**
7. Authors Robert B. Noland, Ph.D., Kaan Ozbay, Ph.D., Stephanie DiPetrillo and Shri Iyer		**8. Performing Organization Report** MNTRC Report 12-18
9. Performing Organization Name and Address Mineta National Transit Research Cosortium Mineta Transportation Institute College of Business, San Jose State University San Jose, CA 95192-0219 Alan M. Voorhees Transportation Center Rutgers, The State University of New Jersey		**10. Work Unit No.** DTRT12-G-UTC21 **11. Contract or Grant No.** Final Report
12. Sponsoring Agency Name and Address U.S. Department of Transportation Research & Innovative Technology Admin. 1200 New Jersey Avenue, SE Washington, DC 20590 New Jersey Department of Transportation PO 600 Trenton, NJ 08625 Federal Highway Admin. US Department of Transportation Washington, DC 20590		**13. Type of Report and Period Covered** **14. Sponsoring Agency Code**
15. Supplemental Notes Report is available, with separate covers, from each sponsor.		

16. Abstract

Transit-oriented development (TOD) in New Jersey is evaluated using a variety of methods and different outcome measures. Data was gathered from respondents residing around eight train stations in New Jersey and up to two miles away from those stations. Additional data was gathered from four focus groups of those living near various train stations with some development and interviews with stakeholders engaged with the land development process. Three areas were also selected for a detailed case study analysis. Qualitative analysis focused on the perceptions of the benefits of TOD and any shortcomings that are seen. Analytical work included an analysis of travel behavior, including frequency of walking, driving and using transit; potential health benefits associated with living in proximity to a train station; social capital or civic engagement in areas proximate to the train station; traffic safety associated with proximity to the train station and other built environmental measures; residential property valuation associated with train station access and TOD amenities; benefits to users of rail transit for commute access to New York City and other destinations; and, an analysis of regional impacts using a regional travel demand model to examine changes in train usage and highway congestion. Beneficial effects of TOD and development near train stations is found in most of our results.

17. Key Words Transit-oriented development; Transit; Train stations; Rail stations; Pedestrians	**18. Distribution Statement** No restrictions. This document is available to the public through The National Technical Information Service, Springfield, VA 22161		
19. Security Classif. (of this report) Unclassified	**20. Security Classif. (of this page)** Unclassified	**21. No. of Pages** 294	**22. Price** $15.00

Form DOT F 1700.7 (8-72)

ACKNOWLEDGEMENTS

Many thanks to all who have contributed so greatly to this work: members of the Alan M. Voorhees Transportation Center staff including Nicholas Tulach, Elizabeth Harvey, Ugo Lachapelle, and Andrew Kay; Bloustein planning students Kimberly O'Neill and Grant Engel; Civil Engineering students Sandeep Mudigonda and Ozgur Ozturk; Marc Weiner and Orin Puniello of the Bloustein Center for Survey Research; Vivian Baker, Janice Pepper and Tom Marchwinski of NJ TRANSIT; and Edward S. Kondrath and Camille Crichton-Sumners of the NJ Department of Transportation. Thanks are also given to Zillow™ Real Estate Research for providing property valuation data for part of this study.

The authors also thank MTI staff, including Executive Director Karen Philbrick, Ph.D.; Director of Communications and Technology Transfer Donna Maurillo; Research Support Manager Joey Mercado; and Webmaster Frances Cherman, who also provided additional editorial and publication support.

This report is available from the New Jersey Department of Transportation as report FHWA-NJ-2014-014 and from the Mineta National Transit Research Consortium as report 12-18 (project #1142).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Background

In 2010 the Alan M. Voorhees Transportation Center (VTC) at Rutgers, The State University of New Jersey, under contract with the New Jersey Department of Transportation and with cooperation from NJ TRANSIT, completed research examining the barriers to Transit-Oriented Development (TOD) in the state of New Jersey. One outcome of that work was a desire by NJ TRANSIT to document the beneficial impacts that this kind of redevelopment practice could have on New Jersey communities. To satisfy this knowledge gap, the VTC research team undertook this current research effort, the objective of which was to provide an overview of the beneficial impacts of TOD and other development that is proximate to train stations in New Jersey. This can lead to more vibrant and healthier communities and provide personal benefits to those choosing to live in TODs and near stations. Municipalities that seek to intensify development in their station area also benefit, as does NJ TRANSIT, which stands to gain increased revenue from new customers.

Methodologies

This study used a variety of approaches to examine the beneficial impacts of TOD and development near stations. This included qualitative and quantitative approaches, as well as primary data collection. Our focus was on eight municipalities in northern and central New Jersey, selected in consultation with staff from NJ TRANSIT. These stations were Cranford, Jersey City (Essex St), Metuchen, Morristown, Newark (Broad St), New Brunswick, Plainfield, and Rahway. The eight target stations were surveyed using a random, online/mail-back survey protocol. Our mailing of the survey targeted residents living near the station and up to two miles distant. Secondary data around each station was also collected and used in some of our analyses.

In addition, we conducted focus groups around four stations: Asbury Park, Collingswood, Morristown, and Rahway. Detailed case studies were conducted for three stations: Cranford, Morristown, and Rahway. With the exception of Collingswood, located on the PATCO high-speed line to Philadelphia, and Jersey City (Essex St.), located on the Hudson-Bergen Light Rail line, all other stations were served by NJ TRANSIT commuter rail service. Newark (Broad St.) is also served by the Newark Light Rail. Additionally, key informant interviews were conducted with environmental, health, and planning professionals, as well as developers working in a range of municipalities in northern and central New Jersey. This variety of methods and data sources provides regional and socioeconomic variation in our analysis and a comprehensive view of the benefits of TOD throughout New Jersey.

Benefits were assessed on the following metrics, primarily by analyzing differences for those areas near the station versus those areas further afield:

- Perceptions of residents and those involved with the development process
- Frequency of walking, transit use, and driving
- Social capital and civic engagement
- Self-reported health
- Pedestrian, bicycle, and vehicle casualties
- Average residential property value
- Out-of-pocket and travel time costs
- Regional congestion costs and other external costs

Findings

Case Study Analysis

We prepared detailed case studies of the communities of Cranford, Morristown, and Rahway. Each community has pursued a strategy of station area development that includes TOD. Each has had different reasons for and taken different approaches to such development. Cranford sought to develop underutilized properties and to expand its mix of housing beyond single-family homes, so as to satisfy the needs of an aging population. A county seat with a colonial past, Morristown has seen previous redevelopment adjacent its town green and has a desire to extend this activity through a new TOD built adjacent to the station. Rahway has supported extensive redevelopment through TOD with a focus on development of an arts district. Our focus groups in Morristown and Rahway generally confirm the success that has been achieved in these communities, but note a few shortcomings (discussed below). Our case studies provide descriptive information on the different characteristics of these selected municipalities and how they have sought to benefit from TOD. In each case, these communities have been able to add populations to largely build-out landscapes, expand the variety of its housing stock, and create locations where residents can satisfy their needs without personal vehicles.

Perceptions of Residents, Planners, and Developers

We found broad support for more intense development around the four transit stations for which we conducted focus groups. Residents of these areas appreciate the rejuvenation of their communities, access to transit, and the ability to easily walk to destinations. Likewise, the planning and development community is enthusiastic about the prospects for TOD and sees many beneficial impacts with which most residents agree. The main negative seen by both groups was the lack of practical retail stores moving into their communities. While most expressed positive viewpoints about the development that had occurred, they would prefer to have stores that cater to their day-to-day shopping needs. There were also concerns about pedestrian safety, especially near transit stations with large amounts of pedestrian activity. This suggests a need for planners and traffic engineers to focus more on the needs of pedestrians, the quality of the pedestrian environment created, and controlling the speed of vehicle traffic in these areas.

Frequency of Walking, Transit Use, and Driving

Analysis of our survey data found that those living closer to transit stations were more frequent walkers and transit users while also being less frequent drivers, compared to those living more distantly. Those living further out (up to two miles distant) tend to drive more frequently and both walk and use transit less frequently. This analysis controlled for a range of other factors that are known to affect travel behavior. These include individual attitudes of respondents to their neighborhood, how long they have lived in the neighborhood, built environment measures, and a range of socioeconomic factors, including income and vehicle ownership. We found a mix of different effects, including:

- associations between denser local street networks and increased walking frequency;
- higher employment density, associated with less frequent transit use and less frequent walking;
- lower vehicle ownership, associated with more frequent walking and transit use; and
- more frequent transit use and walking among those with longer commutes.

These results demonstrate one of the primary benefits of TOD and development near train stations. Since those living closer to the train station drive less, they also create fewer negative impacts associated with driving (such as pollution, noise, and congestion). Their increased use of public transit benefits the finances of the transit agency and their increased propensity to walk can have health benefits.

Social Capital and Civic Engagement

The survey collected information on five potential indicators of civic engagement or social capital. These included whether respondents had volunteered in their neighborhood; whether they think their neighborhood is a good place to live; whether their neighborhood gives them a sense of community; whether they know their neighbors; and whether they feel most people in their neighborhood can be trusted. Associations with proximity to the train station were mixed. Those who reported their neighborhood was a good place to live and that their neighborhood gave them a sense of community lived closer to the station. Other measures were not associated with proximity to the station. Our focus group analysis supports this view as participants felt connected to their community and felt the walkability helped them make connections within their community. The built environment played a moderating role in some cases with higher population density being positively associated with two measures and higher employment density being negatively associated with two measures. Those living in a detached single-family home had the strongest positive association with all our social capital measures. These results are somewhat suggestive that social capital may be associated with more compact living if that can occur in single-family housing.

Public Health Benefits

Our survey instrument included a series of questions on the health of respondents. To measure potential health outcomes, the survey instrument elicited self-reported responses on five chronic conditions (heart condition, diabetes, asthma, high blood pressure, and obesity) and on whether the respondent's doctor had advised them to increase their physical activity. Analysis of these variables focused on how they are associated with proximity to the train station. A major issue with this data is that younger people tend to live either in TODs or closer to the station. This led to some confounding effects in our data that made it difficult to separate the influence of age on health compared to the influence of living closer to the station or in a TOD. In almost all of our models, those households with a higher average household age reported have more health issues. The two exceptions were for those reporting asthma and obesity, both of which we would expect to be somewhat less associated with aging. To separate the effects of aging and resident location we estimated models that interacted the two effects; however, in all cases it was not possible to show a distinct effect of distance from the station on the self-reported health of respondents. Other control variables that measured the built environment or travel behavior had mixed effects, mostly showing no association with our self-reported health variables. We also assessed another measure of walking activity, based on short walks; while frequency of short walks was not associated with station proximity, it was associated with more frequent transit usage.

These results suggest that a more detailed study of the health benefits associated with where people live is needed, in order to disentangle the effects of aging and choice of where people live.

Pedestrian, Bicycle and Vehicle Casualties

Those areas with higher population density have been found to be associated with a lower frequency of traffic casualties. We examined this issue with data from our eight targeted transit station areas using a spatial modeling approach. We find a very weak association between pedestrian casualties and proximity to the station. More bicycle casualties tend to occur near the station, while the opposite is true for vehicle casualties. These results may partly reflect the activity patterns of each mode of travel and a weakness of this analysis is the inability to completely control for exposure (of each mode). While vehicle casualties are fewer near stations, this is likely due to slower speed roads, compared to higher speed roads more distant from the station. There may be more bicycle activity near stations resulting in more casualties relative to further out. The weak association of pedestrian casualties with proximity to the station may simply reflect a lack of good control for pedestrian exposure. Increased employment density is associated with more pedestrian casualties and may reflect inadequate pedestrian amenities in areas with more pedestrian activity. Thus while areas around train stations do not appear to strongly influence pedestrian casualties, this may be due to a lack of suitable pedestrian amenities that increase safety. Our overall conclusion is that while there are some benefits of reduced vehicle casualties proximate to stations, more needs to be done to make these areas safer for pedestrians and bicyclists, especially when there is high employment density.

Average Residential Property Value

The appreciation of property values in transit station areas represents an increase in demand for housing and other activities near the station. This can provide increased tax revenue for municipalities and benefit those who currently live near the station. We found higher average residential property valuations near TOD stations compared to areas further out. We also found that areas around stations with direct service to New York City have higher property valuations compared to areas more distant from the station. Our analysis was based on average Census block group “Zestimates” of residential property value provided by Zillow.com. The analysis controlled for other factors typically associated with residential properties, including school quality, access to parks and greenspace, population density, household income, and crime. All showed the expected effect on relative average values.

Our results show a diminishment in value the further a block group is from the station. The reduction is less for proximity to New York City direct service stations than for other TOD stations, suggesting that access is more highly valued than the other attributes of a walkable neighborhood with TOD. In both cases, however, there is clear value associated with proximity to the stations.

Out-of-pocket and Travel Time Costs

One of the benefits of being near a train station is the access it provides to numerous destinations. The costs of owning and operating a motor vehicle are relatively high, including parking costs, which can be quite high in central areas of Manhattan. This analysis evaluated NJ TRANSIT onboard survey data to examine the distribution of destinations from our eight target transit stations. From this we estimated the out-of-pocket and travel time costs for both rail and vehicle trips. Out-of-pocket expenditures are generally much less for those traveling by train from all of our stations. The travel time costs show some variation, mainly due to assumptions made on how individuals value time. In general, those stations closer to Manhattan and with lower income populations have lower travel time costs for rail compared to using a car. This analysis included an assessment of various “control” sites that do not have TOD and could be useful to determine the suitability of various sites for future development.

Regional Congestion Costs and Other External Costs

Regional effects of shifting population from outlying areas to within a half-mile of the eight target train stations were analyzed using the North Jersey Regional Travel Model – Enhanced (NJRTM-E) model for North Jersey. This is a regional travel model with various inherent assumptions concerning individual travel behavior. Costs were estimated using the Advanced Software for Statewide Integrated Sustainable Transportation System Monitoring and Evaluation (ASSIST-ME) model. Results of this modeling exercise show that there is an increase in rail transit usage and a decrease in vehicle usage, consistent with our other modeling results on the frequency of modal use. The increase in ridership is a clear benefit for NJ TRANSIT, as it leads to increased revenue for the system. Users also benefited directly from reduced commuting costs. The estimates of external cost changes, while generally showing the expected effect of less congestion, air pollution, accidents, noise, and maintenance costs, were all very small, mainly because the scenario analyzed was a relatively small shift in population for each area.

Conclusions

Our main findings are that increased development near train stations in New Jersey can lead to a wide range of benefits – for transit users, residents of the area, and the municipality that develops TODs. These range from increased interaction among neighbors and those within the community, more walking activity with consequent health benefits (although our analysis of self-reported health was inconclusive), less driving with potential pollution and other costs, and increased tax revenue for the municipality from increased property values. Safety benefits can also occur but require making areas safe and walkable for pedestrians, something reiterated by our focus group participants. The difficulty of attracting a greater variety of practical retail establishments to station areas was seen as a deficit by residents and a challenge by planners and developers. In total this study provides a contribution to our understanding of the benefits of TOD and development near stations.

Moreover, these findings provide evidence for continued support of targeted redevelopment near New Jersey's transit stations. Benefits from TOD are extensive and accrue to multiple populations. Rare are policies that can positively affect physical and mental well being as well as environmental health and economic robustness. Encouragement of TOD in New Jersey communities through local and state policies and initiatives buttress these gains and help to bring improvements to transit served locations.

Current policy in New Jersey, via the Transit Village Initiative, is one means of encouraging communities to make it easier to develop TODs and improve the walkability of station areas. Currently there are 28 municipalities that have been designated Transit Villages.[1] These developments need to be supplemented with more and better transit service – access to New York City, in particular, but also to other major employment destinations, such as Newark, New Brunswick, Jersey City, and Atlantic City, among others. This requires further investment in transit and, in the case of New York City, whose rail system is currently operating at full capacity during peak periods, significant increases in rail capacity.

Other complementary state policy includes the Complete Streets initiative. This policy requires the consideration of all modes of travel in the construction of new streets, or the redevelopment of existing streets. While the state policy applies to state-owned roads, 91 municipalities and 7 counties have adopted similar policies (as of May 2014); sixteen of these are also Transit Villages. Consideration of the walking environment on streets surrounding stations can increase pedestrian access to stations and improve the overall living environment for those choosing to reside near stations and in TOD.

A coordinated approach to improve transit service, improve the walkability of station areas, and to encourage changes in zoning and planning requirements so that TOD can happen, will lead to many of the benefits identified in this study. NJDOT, NJTRANSIT, counties and municipalities all have a role to play; private developers are ready and waiting to provide TOD to many communities.

[1] For more information see the NJ Department of Transportation Transit Village Initiative website, http://www.state.nj.us/transportation/community/village/index.shtml

INTRODUCTION

Over the last decade transportation planners have reached a consensus on the value of focusing development around existing transit facilities. Transit-oriented development (TOD) is seen as capable of solving a multitude of urban problems, beyond just those associated with the transportation network. The intent of this research study is to examine how development of TODs around transit stations can result in a large range of beneficial outcomes. The focus is on TOD and immediate station areas in New Jersey compared to similar areas more distant from the station. With this goal, we have collected both qualitative and quantitative data, including data from a survey that was implemented around eight transit station areas.

The presumed benefits that could accrue from TOD have been previously spelled out[(1)] and these include:

- Location efficiency from numerous travel and economic benefits;
- Value recapture from direct savings to individuals, households, regions, and states;
- Livability improvements in environmental conditions, mobility choices, increased accessibility and health;
- Financial returns to local governments, transit agencies, developers, and employers;
- Choice in housing types, retail types, and transportation options; and
- Efficient regional land use patterns resulting in reduced greenfield development, job and housing balance, and shorter commutes.[(1)]

Cervero (2004) also documented potential social, environmental, and fiscal benefits of TOD defining both direct and indirect benefits. The primary direct benefits are those that can accrue to the transit agency – increased ridership and revenues. Other potential direct benefits include neighborhood revitalization, financial gains through joint development, increases in supply of affordable housing and revenues to business and land owners near transit stops. According to Cervero, secondary benefits can include congestion relief, land conservation, reduced road expenditures, and improved safety for pedestrians and cyclists.[(2)]

Evans and Pratt (2007) expanded the potential transportation benefits from TOD to include increased interaction among neighbors and workers gained while walking to and riding on transit, new “choice” riders – individuals who might otherwise drive, mode shifts for access to station (trading auto for walk or bike trips), reduced parking requirements, and improvements in environments through reduced emissions and energy usage due to less-energy-intensive travel modes.[(3)]

Our initial work was aimed at understanding how those who live near selected TOD areas perceive both the benefits and potential downsides of development near the station. Four focus groups were organized in station areas across the state, including Asbury Park, Collingswood, Morristown and Rahway. Parallel to this effort we also interviewed local developers, planners, and others involved with the development process in New Jersey. This provided an alternative perspective on how TODs have either met their potential or faced various difficulties. In addition, we conducted three detailed case studies for Cranford, Morristown, and Rahway, providing additional context for the process of TOD development.

Eight station areas were selected for more intensive study and a survey instrument was developed to gather data from individual respondents living in new TODs, near the station, and up to two miles distant. The station areas surveyed were Cranford, Jersey City (Essex St), Metuchen, Morristown, Newark (Broad St), New Brunswick, Plainfield, and Rahway. This provided a broad cross-section of different areas with populations of varying socioeconomic status.

From these data we were able to conduct a number of different analyses. Our main effort was focused on variation in travel behavior between those living near the train station and those further afield. Analysis of these data included simple cross-tabulations to show how distance from the station affected the frequency of using various modes of travel (driving, public transit, and walking). A more detailed structural equation model that includes attitudinal variables, length of time living in the community, built environment factors, and a number of socioeconomic control variables was also developed.

There is a belief that more compact neighborhoods, such as those near a train station, will lead to increased civic engagement or social capital among residents. Our survey instrument included specific questions intended to examine this effect. These are analyzed with the aim of determining whether proximity to the station has any significant impact, while controlling for many other factors that might also increase social capital.

Increased walking activity is often associated with better health. Our analysis examined how measures of self-reported health (collected via our survey instrument) were associated with proximity to the train station. A variety of self-reported health measures were collected, allowing us to examine whether those most associated with physical activity have any relationship with proximity to the station.

One issue that proponents of TOD and compact development have promoted is that these areas are associated with reductions in traffic, pedestrian, and bicycle crashes. We examined this issue using a spatial analysis approach that allows correlation of area-specific built environment and socioeconomic metrics to the frequency of crashes. We also introduced Walk Score™, an internet-based measure of walkability, into the analysis.

An evaluation of how residential property value is associated with proximity to both the TOD stations and other nearby stations was conducted. The hypothesis is that residents value locations close to a station for access to the station or for the amenities provided by development around a station. We used census block group averages of property valuation estimates supplied by Zillow. This data enabled us to correlate the "Zestimates" – Zillow's term for their estimates of property valuations – with various features of the area that are typically found to be associated with housing and property values.

To estimate the financial benefits that TOD and station area residents receive from using the rail system, we used NJ TRANSIT onboard survey data to derive the travel destinations of transit users from each of our eight transit station areas. Using various common assumptions on travel time costs, data on parking and driving costs, and data from the survey, we derived the relative costs of using transit versus driving for each location. This also provides an indication of how attractive various stations are for more intense TOD development.

In order to examine the potential external costs and benefits of TOD, we used the North Jersey Regional Travel Model – Enhanced (NJRTM-E). Our analysis shifts population to locations proximate to the train stations from those further out for our eight targeted transit stations. This allows an evaluation of how TOD may affect regional congestion. The outputs of this model are then used in an economic cost model developed for New Jersey, ASSIST-ME, which provides changes in costs for a variety of indicators, including travel time, pollution, and noise, as well as road maintenance costs.

The first section of this report includes a literature review that documents much of the prior research in these areas. This is followed by our qualitative analysis, based on our focus groups and interviews with professionals, plus a summary of what was learned from our case studies. The quantitative analysis is then described, including the travel behavior, social capital, self-reported health, safety, property value analysis, and the user-benefit analysis. The economic evaluation based on travel demand modeling work is then presented, followed by our conclusions.

LITERATURE REVIEW

Transportation Impacts

There is considerable evidence that TOD residents drive less than those living in non-transit-supportive locations.(4,5) The density, mix of uses and relative accessibility, allows residents, as well as workers and visitors to fulfill their daily needs without driving.

Cervero (2004) found evidence that many TOD ridership gains were a result of self-selection – individuals who choose a residential location in order to be close to transit. Analyzing travel diaries from California residents, the researchers found that nearly 20 percent of those who lived within a half-mile of transit used transit to travel to work, compared to less than nine percent of those living more than a half-mile from a station.(2)

A key question is whether those who desire to drive less choose to live in transit-accessible locations. If this is the case, then this self-selection into certain neighborhoods could potentially bias statistical results. However, recent research that has sought to control for self-selection bias has found that it plays a small role and that statistical associations are still substantial.(6) Thus, despite any self-selection bias, TODs can still lead to net reductions in vehicle travel. Chatman (2009) suggests that it is those households who value accessibility most who may be most set in their ways; that is, they take transit already, while those who value accessibility least are more likely to change their behavior if they live in a TOD. Thus, self-selection could lead to underestimates of the impact of TODs on travel.(7)

One potential impact on travel behavior is the effect of TOD on vehicle-miles traveled (VMT). Reductions in VMT result in lower energy demands as well as reduced demands on the road network. Lower energy demands have economic and environmental benefits while reduced demands on the road network can result in lower long-term investment requirements.(8)

Cervero and Arrington (2008) found that residents of 17 TODs averaged 44 percent fewer vehicle trips than estimates based on the trip generation manual published by the *Institute of Transportation Engineers*. The authors noted that vehicle trip rates were particularly low in Washington, DC and Portland, OR where regional and corridor planning for TOD has been adopted and that neighborhood densities and vehicle trip rates were inversely proportional – as densities rise, trip rates fell. These findings suggest that attempts to model the effects of TOD must account for regional planning practices and neighborhood land use characteristics.(5,9) Looking only at commute trips, Arrington and Cervero (2008) found that residents living near transit were five to six times more likely to commute by transit than others living in the region.(5)

While residential density is a key feature of TODs, the mix of land uses within TODs can also reduce vehicle travel. Bartholomew and Ewing (2010) noted that increases in proximity and convenience allowed TOD residents, workers and visitors to complete their daily activities within a smaller area, which results in shorter travel distances, lower average vehicle trip rates and lower VMT.(10,11) Ewing & Cervero (2010) disentangle the effects of the "5 D's" associated with smart growth: density, diversity, design, destination accessibility, and distance to transit. Diversity tends to lead to more walking than most other effects, with the exception of design features.(4)

Recent work by Boarnet et al (2010) attempts to parse out whether VMT reduction is simply due to the presence of transit (rail and bus) or whether land use plays a significant role. Looking at detailed travel diary data from the greater Los Angeles area, they examined land use characteristics in the neighborhood as well as regional access to jobs and to the transportation network. They found that there is large variation in how proximity to transit affected travel. One consequence is that studying regional average features of the built environment may mask many of the more localized impacts that affect individual travel decisions.(12)

Looking at barriers to TODs in New Jersey, Chatman and DiPetrillo (2010) found that auto commuting and auto ownership were strongly correlated with housing type (size) and tenure as well as the amount of available parking, and less so by rail station access. These findings suggest that an effective TOD impact model should include measures of housing characteristics and parking availability (as well as parking regulation and policies) in addition to mere numbers of units.(13)

In EPA's recent examination of location efficient housing and its effect on energy usage, TOD housing was assumed to generate 45 percent fewer VMT than "conventional suburban development."(14) This analysis reflects differences in development patterns, walkability, and other factors not picked up by standard trip generation models.

Potential economic impacts

Economic impacts and benefits can be characterized by whether they accrue to individuals and households or to communities and regions, or to specific firms. Mounting evidence indicates that living in a transit-supportive location results in lower total expenditure on the two largest household expenses – housing and transportation. In recent years, efforts have been undertaken to develop measures of these kinds of impacts. One such effort is the Housing Affordability Index developed by the Center for Neighborhood Technology (CNT); this provides an estimate of the housing and transportation costs for households within block groups (a proxy for neighborhood). The model used by CNT to estimate these costs stipulates five independent variables – density, jobs access, neighborhood services, walkability, and transit connectivity.(15)

There is a large and growing literature on the economic impact of transit service that examines (1) property valuation;[16-20] (2) congestion costs;[21-23] and (3) agglomeration economies.[24,25] Residents can also benefit from reduced transportation costs, both in terms of travel time and out-of-pocket costs.

Property Valuation

Hedonic regression modeling is used to examine the effect of rail access on residential housing prices. These studies indicate that home owners are generally willing to pay a premium to be located near a station in order to reduce commute times; however, it has been found that while home owners wish to be close, they may prefer not to be too close to stations as some negative characteristics may outweigh the locational advantages. For example, single-family homes in the Atlanta region were found to have prices of properties closest to stations (within a quarter mile) selling for 19 percent less than properties located more than three miles from stations.[17] The researchers considered physical characteristics of the housing (number of bedrooms, number of baths, size of lot, basement, fireplace and age of house) as well as neighborhood characteristics (crime, noise, pollution, and the unsightliness of the station). Recent studies have accounted for different housing forms (single-family vs. multi-family), parking availability and amenities offered by TOD locations.[26]

Some studies have also found that positive effects on property values are greater for stations served by commuter rail than by heavy rail, and that Bus Rapid Transit generally decreases nearby property values.[11] In the case of commuter rail, one study in Buffalo, NY, found that apparent proximity to a station (by aerial distance) had an added advantage compared to network distance, and that proximity effects were positive in high-income station areas and negative in low-income station areas.[27] However, it is important to note that these effects on property values also depend on the frequency, geographic extent, and speed of the transit service provided, as well as the extent of nearby traffic congestion.[11]

The design features of TODs also have value to residents. This has been demonstrated using hedonic pricing models.[26] In particular, it has been found that design features are capitalized into housing values. These features included street connectivity, smaller block sizes, even mix of land uses, better pedestrian access to commercial areas, and proximity to light rail stations (in this case, based on data from Oregon).

Mathur et al (2009) explored whether expressed opposition to TOD would affect housing prices. They examined single-family home prices near four suburban San Francisco TODs, believing that TOD development should affect housing prices. Opposition to TOD may be voiced but true negative effects of such development should be seen in lower housing prices of property close to new TOD. Increases in housing prices, however, would indicate that TOD had a positive effect on surrounding neighborhoods. Mathur et al (2009) found a positive effect from one TOD and no effect from the remaining three TODs.[28]

Several studies show that TOD has a synergistic effect on property values. Research by Bartholomew and Ewing (2010) suggests that compact development can generate a premium of 40-100 percent compared to houses in nearby single-use subdivisions.[11] Duncan (2011) found that, for condominiums in San Diego, CA, distance to a transit station could become a significant predictor of property values given a pedestrian-oriented environment, specifically a favorable intersection density and a considerable amount of practical commercial establishments.[29]

Congestion and Other External Costs and Benefits

Development near rail stations can affect the regional transportation network and generate both costs and benefits in different ways. If trips are shifted to transit or are shorter, there may be reductions in total vehicle travel with consequent reductions in external costs of pollution and congestion. The transit agency will see benefits from increased ridership and revenue. Several studies have examined these issues, typically using regional travel demand models. Regional travel demand models have been used to estimate these effects which can extend beyond the immediate area where the TOD is located.

In a recent study looking at TOD proposed along commuter rail in the Austin, TX area, Zhang applied a conventional four-step travel demand model to simulate traffic outcomes in three TOD scenarios – no TOD, rail-only TOD, and TOD with rail and bus-feeder. In order to measure the impact of TOD in Austin, Zhang redistributed population and employment growth in Austin's four-step travel demand model.[30,31] This model used area, population and employment density and household size to estimate employment and population gains. Zhang re-estimated the model's mode choice for two scenarios of TOD development and calculated the shift in percentage of trips by mode. The model predicted increasing losses for single-occupancy vehicle (SOV) trip share and gains for transit trip share based on the increasing level of TOD development. After the mode choice step was completed, the highway and transit assignment models were calibrated based on the new demand levels. Zhang was able to estimate a significant drop in person-miles traveled by automobile and an increase in person-miles traveled by transit associated with the TOD.

Zhang concluded that TOD reduced congestion overall even if drivers are not persuaded to abandon their vehicles. Transit distances between origins and destinations were shortened. However, the author suggests that the benefits of lower congestion may accrue to those at a distance from the TODs. Local neighborhoods near TODs may not receive the benefits of lower congestion, which can make it difficult to promote TODs locally. "Though TOD residents drive less, the increased concentration of people and jobs in the TOD area may offset the reduced vehicle-miles traveled (VMT) or even increase traffic density on local roads, possibly resulting in no net improvement or even increased congestion in those areas."[30] Congestion can be reflective of economic activity, and thus, may not necessarily represent a cost in this context.

Another study estimated that TODs can reduce the need for road construction and long-term maintenance costs. A 2008 *Transit Cooperative Research Program* (TCRP) report estimated that TOD led to the need for an estimated 188,300 fewer lane-miles of construction.[32] Measuring the effects of a TOD on highway network congestion is a critical component of fully understanding the precise impact of a TOD. For example, TOD evaluations have shown how TOD has reduced highway transportation costs and externalities such as road maintenance and infrastructure expenses, as well as external cost reductions from reduced air and noise pollution and fuel consumption.[32]

Cervero notes several weaknesses in using regional travel demand models to estimate TOD impacts. However, he shows various methods to overcome these weaknesses, including modified vehicle ownership in TODs that affect trip generation and mode choice and methods to post-process model results.[33] In addition to the traditional trip generation and attraction variables of household size, income, auto ownership, and employment, Cervero suggests that land use variables such as employment density, ease of walking access, and a land-use-mix measure be included in models. The influence of TODs on travel estimates can be affected by the coarser nature of the spatial data used to estimate user behavior in mode choice models.

One of the solutions proposed by Cervero et al. (2004) involves post-processing the outputs of the four-step modeling process using elasticities based on some of the spatial and urban design variables, such as land use. Alternatively, models different from the four-step process can also be used to capture the finer-grained/local variables that may influence transit ridership. Examples of such approaches can be found in several references. [34-36]

An analysis was done that used the North Jersey Regional Transportation Model – Enhanced (NJRTM-E), a travel demand model for northern New Jersey, to estimate the impact of TOD in Bloomfield, NJ.[37] The project called for development and increased parking capacity at the Bloomfield rail station, with the intent to increase rail transit usage. The NJRTM-E model was run with the planned roadway improvements and parking capacity expansion and the assignment modules were run to compare the differences between the planned scenario and existing conditions. The estimated benefits of the project included reductions in vehicle congestion, vehicle operating costs, vehicle accidents, air and noise pollution, and maintenance costs at the network-level. The benefits due to TOD at the Bloomfield train station were calculated as the reduction in trips from the highway network, and the effect of that reduction on the highway network. Accordingly, marginal costs of these trips were calculated for each cost category and summed.

To determine which trips were likely to be shifted, the number of rail trips originating at the Bloomfield train station and their destinations were compiled in NJRTM-E. Then marginal costs for highway trips between the same origins and destinations were estimated using ASSIST-ME, a post-processing tool.(38) The average of the marginal costs was weighted according to the number of transit trips to their destinations to find a representative transit trip originating in Bloomfield. Analysis of the transit origin-destination trips in NJRTM-E revealed that most rail trips originating in Bloomfield are destined for New York City, Newark, or Jersey City. Since rail transit trips are most likely to be commuting trips, only AM Peak and PM Peak period marginal costs were considered in the study.(37) Daily benefits for introducing TOD were $20,000-30,000 for congestion costs, $1,100 for vehicle operating costs, $200 for air pollution costs, $14 for noise costs and a loss of $5 for maintenance costs.

Agglomeration Benefits

Agglomeration economies are typically overlooked in most analyses. This is an external benefit that accrues to firms that locate in areas that are both more accessible and more concentrated. This occurs through various mechanisms, for example the availability of a larger pool of labor, and the ability to more easily share information and knowledge.(39) Graham (2007) developed a technique to estimate agglomeration elasticities (i.e., the change in productivity for a given change in access), using data from the UK. His results apply to accessibility in general and not transit *per se*, but show substantial benefits associated with agglomeration.(24) Research by Chatman et al (2012) for TCRP H-39 finds that transit infrastructure can lead to large agglomeration benefits, measured by increases in employment density and regional population.(40)

Health benefits of TOD

The health impacts associated with more walkable neighborhoods has been documented, but not necessarily for TODs.(41) There are a number of potential health outcomes that can be derived from TOD projects, yet in many circumstances, the specific design aspects and qualities of the TOD may have a large influence on these effects and their magnitude. For example TODs may be in or near major centers of activity or further out on the fringes of these centers. This could influence residents' car ownership levels, the level of ambient air pollution and the attractiveness of transit access. The type and function of the transit station (e.g. park-and-ride, terminal for feeder bus service) may also influence the health benefits of TOD. For each potential health effect, a brief description is provided, along with ways to measure the health impacts of TOD, if they exist.

Physical Activity

TOD is expected to provide more nearby destinations that can be accessed by walking and bicycling. While the relationship between the built environment and walking has been established, only more recently has research specifically examined the use of transit as a potential correlate of walking. Because a transit trip often includes walking at both ends of the trip, the relationship makes intuitive sense. Both Dannenberg and colleagues (2003) and Lee and Moudon (2004) established the need to more specifically explore the relationships between transit use and walking.[42,43] A number of studies have found an association between using public transit and physical activity, and especially walking for transportation (also referred to as active transportation). Only a few of these studies directly assessed areas described as transit-oriented development. Nonetheless, because their designs typically capture highly walkable environments, the studied neighborhoods often share similar characteristics with TODs.

There are a number of ways in which transit use may influence physical activity: Transit users need to walk to transit stops and from transit stops to destinations.[44] Based on an analysis of the National Household Transportation Survey, transit users spent a median of 19 minutes daily walking to and from transit and about a third met physical activity recommendations (walking five times a week for approximately 30 minutes or cumulating 150 minutes of physical activity over the week) solely by walking to and from transit.[44]

Transit users also likely walk more because they access services by walking within their neighborhoods and at their destinations.[45] Walking to neighborhood services is supported by TOD's with a strong land-use-mix component. Associations between transit use and physical activity are found regardless of whether residents live in a TOD or not. It has been found that transit users living in high and low walkability neighborhoods were more likely than non-users of transit to walk more. The difference between users and non-users was greater in low walkability areas.[45] Near both their homes and their workplaces, transit commuters were more likely to take walk trips to access grocery stores, restaurants, banks, post offices and other services. Those commuting to work over 50 percent of the time by transit were 3 times more likely to meet physical activity recommendations, and walked on average 5 to 10 more minutes than those never using transit to commute.[45]

Each additional transit trip seems to translate to an increased likelihood of meeting physical activity recommendations.[46] For each additional transit trip, participants were found to be approximately 3.5 times more likely to meet physical activity recommendations. Each additional motorized trip, on the other hand, decreased the likelihood of meeting physical activity recommendations.

One analysis, carried out in New Jersey, assessed the physical activity patterns of transit commuters living near three different suburban rail stations.[(47)] Seventy-eight percent of riders living near a station met physical activity recommendations (compared with 44 percent for the entire state of New Jersey) and a third of all surveyed commuters increased their levels of physical activity as a result of system improvements (Secaucus Station). Increases in walking were around 10 to 20 minutes in each direction and were primarily a result of walking more at the egress point, in midtown Manhattan.

Another study involving New Jersey participants collected self-reported information and distributed pedometers to train and car commuters in northern New Jersey.[(48)] Train commuters reported an average of 30 percent more steps and were four times more likely to walk 10,000 steps (the equivalent of meeting physical activity recommendations).

A study was conducted in an area of Salt Lake City that was consistent with TOD in terms of zoning and that had just received a new TRAX light rail stop.[(49-52)] Within a walkable area of a half-mile surrounding a new light rail station, participants that were continuing riders of the light rail system lived on more walkable street blocks than those not using it. New riders were also more likely than non-riders to live on a walkable block that was denser, more diverse and safer from crime. This study also showed that the development of a new light rail station in a neighborhood resulted in some residents changing behavior and using light rail. These residents also incidentally increased their levels of physical activity.[(50)]

This increase in physical activity associated with transit use has also been associated with upstream health outcomes such as Body Mass Index (a marker of obesity). In one study, additional minutes spent walking were translated into energy expenditure and reduction in obesity prevalence. Using this potential reduction, the present value savings of $5500 per person was calculated and it was suggested that quality-adjusted life years could be even higher.[(53)] Another study found that the use of Light Rail Transit was associated with a reduced BMI of 1.18 kg/m^2 and an 81 percent reduced odds of becoming obese over time.[(54)]

Stokes and Colleagues (2008) assessed the effects of light rail transit development on health care costs in Charlotte, NC.[(55)] By linking the cost of obesity to the health care system, estimates of future riders, area obesity rates, and the effects of public transit on physical activity, they were able to estimate the potential yearly public health cost savings associated with the infrastructure. They found 9-year cumulative public health cost savings of $12.6 million, a relatively small cost saving compared to the costs associated with constructing and operating a light rail system. Yet, they suggest that health benefits and healthcare cost reduction benefits, if they cannot justify a project by themselves, can be used by urban planners in their assessments of the costs and benefits of infrastructure design.

Automobile Crashes and Pedestrian Safety

The reduction in car travel in TODs, as well as the street design may result in fewer crashes and in particular fewer pedestrian crashes.[56] This is primarily linked to the urban design associated with TODs, such as narrower streets and lane widths, better pedestrian facilities, traffic calming, and other features that tend to slow the speed of vehicles. Thus, this type of impact can be highly dependent on the precise design features of a TOD as well as how it is connected to the regional transportation system. Research has also shown that both automobile crashes and pedestrian injuries are lower in areas with higher residential population densities, albeit higher in areas with commercial activity or higher employment density.[57,58]

Air Pollution

Mobile sources of air pollution contribute to the prevalence and severity of asthma, and other cardio-pulmonary diseases. Air quality benefits can be derived from a reduced presence of automobile traffic within the boundaries of a TOD, although TODs can also serve as traffic generators. Localized exposure, which can be dependent on the amount and mix of traffic (e.g. heavy-duty vehicles), is critical to how emissions affect health. Various techniques are available to assess this, for example simulation models.[59] Close exposure to particulates (primarily from diesel engines) has been associated with a variety of health effects, most importantly increased incidence of asthma.[60] Whether TODs result in increased exposure to particulates relative to traditional greenfield suburban developments is not known, but actual exposure levels are highly sensitive to the quantity of traffic and the closeness of that traffic to housing and the streetscape.

Mental Health and Stress

Driving on congested arterials is a common source of stress, which may be reduced by a lifestyle involving more non-motorized transportation and the use of reliable and efficient public transit.[61] Quality of life, life satisfaction, happiness, the ability to age in place, sense of community and neighborhood interactions are also outcomes that may be considered as important to human health.

Community Impacts

TODs have the potential to improve the livability of the community in which they are located, both for those who already live in the community and those who come to it for the amenities offered by the new development. While there are many ways that TODs can positively affect a community (and be affected by that same community), the potential to affect community engagement or what is known as social capital has received recent attention.

<u>Civic Engagement and Social Capital</u>

Portney explored the relationship between civic engagement and sustainability in American cities. Analyzing data from the 2000 Social Capital Benchmark Survey, he concludes that residents of cities more engaged in sustainability efforts do tend to be more active in the participatory process.[(62)]

In terms of social ties within a community, a study by Freeman found that there was strong statistical significance between the proportion of residents who drive to work and the existence of neighborhood social ties. Specifically, he found that a 1 percent increase in the proportion of residents who drive to work led to a 73 percent decrease in the odds that a randomly selected individual would have a neighborhood social tie.[(63)]

Studies have also shown that compact, mixed-use development can lead to an increased feeling of connection to one's community. A survey of residents in Galway, Ireland, found that those living in more traditional neighborhoods (those consisting of mixed-use and pedestrian-oriented development) compared to more modern, automobile-dependent neighborhoods felt more connected to their community, were more likely to know their neighbors, and were more likely to trust others.[(64)]

Potential environmental impacts

The three primary environmental impacts that are linked to driving include air pollution (mentioned under health impacts), greenhouse gas emissions, and noise. Greenhouse gas emissions, primarily CO_2, are associated with climate change. New Jersey has established targets for reducing greenhouse gas emissions by 50 percent by the year 2050 (based on 2005 emission levels), with a goal of doubling transit ridership and promoting TODs as part of the plan to reach this target. Noise can also be considered a health impact and has been demonstrated to have a mortality effect.[(65)] The literature on the links between vehicle travel and both pollutant and greenhouse gas emissions is well established (EPA's MOVES model can assess these emissions).

The health effects of road traffic noise have been well documented and generally are viewed as stress-related. Various modeling tools are available to assess noise based on estimates of vehicle speeds, volume and the fraction of heavy-duty trucks. It is notable that reduced speed of vehicles can result in lower noise levels. TOD areas with pedestrian supportive street design can result in slower traffic speeds and reduced traffic noise compared to that generated by traffic moving along highways.[(66)]

Of particular interest for TODs, is how the geometry of an area, in relation to how it is exposed to heavy traffic flows, may affect total noise levels. One such study utilized extensive traffic counts together with analysis of aerial photography of the types of vehicles present in urban neighborhoods.[67] These data were mapped such that GIS models could be generated and used to estimate locations of high noise annoyance.

Conclusions

This review of existing knowledge has established that TODs have an impact and that in most cases this is a beneficial impact. This review provides guidance on where our efforts should be focused and what data are desirable to collect to measure the impacts of TODs.

Good information is available on the transportation impacts of TOD and smart growth developments. While this information may not be strictly generalizable to New Jersey, it serves as a good reference point for estimating effects from our own survey work. Much of this research links land use and urban design components to walking and travel by different modes and our survey instrument will be designed to allow this type of analysis.

Economic impacts include property value changes, congestion costs, and external agglomeration benefits. Of these, it is well acknowledged that more accessible locations have a higher property value, although this can be dependent on the particular characteristics of the area surrounding a transit station, for example whether it is perceived as unsafe. Congestion costs are more difficult to measure and are dependent on whether overall network congestion is reduced from mode shifts from auto to transit or non-vehicular modes as opposed to whether the attractiveness of a walkable TOD area attracts traffic (and consequently economic activity). Thus, congestion can be an indicator of economic benefits as well as being a cost, depending on where and when it occurs. A property valuation study is one way of assessing benefits of TOD, although one must be cognizant of “double counting” benefits, as these represent a capitalization of amenities into the property value.

Health benefits, primarily the increase in walking associated with TOD – and with transit use per se – are well established. While the link of active transport to obesity and other health impacts has generally been established, it is less definitive whether TOD itself can be directly linked to health benefits. Walking activity is the key mediator that affects health outcomes. Our survey instrument will collect data on self-reported measures of health as well as walking activity.

Other health effects include traffic and pedestrian safety, air pollution, and stress associated with driving. Pedestrian safety research has established some links between land use and urban street features and how they can affect pedestrian safety; data for New Jersey is readily available to further explore these linkages. Air pollution is linked to both the quantity of traffic and the proximity of residents to that traffic, and it is unclear precisely how TODs might affect this aspect of public health, as this would depend on specific design features. While existing emissions models can be applied, they are not suited to estimating localized effects without significant effort. Effects of stress and how TOD living may change stress levels is an area with insufficient information to draw any firm conclusions, although it is acknowledged that driving in congested conditions can induce stress.

Environmental impacts, primarily greenhouse gas emissions and noise, are associated with VMT. As greenhouse gas emissions are global in nature, shifts in travel mode can serve as a basis for estimating changes. Noise is a more localized impact, and travel modeling tools can generate rough estimates. These effects will be examined using the regional transportation model for North Jersey.

QUALITATIVE ANALYSIS

A qualitative assessment of the views held by municipal officials, planners, developers, and residents on the desirability, benefits, and potential problems with TOD development was the focus of this analysis. The qualitative work conducted also informed the design of our survey instrument.

One of the objectives of this qualitative work was to examine the congruence between planning practitioners' expectations for TOD benefits and residents' experiences of living in and around TOD. The beliefs expressed by professional planners, developers, and other stakeholders, and their correspondence to the perspectives of those currently living in TOD areas and around TOD-adjacent train stations are analyzed. Information on professional perspectives was gathered via key informant interviews and information on resident perspectives via focus groups held in four TOD areas. These were proximate to the following stations: Morristown, Rahway, Asbury Park, and Collingswood, all on different rail lines, and all except Asbury Park are part of the New Jersey Transit Village program. The qualitative analysis was further informed by three detailed case studies conducted for Morristown, Rahway, and Cranford stations.

The interviews are discussed first, followed by the focus groups of residents, and finally a synopsis of the case studies. Insights on their perspectives are summarized in the conclusions.

Key Informant Interviews

The interview process collected information from a wide variety of stakeholders on critical topics related to transit-oriented development in familiar places. We attempted to be as inclusive of different types of stakeholder groups as possible. We also tried to keep the interviews as open as possible to allow the informants the ability to judge for themselves the effectiveness and importance of transit-oriented development with respect to their area of expertise. Several key themes emerged from the various opinions of the informants. Overall, these informants perceived the benefits of TOD to include improving the quality of life for residents through increased access to jobs and shopping; a stronger sense of community, lower transportation costs; the opportunity for frequent, efficient transit systems and shared parking; increased physical activity; and less impact on the environment. Common issues mentioned in relation to TOD were increased traffic congestion, increased housing costs, reluctance of retailers to rely on structured parking, fiscal impacts (both municipal cost savings and increased revenue), and – most commonly noted – the necessity of high-quality transit to provide substantial benefits.

Methodology

A total of 14 interviews were conducted from mid-2011 to early 2012. Researchers interviewed two municipal officials, two community development and involvement informants, three developers, two economic development and financial consultants, one public health informant, one environmental informant; and three business improvement professionals.

Participants were selected through a multi-stage process that involved both VTC staff and the client, NJDOT. First, we defined topical areas as inclusively as possible, including:

- Local government officials
- Developers/Property managers
- Economic development & financial informants
- Public health informants
- Environmental informants
- Community involvement informants
- Business improvement informants

The criteria for selection were primarily based on familiarity and ease of access. Both VTC staff and the NJDOT client are well connected with New Jersey stakeholders, but some of the participants were in areas neither VTC nor NJDOT had been in contact with before. The selection process yielded between four to twelve candidates for each category. These candidates were further vetted through a selection process that evaluated the likelihood of response and level of expertise in the substantive area. This final selection process left two to five candidates per topic area. Other candidates were held on a reserve list in case the primary contacts were unable to participate. Interviews were conducted via telephone and in person, based on the desire of each respective participant. Additional interviews were added in early 2012 to include business improvement professionals as a distinct category from economic development and financial informants. Interviews were recorded by VTC staff. An interview guide was developed and appears in Appendix I. Recordings and notes were used to generate a summary of the discussion, which was then distributed back to the participant for editing and clarification. These summaries were then stripped of identifying information and used for drafting the final report. A detailed analysis of the specific contributions of each group of participants follows.

Detailed Analysis

Five municipal officials were interviewed from both a large urban city and a smaller suburban community, the latter along NJ Transit's North Jersey Coast Line. All expressed a common goal during their interviews: to channel growth to specific locations in order to offer a more urban quality of life, with fewer cars and more efficient public transit. The interviewee from the suburban community expanded on this goal to include attracting young people, who they feel are important to the growth and vibrancy of their municipality. Those from the urban city have already gone as far as to eliminate parking requirements for most new buildings while including bicycle parking requirements. They also mentioned that much of the parking in office buildings has gone underutilized, and only one in five employees own cars. The suburban community is planning for TOD and adopting plans that permit and encourage such development.

The municipal officials from both cities agreed that the primary benefit of TOD is the opportunity to grow [in density] and improve the quality of life for their residents. The suburban community official specified that the improvement consists of a balance between green space, transport, housing, and work. Another impact acknowledged by the municipal officials from the urban city was that TOD leads to increased traffic congestion, which limits driving and allows for more efficient transit systems to operate. However, in the suburban community it was felt that the increased traffic congestion might negatively affect commuting, emergency services, and air quality. Though traffic congestion can be a boon for rail transit, which operates on its own network, other important services, such as emergency response, still need to be able to use roads that are relatively free of congestion. In this sense, policy makers (in the view of the suburban official) cannot ignore the problem of congestion in hopes of discouraging auto traffic and encouraging transit ridership. Finally, the urban city officials noted that TOD makes it easier to plan and implement parking controls for residential and commercial uses, and that it offers an alternative to higher-priced living in bigger cities such as New York City. The interviewee from the suburban community also mentioned this final point, commenting that TOD allows people to live in the suburbs while having a vibrant urban lifestyle.

The community development and involvement informants have also made progress in developing TOD; one informant noted they have incorporated TOD into their planning toolkit, while the other is proposing a transit loop to better connect existing transit systems with residents and create denser development. These informants view the primary benefits of TOD to be improved job access and local job creation, as well as opportunities for mixed land use. One community development informant explained that increasing the amount of mixed land use means increased local shopping opportunities, which in turn means shorter travel distances are needed and more local dollars can be captured by the community. This does not necessarily draw on the transit aspect of TOD, but rather makes use of the mixed, dense development pattern. The other informant also mentioned that a side benefit of TOD planning is bringing community members together to discuss challenging issues. She concluded that TOD connects the goals of regional planning with those of local planning. Finally, the main issue addressed by the community development informants was that TOD often raises residents' concerns with density.

The three developers who were interviewed all discussed the benefit of a strong community in TOD neighborhoods, which can aid in placemaking, attracting regional businesses, and lowering residential turnover. As a result, TOD can help support economic growth and dynamism in a sustainable way. The developers also discussed increased accessibility as a prime benefit of TOD – specifically, accessibility within the TOD through increased walkability, as well as accessibility to and from outlying areas through improved public transit and shared parking.[2] Regarding shared parking, one developer commented that parking structures can raise energy efficiency and make the surrounding land more valuable, contributing to the economic success of the area. Two of the developers also discussed the benefits related to housing. While TOD can increase the value of housing, it can also reduce transportation costs, which can allow for a higher percentage of household income to be spent on housing. In addition, providing affordable housing within TODs can provide associated benefits of mixing income levels, and allowing all types of people to access the local community. One developer also noted that in the current down economy, for-rent development in well-served transit neighborhoods are in demand – indicating that there has been a call for more TOD. In conclusion, this developer felt that TOD is "a total alignment of interests."

When asked about conditions that limit or adversely affect TOD, two of the developers discussed the necessity of high-quality public transit – that is, frequent transit that provides efficient transfers to other lines and transit systems in order to attract riders. Two developers also raised questions about retailer expectations regarding parking in TODs. Each suggested that most New Jersey retailers are not used to providing parking in structures; generally, they are familiar with suburban strip mall style development with parking directly in front of the establishments. The developers interviewed believe this reluctance to support structured parking can lead to retail vacancy, though they did not specify exactly why this might be the case.

[2] Improved public transit is often achieved in TOD by consolidating services at a single point, creating simpler, faster transfers. Some of these improvements are contingent on the cooperation of the public transit agency. Shared parking can increase the efficiency of parking supply, therefore allowing denser development clustered around activity centers, which was viewed as desirable by most of our interviewees.

Much like the views from the development community, the economic development and financial consultants also noted that TOD housing is in demand by young adults, as well as retiring baby boomers looking to downsize. However, in stark contrast to the opinion of the developers, they felt that small retailers are faring well in TOD environments and offered that these retailers are adapting to the transit-friendly, attractive downtowns fostered by TODs. As we note in our discussion of residents viewpoints, this type of development that is successful around TODs, may not serve the needs of residents.

The fiscal specialists also discussed how TOD can help lower not only transportation costs for households – giving them more disposable income to use toward housing and other costs – but also lower infrastructure costs including snow removal, street cleaning, and garbage pickup. Increased density in particular, allows cities to consolidate their services around a smaller area. This creates significant efficiencies for all types of city services, and this fact was not lost on the fiscal specialists in the group. One of them explicitly pointed out the service savings as a major factor driving his support for dense TOD in an older northern New Jersey city.

Finally, they discussed how TOD has evolved from a convenient place to live and a convenient commute to a destination in itself. As an origin *and* a destination, the benefits of TOD extend beyond the community. Several participants cited the potential of TOD to bring artists and entertainment back to their downtown areas, where rail transit stations have long existed. This coincides with the view that traditional types of consumer retail are no longer viable on the same scale as before. The fiscal specialists in particular were aware of the changes rapidly affecting the brick-and-mortar retailers in dense, urban centers. Even despite a resurgence of interest in these types of places as entertainment and living places, these participants noted the lack of success of consumer goods retailers in TOD. Instead, they said they sought to expand the "secondary" arts and entertainment destinations, such as restaurants, galleries, clubs, and bars (something that some TOD residents saw as nice amenities, but not as useful as more practical stores).

As with the developers, one economic development consultant mentioned the need for transit service to be of high quality so as to support a TOD and yield significant benefits. Holding back these potential improvements, according to this participant and others, is New Jersey's broken system of school funding. Addressing the needs of families for quality schools in dense, urban neighborhoods holds back the potential of TOD to serve as anything other than transitional housing for young professionals and empty nesters. Some participants believe that TOD cannot fully reach its full potential without allowing residents to stay in the community throughout all life stages, including raising a family. The other economic development consultant also mentioned the issue of housing affordability; as land near existing transit stations can be costly, it can be difficult to provide enough affordable housing in a TOD. Others mentioned workable solutions for affordable housing (such as tax credits to lower development costs), but most mentioned it as a significant hurdle yet to be solved and made more difficult by the poor economic conditions.

Discussion with the public health informant centered on several health-related effects that may accrue from TOD. TOD can increase physical activity, primarily walking, by providing an opportunity for people to integrate it into their daily lives. This can benefit all age groups, especially seniors. TOD can also potentially reduce stress, but in order to do so, public transit must be convenient and reliable. TOD can improve accessibility for many population groups, including low-income residents, seniors, and teens. For low-income residents, it can improve access to food. For seniors, it can reduce automobile dependence and allow them to live full lives even as aging may make driving more dangerous. Teens can also benefit from less automobile dependence. It allows them increased independence and may reduce the risk of teen drunk driving.

Finally, the environmental informant offered several environmental benefits provided by TODs. By reducing vehicle-miles traveled (VMT), TODs can reduce air pollutants. By building more densely and using less geographic area, TODs can help protect natural habitats, reduce impacts on water resources, use less energy, and reduce the need to maintain more infrastructure. These benefits make energy-saving technologies more feasible to implement, and can help catalyze remediation projects on brownfields.

The environmental informant also brought up the issue of parking requirements, which are considered a balancing act between environmental protections and safety issues, such as fire equipment access. Current parking and roadway regulations are in place to ensure easy access in case of an emergency versus the goal of reducing building footprints for stormwater management. The environmental organization has worked to accommodate parking requirements through the development of structured parking as a way to reduce the overall project footprint and minimize stormwater runoff, while maintaining emergency access.

Focus Groups

Between June 2011 and March 2012, the Alan M. Voorhees Transportation Center (VTC) conducted four focus groups with the aim of determining the views of residents on TODs and station area development in their community. In each group, between 10 and 12 residents living near four representative transit stations were invited to share their perceptions of and experience with TOD projects and how these projects have affected their quality of life and transportation behavior. A minimum of eight individuals attended each focus group.

Methodology

We designed a focus group topic guide that served as an outline script for moderators (Appendix I). The topic guide includes an introduction, discussion of the group "rules" (including the confidential nature of focus groups), the scope of the content to be discussed, and specific points to be covered during the discussion.

The focus group guide spelled out questions on the essential topics of interest, the impacts of TOD upon the community. The main topics of discussion were TODs' impact on:

- Transportation
- Economic development
- Health
- Environmental conditions
- Overall effect of TOD on the community

Questions were open ended, and designed to elicit conversation among participants. In this way, participants were able to spur each other's memories, talk about shared and unique experiences, and offer their opinions on general discussion topics as well as on the specific prompts in the guide. The guide provided an overall framework for the conversation, and depending on the direction of the discussion some groups deviated from the guide, but still provided useful information.

In consultation with the client, four station areas were selected that assured geographic and demographic diversity. Those selected include Asbury Park, Collingswood, Morristown, and Rahway, the latter three have been designated as Transit Villages by the New Jersey Department of Transportation. These stations are served by different rail transit lines (and by two agencies, NJ TRANSIT and PATCO), and all but Asbury Park had extensive development within its town center, located within walking distance of the station, but not directly proximate to the station. Together, they represent a geographically, economically, and socially diverse cross-section of the many New Jersey municipalities that enjoy access to rail transit.

Table 1 – Focus group municipalities and available rail transit service

Municipality	Provider	Line	Completed TOD Projects
Asbury Park City	NJ TRANSIT	North Jersey Coast	Not specifically TOD, but some developments in town center near station
Collingswood Borough	PATCO	N/A	The Lumberyards
Morristown Town	NJ TRANSIT	Morris & Essex	The Highlands, 40 Park, The Metropolitan, Vail Mansion, Vail Commons
Rahway City	NJ TRANSIT	Northeast Corridor & North Jersey Coast	Indigo Hotel, Skyview Tower, River Walk, River Place, Grand Meridia, The Savoy, Park Square

Recruiting for the focus groups was done through targeted mailing of residents who live near the train stations. Residents received a postcard with a call back number, and then would be screened for eligibility by staff from the Bloustein Center for Survey Research (BCSR). The sample for each station was stratified by the following housing location characteristics:

- New housing near station
- Within a half-mile of station
- Between a half-mile and two miles of station
- Single and multi-unit buildings

BCSR contacted 500 households per focus group in order to populate the groups. The sample was drawn by Market Systems Groups for the Asbury Park, Collingswood, and Morristown focus groups, and BCSR drew the Rahway sample using the reference USA database.

Focus group sessions were led by staff from BCSR. The focus groups were recorded. Notes from the sessions as well as written transcripts were used to summarize discussions and to aid in analysis.

Table 2 – Participant profiles and tenure

Municipality	**Number of Participants**	**Participants' Municipality of Residence**	**Range of Tenure**	**Average Tenure**
Asbury Park City	8	Asbury Park (3); Neptune (2); Ocean Township (1); Ocean Grove (1); Allenhurst (1)	10 Months to 56 Years	24 Years
Collingswood Borough	10	Collingswood (8); Camden (1); Cherry Hill (1)	8 Months to 42 Years	13 Years
Morristown Town	12	Morristown Town (11); Morris Township (1)	1.25 Years to 30 Years	11 Years
Rahway City	8	Rahway (8)	8 Months to 59 Years	22 Years

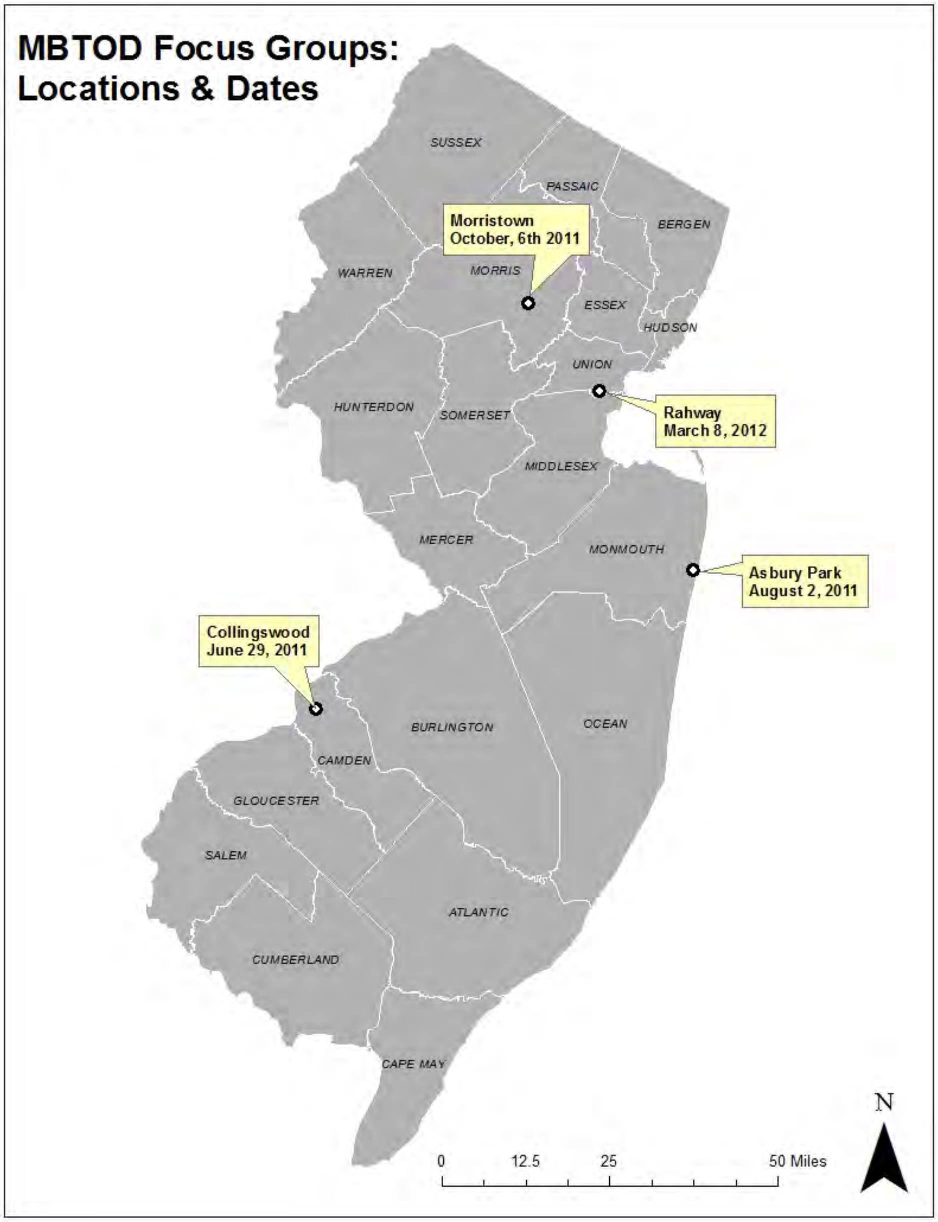

Figure 1. Focus group dates and locations

Analysis

Because participants had varying degrees of familiarity with the concept of TOD, the term was defined very simply at the beginning of each focus group as mixed-use, walkable development around a transit station. In order to gauge participant experience, participants were asked about how long they have lived in the community and how living in an area with TOD affects their transportation habits. The groups had a wide range of responses in terms of residency tenure and transit usage. Some participants had been residents for several decades or their entire lives. Others had only recently moved to the municipality, and a few had moved into new residential TODs. About half the participants in Collingswood, located on the PATCO High Speed Line to Philadelphia, used transit for their commute trip. In contrast, participants in Asbury Park, Morristown and Rahway, use transit mainly to access social and recreation activities, especially in New York City, although some had previously used the train for their work trip. In each focus group, being able to walk to the train station is seen as an advantage, although some participants said they choose to drive to access transit at least some of the time. In Asbury Park, some participants walked or drove to other nearby stations that they lived closer to, rather than Asbury Park station.

Participants in the focus groups generally saw walkable development as providing a convenient way to shop, a good form of exercise, a cost-effective transportation mode, and a way to stay in touch with the community. Participants had different opinions on whether TOD contributed to their everyday walking habits. In Collingswood, there was consensus among participants that they walk more because of the TOD. In Asbury Park, many participants said they "walk everywhere they can." In Rahway, high-gas prices and the mixed-use development contribute to the relative attractiveness of walking. In contrast, some participants in Morristown said TOD does not encourage them to walk more or less since they do not use the train regularly, but they enjoyed various aspects of their downtown, which is very walkable.

Participants were also asked about what economic impacts, such as new jobs or businesses, they have seen in their community as a result of TOD. Several general themes arose from these discussions. Participants were somewhat skeptical about the economic impact of ground level retail in TODs. Several participants observed that the commercial rentals lagged residential occupancy, by a considerable period. Additionally, discussion focused on whether TOD has thus far produced the mix of businesses that residents most need or want. Participants felt that economic development associated with TOD often takes the form of restaurants and bars, whereas they would prefer to see more local retail establishments selling basic or essential goods such as a bookstore, shoe store, or hardware store. A participant in Collingswood bemoaned the inability to purchase socks in the town. In Morristown and Rahway, participants felt that new retail associated with the TOD catered primarily to a commuter population, who may not have a stake in the community. Participants acknowledged however that this new commuter population increased demand for local services and provided a needed boost to the local economy. With the exception of Asbury Park where TOD has not yet played a major role in the city's redevelopment, participants generally felt TOD had an overall positive impact on the local economy.

This finding contrasts to some extent with the views expressed in our key informant interviews. While some of our interviewees saw the difficulty of attracting a diversified retail component that served practical everyday community needs, others saw a real benefit in making TODs destinations in their own right, via the arts and entertainment attractions that were successful in some communities.

Another potential benefit of TOD is that increased walking activity can improve public health. Participants in all four focus groups noted that walking is a valuable and enjoyable form of exercise, and TOD contributes to this by contributing to the walkability of their community. In Morristown, participants noted that the mixed land uses in and near a TOD help to ensure that there are many activities within walking distance, making this healthy mode of transportation attractive. Another Morristown participant noted that plenty of open space and a trail in the area around the train station contributed positively to having a healthy walking environment. In Collingswood, participants felt having the opportunity to walk for transportation contributed to the longevity and quality of their lives. Participants in Rahway and Asbury Park also felt that having a stimulating environment in which to walk contributed to their overall health. It is clear from these focus groups that those living near TODs clearly see improved pedestrian access to amenities as having a positive impact on the health of community members.

When evaluating any new developments in their communities, including TODs, residents are typically very concerned with the impact the development may have on the downtown environment. Changes to local traffic patterns and congestion are usually chief among these concerns. Comparing participant responses from the four focus groups suggests that residents are concerned about traffic and parking issues associated with TOD, but that this concern takes different forms depending on the local context. In Asbury Park, a shore town, new development helps to support the demand for public events, which contributes to traffic congestion and affects residents who find it difficult to park. In Rahway, where traffic is generally light, the participants did not feel the TOD had any appreciable impact on congestion. In Morristown, one participant thought that TODs had generated a great deal of congestion around the train station, but that perhaps nearby office developments and through traffic from other municipalities in Morris County had contributed more dramatically to growth in congestion. Collingswood focus group participants found that the renovations around the PATCO station had indeed caused more traffic, but that it did not negatively affect the quality of life because congestion is limited to peak hours.

These perceptions of traffic impacts inform participants' opinions about how TOD affects the safety of walking and cycling in station areas. At least one participant in each group felt unsafe walking at some time, either because of personal safety or unsafe crossings. In Rahway, where traffic volumes are light, participants felt generally safe as pedestrians. The discussions in Rahway highlighted chaotic pedestrian traffic around the train station at train arrival and departure times. Because there are few cars and many pedestrians, this was not perceived as a problem. The conversations in Morristown and Asbury Park suggested there are issues with pedestrian-vehicle conflicts as well as with absent or poorly maintained sidewalks in these communities. Six participants in Morristown said they had a "near miss" with a vehicle as a pedestrian or cyclist. In Collingswood, participants thought that since TOD generated more traffic, it inherently caused more conflicts; however, some of the participants felt the overall safety was improving as drivers become more conscious of pedestrians and of the new State law requiring motorists to come to a complete stop at marked crosswalks.

Interestingly, while our focus group participants highlighted pedestrian safety as a potential issue, this was not expressed in our key informant interviews. The latter were mainly concerned about congestion impacts, rather than impacts on pedestrian safety. This suggests a potential disconnect between the views of those developing and planning TODs and development around stations and those who live in the communities. It suggests better planning for pedestrian safety is an important issue. Problematic issues of pedestrian safety are also highlighted in our case studies, especially in how streets near station access points are often difficult for pedestrians to cross; Morristown in particular has difficult crossing points to access the train station, and Cranford's station also has a long crosswalk on one side of the station (see case studies in Appendix II).

Another major concern is the aesthetic impact of TOD on the community, which may either contribute to the character of a neighborhood or detract from it. These aesthetic outcomes greatly depend on the individual development and municipality. The clearest contrast between group responses was in Rahway and Morristown. In Rahway, which has been a traditionally working-class municipality and has struggled economically, participants felt the new construction and mixed uses have improved the look and feel of Rahway. Participants seem to be optimistic about the future of these developments, although some complained that the paucity of shops made the TOD feel sparse. In Morristown, which is more economically vibrant and has many areas of historic significance, four participants said that they did not like the one major TOD project, called the Highlands, and said that future efforts to promote TOD need to be better planned, more physically attractive, and better linked to a community vision. These four participants were very vocal in their dislike of the Highlands; other participants had nothing to say. This suggests that in order to maximize support from local residents, a TOD should be an attractive addition to the neighborhood in which it is located, especially where any new construction is likely to be viewed with skepticism. The scale of the development should match the local character of the town – this was particularly true in Morristown where 40 Park – a development similar to the Highlands, but located in an area that already had larger buildings – was not viewed negatively at all.

Participants were also asked to consider the impact of TOD on the local social environment, as walkability is associated with a vibrant street life and increased interactions between neighbors. Many of the participants in the four focus groups agreed that TOD creates more opportunities to meet neighbors and local shopkeepers, and to feel in touch with their community. In Collingswood, for example, participants spoke of recognizing their neighbors on the train platform, forming "healthy" relationships with local friends, and introducing themselves to local residents after repeatedly seeing them downtown. One participant says he even participates in potluck dinners that take place within a TOD. On a similar note, participants in Morristown indicated that having a walkable environment allows them to build relationships with neighbors and owners of local businesses. Some of these sentiments were echoed in Rahway, but in general, the participants there did not feel TOD had contributed to their personal social life.

Conclusions

Overall, participants in these four focus groups felt that the implementation of TOD plans in their communities have had a positive impact. In Morristown, Rahway, and Collingswood, increased walkability, improved access to transit, and more mixed-use facilities have made living in these communities more convenient and more pleasant. Even when participants did not use rail transit for commute trips, they perceived living within walking distance to transit to have a high option value and useful for non-work trips. In Asbury Park, which draws many tourists and is not as well connected by rail regionally, these effects appear to be somewhat more muted – although participants appreciated that when friends or family visited from out of town they could easily take the train to Asbury Park.

The participants in these focus groups were cautiously optimistic about TODs in their community. The question of whether there should be more TOD-type development elicited different responses between and within focus groups. Participants unanimously agreed there should be more TOD in Collingswood. In contrast, no participants in the Rahway focus group were in favor of building more TODs in town, likely because they do not perceive existing developments as being fully occupied by residents and retailers. Participants in the Morristown focus group were divided. Only one participant was in clear disagreement with the proposition there should be more TOD; another felt more TOD would contribute much-needed affordable housing in proximity to the train station; and others were in favor of more TOD, with the qualification that it should be better integrated into the community than the Highlands project. Because Asbury Park has not had any “true” TOD around its NJ TRANSIT station, this question was not posed directly, but participants in the focus group seemed to generally favor efforts to promote the use of transit. In addition, most participants perceive the new construction and businesses created by TOD as an economic benefit to the community.

All four focus groups indicated that the TODs in their community have drawn too many restaurants and bars and too few businesses that provide residents with opportunities to shop for clothing, food and other necessities. They would also like to see more “utility”-type commercial establishments, such as coffee shops, dry cleaners, shoe repair, and other convenient amenities around the train stations. These issues with the particular mix of retail uses in the community are likely related to the larger economic trend of local retailers being unable to compete with regional shopping centers and big box stores, which enjoy considerable backend and logistical efficiencies. In addition, these focus groups indicated that concerns about the traffic impacts of TODs may dissipate after the projects are completed and background growth in congestion is likely a more important issue to residents. Finally, in two of the focus groups, the TODs were seen as strongly contributing to social capital, increasing the quality and extent of social networks in the community.

Our interviews of planners and developers found a general agreement with these same views of how TOD can benefit a community. The main disconnect with residents was their view on the benefits of entertainment-related business establishments, which our key informants generally favored while recognizing that retail establishments were lacking. Developers, urban planners, and those close to the real estate development process understand the nuances of TOD, and showed it in interviews by describing the changing markets for retail in these areas. They pointed out a key disconnect: residents want consumer retail space, but do not shop at these types of places often enough to support them. Instead, wholesale retailers and Internet retailers are shifting the focus of retail to smaller "showroom"-type spaces, which allow customers to interact with products without the pressure of immediate purchase. This change is happening slowly, but it is having a profound impact on the quality and quantity of retail available in new urban spaces like TOD. Another disconnect was in their view of traffic congestion as a problem per se, as opposed to the impact it has on pedestrian safety and access, as expressed by community residents. Planners and developers recognized that station areas need to be walkable, but often do not understand how existing traffic flows impede pedestrian movements and detract from a walkable environment.

Case Studies

The research team conducted an analysis of three municipalities that have used a transit-centered model as the basis of their redevelopment strategy. Cranford in Union County, Morristown in Morris County, and Rahway in Union County have used TOD to address their unique challenges. The selection of these three locations allowed the examination of communities with differing socioeconomic conditions, development histories, and transit service as each is located on a different commuter rail line.

Each community was drawn to TOD for its own unique reasons. Cranford chose this form of redevelopment to improve derelict properties and to create housing for residents who wish to remain in the community once they no longer required single-family homes to meet their family needs. Having seen a number of redevelopment projects succeed near the Morristown Green, the town's core area, Morristown sought to extend this redevelopment effort to the not-too-distant station area where transit agency owned surface parking was repurposed as mixed-used housing, retail, and structured parking. Rahway has taken on perhaps the most ambitious TOD program of the three communities profiled – the renovation of its station, the redevelopment of considerable underperforming property within the station area, and the development of an arts-based economic development program. These three locations provide an excellent laboratory in which to explore the benefits that TOD can bring communities and their residents.

Situated on the Raritan Valley Line, Cranford is the quintessential railroad suburb with walkable streets and a Victorian-era clock that stands in the commercial downtown adjacent to the station. Comprised largely of single-family homes on small lots, Cranford turned to TOD to support its struggling downtown and to create an option for those priced out of existing housing – seniors who want to stay in the community and young adults who grew up there. In 2005 Cranford completed Cranford Crossing. A second mixed-use project, Riverview, is due for completion in summer 2013. While the former project has drawn most of its residents from the town's seniors, the second project is geared toward a younger population.

These projects replaced outdated properties, allowing the environmental cleanup of each site and their reuse in ways that satisfy community demands. The development of these projects required considerable planning, rezoning, and other work on the part of the community and investors. These efforts resulted in additions to Cranford's landscape allowed long-term residents to remain in the community and attracted younger residents who seek different forms of housing and a car-free or car-light existence. Additionally these projects have added to the retail mix in Cranford, allowing the community to sustain its downtown. Soon to be completed pedestrian improvements will further enhance the area, and allow safer waking conditions.

Figure 2. Cranford Crossing (raised tracks in background)

Perhaps best known as Washington's headquarters in 1776 and 1779, Morristown's long history spans from colonial times through its 19th and early 20th century industrial and commercial heyday and continues into the present when it has emerged as a regional center. The town green lies at its heart, surrounded by a mix of commercial, office and residential uses. Situated on the Morristown and Essex Line, the Morristown rail station stands about a quarter mile from the town green. The town views TOD as a way to maintain its viability and substantial redevelopment that has occurred both near the green and the station. One of the most interesting projects is the Highlands at Morristown Station, a joint development effort undertaken by NJ TRANSIT.

Morristown has seen a number of recent redevelopment projects, the majority of which, though within walking distance of the Morristown Station, are proximate to the Morristown Green. Redevelopment of surface parking adjacent to the station that resulted in the Highlands at Morristown Station has expanded improvements in the community's downtown housing stock and retail locations and has contributed to its financial well being. As evidenced by the Morristown focus group, development of the station area has been generally well received by residents, although some objected to the aesthetics of the Highlands and felt it was out of place for the character of the town. Further improvements are needed to adequately address the needs of pedestrians.

Figure 3. The Highlands at Morristown Station as seen from the platform

Located at the confluence of the Northeast Corridor and North Jersey Coast lines, Rahway sees TOD as a way to address the decline in local industry and to revive its moribund downtown. Since the late 1990s Rahway has undertaken an ambitious agenda of mixed-use redevelopment near its train station in an effort to bring new residents and businesses to its struggling core. Additionally Rahway has chosen to couple its TOD agenda with support for the arts.

Rahway pursued improvements to its station and surrounding properties that allowed the community to (1) rebuild its downtown, (2) increase income mix among residents by attracting more financially well-off residents interested in new housing and an easy rail commute to Newark and New York, and (3) draw visitors to its arts-focused businesses and attractions. The city is home to multiple projects within walking distance of the station. As evidenced by the focus group, residents are pleased with the redevelopment activity taking place in the community, as new projects often replace derelict properties. However residents would like to see more successful and practical retail to take hold in Rahway's station area. While not all of the redevelopment projects met with immediate success due in part to poor market timing and overambitious programs, the municipality and its residents – both old and new – have gained from these new additions to the Rahway landscape.[3] Revenues from redeveloped properties have placed the community in a more advantageous position as intensifying land uses at the city's core has provided increased tax revenues disproportionate to municipal costs.

[3] In one instance, the developer went bankrupt; some units were not completed and promised road improvements were not done. Another case involved a hotel and condo residential development, which ended up offered as rentals after the 2008 market crash; while the rentals are largely occupied, the retail component remains empty.

Figure 4. Carriage City Plaza as seen from the Rahway Station platform

While each of these three communities came to TOD for unique reasons, all have gained from the endeavor. Each has been able to add new population in landscapes that were essentially built-out. Each has expanded the type of housing stock available to residents, allowing some residents in each community to live car-free or car-light. Each has been able to convert underperforming properties into those that provide improved revenues to the community. All three have expanded the amount of retail space available within the community – though not all have had success in fully utilizing the new retail space.

The Cranford, Morristown, and Rahway case studies are available in Appendix II.

QUANTITATIVE ANALYSIS

Analytical work conducted focused on a variety of areas and methods. The intent was to examine a broad range of potential benefits (or costs) associated with more intense development around train stations. We maintain our focus on the eight transit stations for which we also collected primary data via a mail-back/internet survey protocol (the survey instrument is reproduced in Appendix I). Our analysis required both this primary data plus secondary data that are readily available. Our primary analysis uses our survey data to examine associations with self-reported health, measures of social capital, and travel behavior as measured by the frequency of using public transit, driving, and walking. We then discuss the analysis based on secondary data, which included an analysis of traffic safety around the eight TOD station areas and a hedonic analysis of the change in estimated property valuations. An additional analysis used NJ Transit onboard survey data to evaluate the user-benefits associated with living near the train stations. The final analysis used a regional travel model (NJRTM-E) and an economic costing model (ASSIST-ME) to evaluate regional impacts of a shift in population to be nearer the train station. Much of our evaluation focuses on differences between those living near and those further away from the transit station.

Survey Data Collection

Data was collected in the summer of 2012 using a combined online/printed survey of households residing in or near eight locations with rail transit. The sampling frame targeted 1000 randomly selected households in each site – stratified by distance from the station. These strata were for households located within a half-mile of the station (400 respondents or 40 percent of the sample), those residing in new or substantially renovated structures within a quarter mile of the station (up to 200 respondents or 20 percent of the sample), and those between a half-mile and two miles distant from the station. For Metuchen, Cranford, and Plainfield stations, there were fewer than 200 addresses for new housing. Metuchen had no new housing; Cranford had 66 residences and Plainfield 75. The balance of the sample for these locations was reallocated to the half-mile radius strata in each case.

The stations were selected in consultation with staff from New Jersey Transit, and represent a broad range of different demographic characteristics. Metuchen and Cranford are relatively affluent areas, while Plainfield, New Brunswick and Newark are relatively low income (see Table 3). Different transit lines were also selected. Most are commuter rail lines, but Newark Broad St. is served both by commuter rail and the Newark subway (a light rail line) and Essex St. in Jersey City is served by the Hudson-Bergen Light Rail line. Figure 5 displays the geographic location of the stations.

Table 3 – Demographics by municipality

Municipality	County	Station	Line	Station ridership (FY11)	Ridership on line	% of line	Total population	Population density (pop/sq mi)	Median HH income
Newark	Essex	Newark Broad St	Morris & Essex / Newark Light Rail	2,316	52,300	4.4%	274,674	11,356	$35,659
Jersey City	Hudson	Essex St	Hudson-Bergen Light Rail	1,152	41,000	2.8%	243,257	16,447	$54,280
Metuchen	Middlesex	Metuchen	Northeast Corridor	3,795	110,800	3.4%	13,431	4,859	$94,410
New Brunswick	Middlesex	New Brunswick	Northeast Corridor	4,879	110,800	4.4%	53,933	10,312	$44,543
Morristown	Morris	Morristown	Morris & Essex	1,846	52,300	3.5%	18,457	6,299	$64,279
Cranford	Union	Cranford	Raritan Valley	1,189	21,250	5.6%	22,414	4,641	$107,052
Plainfield	Union	Plainfield	Raritan Valley	897	21,250	4.2%	49,043	8,147	$52,056
Rahway	Union	Rahway	Northeast Corridor / North Jersey Coast Line	3,066	110,800	2.8%	26,968	6,915	$58,551

Sources: NJ TRANSIT, 2006-2010 ACS, 2010 Census

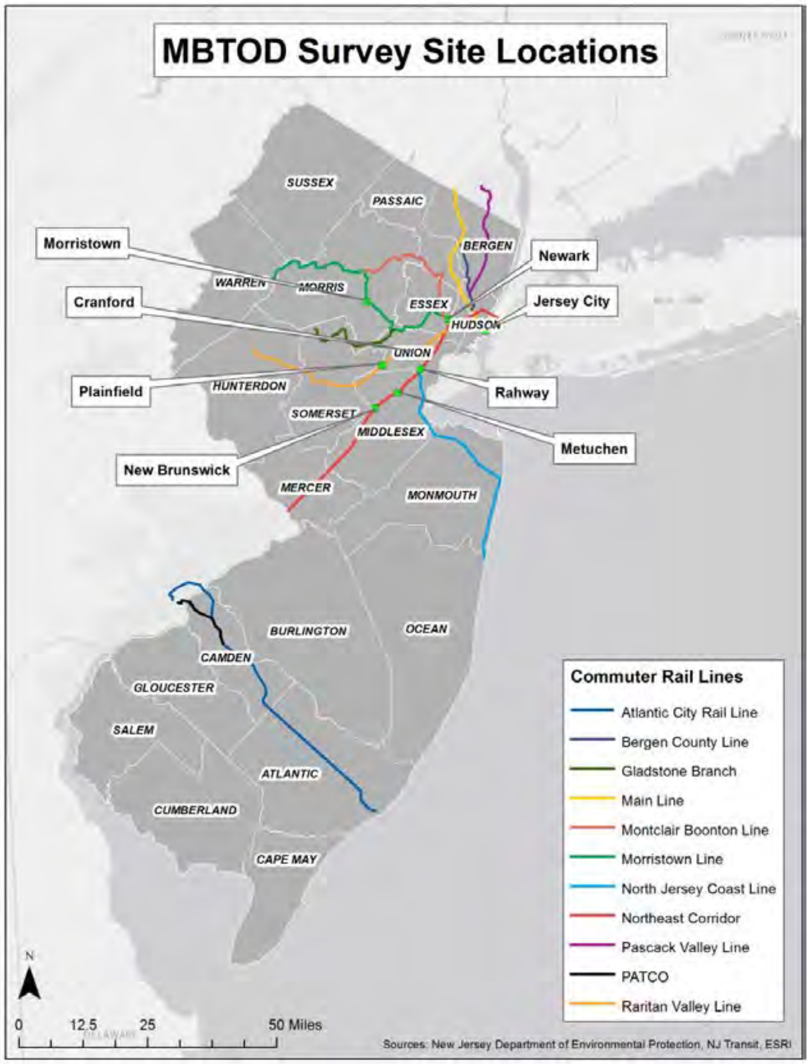

Figure 5. Map of station locations and NJ TRANSIT rail lines

Our survey protocol included an advance letter advising respondents that they will receive the survey, a survey invitation directing respondents to the online questionnaire, a three-day follow up post card, a three-week follow up letter, and a final follow up letter with a printed questionnaire.[68] All households received a $1 bill as incentive to encourage their participation. In an effort to increase response rates from underperforming station areas (specifically Newark Broad St and Plainfield), a portion of these households received an additional $1 bill incentive in the fifth and final mailing that also delivered the printed questionnaire. Overall, the response rate for the survey was 23.5% though the rate varied by community. The response rate from the poorer and urban communities in Newark and Plainfield were about 15%, while the rate from affluent suburban communities such as Metuchen and Cranford were respectively 35.2% and 29.3%. A total of 1629 responses were received from a mailing of 8000, but with 6938 valid addresses. There is no consistent pattern of response rate between the various strata that were sampled. Of those completed surveys received, 74.1%

completed the questionnaire online; online responses were less in lower income municipalities. The overall survey response statistics are shown in Table 4. Table 5 lists the stations as well as information on the response rates while Table 6 shows the response rate for mail and online versions.

Table 4 – Response overview (adjusted)

Measure	Statistic
Response Rate	23.5% *(1629/6938)*
Completes	1629
Completes by Mail	422 (25.9% of completes)
Completes by Web	1207 (74.1% of completes)
Adjusted Sample	6938
Initial Sample	8000
Refusals[4]	118
Vacant Addresses[5]	192
Bad Addresses[6]	47
Mail Retuned to Sender[7]	805
Deceased[8]	18

Note: These calculations take into account changes in the sample due to vacant addresses, bad addresses, deceased respondents, and mail returned to sender.

Table 5 – Response rate by station and strata

Station	Total Response		New Housing		Inside 1/2 Mile		Outside 1/2 Mile	
Cranford	29.3%	270/923	18.2%	10/55	32.1%	159/495	27.1%	101/373
Essex Street (Jersey City)	22.3%	189/846	18.2%	31/170	24.7%	86/348	22.0%	72/328
Metuchen	35.2%	326/925	N/A	N/A	39.6%	222/561	28.6%	104/364
Morristown	24.5%	217/887	21.2%	36/170	21.5%	73/339	28.6%	108/378
New Brunswick	20.1%	171/850	28.2%	46/163	13.7%	45/328	22.3%	80/359
(Broad Street) Newark	15.2%	117/772	23.2%	22/95	16.4%	56/341	11.6%	39/336
Plainfield	15.0%	128/851	20.6%	13/63	7.5%	32/429	23.1%	83/359
Rahway	23.9%	211/884	28.8%	45/156	21.1%	74/350	24.3%	92/378
Total	23.5%	1629/6938	23.3%	203/872	23.4%	747/3191	23.6%	679/1500

[4] This number combines the refusals that were received by phone and mail to BCSR and VTC.
[5] This designation refers to mail that was returned to BCSR marked either "Vacant" or "VAC."
[6] This designation refers to mail that was returned to BCSR marked either "Address Unknown" or "Insufficient Address."
[7] This designation refers to mail that was returned to BCSR marked either "Attempted Unknown" or "Unable to Forward."
[8] This number combines the deceased information by phone and mail to BCSR and VTC.

Table 6 – Completes by station and survey method

Station	Total	Web	Mail	% Web
Cranford	270	196	74	72.6%
Jersey City	189	162	27	85.7%
Metuchen	326	254	72	77.9%
Morristown	217	164	53	75.6%
New Brunswick	171	135	36	78.9%
Newark	117	72	45	61.5%
Plainfield	128	77	51	60.2%
Rahway	211	147	64	69.7%
Total	1629	1207	422	74.1%

Table 7 – Completes by strata and survey method

Strata	Total	Web	Mail	% Web
New Housing	203	171	32	84.2%
Inside ½ Mile	747	565	182	75.6%
Outside ½ Mile	679	471	208	69.4%
Total	1629	1207	422	74.1%

Table 8 – Refusals and vacant addresses

	Refusals	Vacant Addresses	Mail Returned to Sender	Bad Addresses	Deceased
Total	118	192	805	47	18
By Strata					
New Housing	9	53	208	8	0
Inside 1/2 Mile	55	74	364	25	5
Outside 1/2 Mile	54	65	233	14	13
By Station					
Cranford	24	15	52	3	7
Jersey City	6	12	129	13	0
Metuchen	25	19	47	3	6
Morristown	12	46	62	4	1
New Brunswick	15	28	116	5	1
Newark	6	12	208	7	1
Plainfield	15	22	118	9	0
Rahway	15	38	73	3	2

Travel Behavior Analysis

It is hypothesized that those who live closer to a train station are more likely to use public transit, walk for various activities, and use their cars less. These issues are analyzed using survey data collected for the eight TOD study areas and for a sample that includes those living in TODs that are within a quarter mile of the train station, those within a half-mile of the train station, and those up to two miles distant from the station. We approach this analysis in two ways. First we present simple cross-tabulations of variables that measure the frequency of travel by mode and the mode used for commuting. We also investigate what modes are used for various travel purposes. Cross-tabulations are presented based on how far each respondent lives from the train station. However, this analysis is not able to control for various other factors that may affect travel behavior, such as socioeconomics, vehicle ownership, and attitudinal factors.

Our main metric for examining travel behavior is self-reported information on how frequently respondents use various modes of travel. We also collected data on the primary mode of travel for their commute trip. These variables are examined in more detail using a structural equation model that controls for the many interactions associated with mode usage, including attitudes residents have about their neighborhood and how long they have lived there. These controls and interactions are meant to minimize self-selection bias, that is, those who want to use public transit or want to walk more will locate closer to the train station and more walkable environments.

Cross-tabulations

The key outcome variable of interest is the frequency that each respondent either drives, walks, or uses public transit. These are measured in the survey instrument based on whether the respondent reported using the mode of travel based on six ordered responses (“every workday,” “few times a week,” “once a week,” “once a month,” “few times a year,” or “never”). The distribution of these choices for the entire sample is shown in Figure 6.

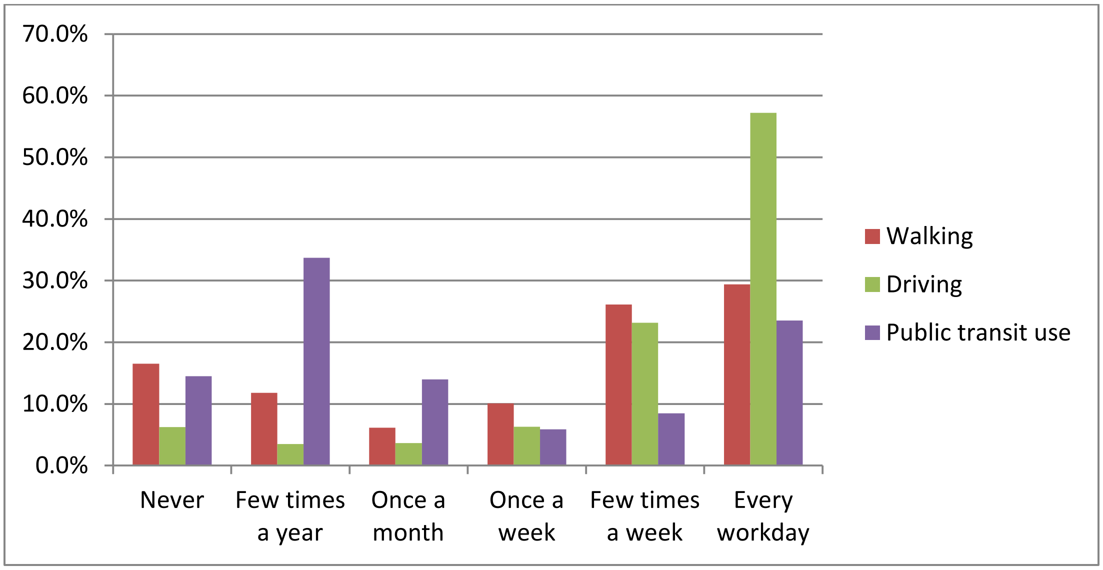

Figure 6. Frequency of mode usage

These relationships are also displayed in tabular format in Table 9. These also are broken down by how close each household is to the train station, by combining those who live in a TOD with those within a half mile of the station compared to those living beyond one-half-mile out to about two miles from the station.

Table 9 – Cross-tabulations of modal use frequency and distance from train station

	Walking Frequency			Public Transit Use Frequency			Driving Frequency		
Frequency	Lives in TOD or within ½ mi	½ to 2 mi	Total	Lives in TOD or within ½ mi	½ to 2 mi	Total	Lives in TOD or within ½ mi	½ to 2 mi	Total
Never to a few times a year	174	244	418	345	393	738	101	49	150
row %	41.6%	58.4%		46.7%	53.3%		67.3%	32.7%	
Once to a few times a week	334	201	535	155	65	220	297	157	454
row %	62.4%	37.6%		70.5%	29.5%		65.4%	34.6%	
Every workday	313	121	434	256	104	360	468	415	883
row %	72.1%	27.9%		71.1%	28.9%		53.0%	47.0%	
Total	866	612	1,478	901	631	1,532	900	643	1,543
row %	58.6%	41.4%		58.8%	41.2%		58.3%	41.7%	

These cross-tabulation results show two primary characteristics of the sample. First, most people drive quite frequently and at least several times a week, if not every workday. However, of those who never drive or only drive a few times a year, proportionally more live within a half-mile of the transit station. Second, a sizable fraction of the respondents are infrequent walkers; about 30 percent (418/1478) of the respondents either never walk or do so only a few times a year. More of the infrequent walkers live beyond one-half mile from the station. Those that report walking every workday are much more likely to live near the station than further away. Public transit use is more variable. About half of the respondents either never use public transit or do so only a few times a year. The fraction of those in this category is greater the further they live from the station. A sizable share of the sample uses public transit every workday and this share is greater for those living close to the station.

These mode use frequency questions were asked in the context of work trips, but were not specifically meant to reflect work trips only. This was partly due to how the question was placed within the survey questionnaire, immediately following a section with detailed questions about the work trip.

One additional question was asked about the frequency of walking. This was phrased as asking how often one walks outdoors for five minutes or more, and was asked within the context of various public health questions. It is apparent that this question was answered differently from the first question on walking frequency and clearly the placement of the question and the context resulted in a slightly different answer. The two variables are not highly correlated (R=0.226). Preliminary analysis of this variable suggests that results are quite different. While we use the general question on walking activity in our multivariate analysis, this second question is used in our evaluation of the physical activity benefits of TOD. Figure 7 shows the distribution for comparison with the previous result and suggests a bit more walking activity than revealed by the first question. Table 10 shows the distribution by distance to the train station for comparison; overall results are similar to the first question in that those living closer to the station walk more frequently.

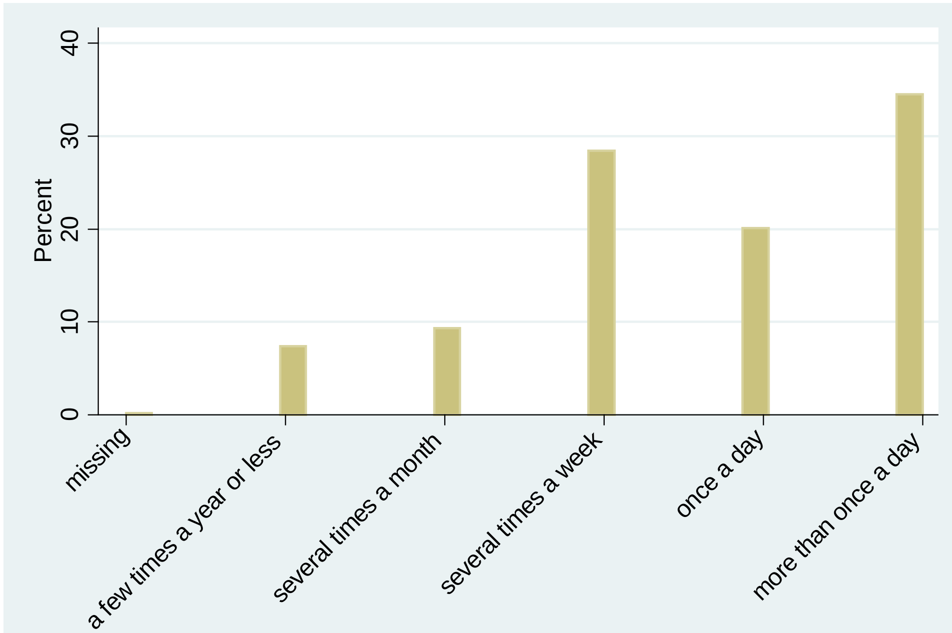

Figure 7. Frequency of walking outdoors
for five minutes or more

Table 10 – Frequency of walking outdoors
for five minutes or more

	Distance to Station		
Frequency	Lives in TOD or within ½ mi	½ to 2 mi	Total
Several times a month or less	140	120	260
row %	53.8%	46.2%	
Once a day or several times a week	424	329	753
row %	56.3%	43.7%	
More than once a day	336	199	535
row %	62.8%	37.2%	
Total	903	648	1,551
row %	58.2%	41.8%	

Additional evidence for the benefits of TOD is revealed in the choice of mode used for work trips. Table 11 provides strong evidence that those living within one-half mile of a train station are far more likely to use public transit for their commute trip than those living further out. They are also less likely to drive to work and, while the absolute values are small, twice as likely to walk to work than those living further from the station. The access mode for those that use public transit (see Table 12) is overwhelming by walking for those that live within one-half mile of the station, while those living further out either drive to the station (or bus stop), carpool, or are dropped off. Interestingly, those living further out are also more likely to bicycle to the station or bus stop, although the absolute numbers are small.

Table 11 – Usual mode of work commute in last week by distance from station

	Distance to Station		
Mode	Lives in TOD or within ½ mi	½ to 2 mi	Total
car or truck row %	373 54.6%	310 45.4%	683
public transit row %	243 71.5%	97 28.5%	340
walk row %	38 76.0%	12 24.0%	50
Total Row %	654 61.0%	419 39.0%	1073

Table 12 – Access mode for public transit

	Distance to Station		
Access Mode	Lives in TOD or within ½ mi	½ to 2 mi	Total
Never use the bus or train row %	74 40.2%	110 59.8%	184
Drive car, truck or van row %	63 19.7%	257 80.3%	320
Carpool or dropped off row %	24 24.5%	74 75.5%	98
Bicycle row %	4 33.3%	8 66.7%	12
Walk row %	747 79.8%	189 20.2%	936
Total row %	912 58.8%	638 41.2%	1,550

Table 13 and Table 14 display additional information on how those living close to the station versus those living further away travel. Table 13 provides a breakdown of trips taken to restaurants or coffee shops, which are a major component of some station area developments. Questions were asked based on the starting point for each trip and the most recent trip of this type respondents had taken. Trips starting from home are mainly made with a car, truck, or van (63.6%), but the proportion is larger for those who live more distant (79.8% vs. 52.3%). Not many are made using public transit and those living near the station make far more walk trips to restaurants or coffee shops (42.1% vs. 15.3%). For those trips starting at a workplace, again most are made by driving (51.8%), with less of a difference in share based on where people live (46.5% close to the station vs. 60.0% further afield). Those living closer to the station make more walking trips from their work location (42.4% vs. 28.4%). For those trips that originated at the transit station or stop most were made on foot (60.4%) and again those living closer to the station made more walking trips (68.1% vs. 47.0%).

Table 13 – Cross-tabulation of journey modes to a restaurant or coffee shop

	Origin of trip: home			Origin of trip: workplace			Origin of trip: from transit station or stop		
Mode	Lives in TOD or within ¼ mi	¼ to 2 mi	Total	Lives in TOD or within ¼ mi	¼ to 2 mi	Total	Lives in TOD or within ¼ mi	¼ to 2 mi	Total
Counts									
By car, truck, or van	461	491	952	327	273	600	77	96	173
By public transit	40	19	59	34	12	46	41	18	59
Walked	371	94	465	298	129	427	355	143	498
Other	10	11	21	44	41	85	48	47	95
Total	882	615	1,497	703	455	1,158	521	304	825
Column Percents									
By car, truck, or van	52.3%	79.8%	63.6%	46.5%	60.0%	51.8%	14.8%	31.6%	21.0%
By public transit	4.5%	3.1%	3.9%	4.8%	2.6%	4.0%	7.9%	5.9%	7.2%
Walked	42.1%	15.3%	31.1%	42.4%	28.4%	36.9%	68.1%	47.0%	60.4%
Other	1.1%	1.8%	1.4%	6.3%	9.0%	7.3%	9.2%	15.5%	11.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Row Percents									
By car, truck, or van	48.4%	51.6%	100.0%	54.5%	45.5%	100.0%	44.5%	55.5%	100.0%
By public transit	67.8%	32.2%	100.0%	73.9%	26.1%	100.0%	69.5%	30.5%	100.0%
Walked	79.8%	20.2%	100.0%	69.8%	30.2%	100.0%	71.3%	28.7%	100.0%
Other	47.6%	52.4%	100.0%	51.8%	48.2%	100.0%	50.5%	49.5%	100.0%
Total	58.9%	41.1%	100.0%	60.7%	39.3%	100.0%	63.2%	36.8%	100.0%

Note: Most “other” modes were marked as a trip that respondents did not make. A small fraction indicated taxi as their mode.

Results for trips to grocery or food stores are shown in Table 14. Grocery trips are a common activity and also involve carrying items, making them less attractive for transit or as walking trips. Results reflect this as 84.4 percent of trips from home are by driving and even those living close to the station make 81.8 percent of these trips by driving.

For those making grocery shopping trips from their workplace or upon leaving a transit station or stop, there is more walking activity and over twice as many of these trips are made by walking for those living near the train station. Transit trips are minor for grocery shopping, regardless of trip origin.

Table 14 – Cross-tabulation of journey modes to buy food or groceries

Counts

	Origin of trip: home			Origin of trip: workplace			Origin of trip: from transit station or stop		
	Lives in TOD or within ¼ mi	¼ to 2 MI	Total	Lives in TOD or within ¼ mi	¼ to 2 MI	Total	Lives in TOD or within ¼ mi	¼ to 2 MI	Total
By car, truck, or van	718	556	1,274	362	281	643	94	90	184
By public transit	21	12	33	22	4	26	13	4	17
Walked	122	55	177	108	56	164	136	43	179
Other	17	8	25	50	40	90	63	59	122
Total	878	631	1,509	542	381	923	306	196	502

Column Percents

	Origin of trip: home			Origin of trip: workplace			Origin of trip: from transit station or stop		
	Lives in TOD or within ¼ mi	¼ to 2 MI	Total	Lives in TOD or within ¼ mi	¼ to 2 MI	Total	Lives in TOD or within ¼ mi	¼ to 2 MI	Total
By car, truck, or van	81.8%	88.1%	84.4%	66.8%	73.8%	69.7%	30.7%	45.9%	36.7%
By public transit	2.4%	1.9%	2.2%	4.1%	1.0%	2.8%	4.2%	2.0%	3.4%
Walked	13.9%	8.7%	11.7%	19.9%	14.7%	17.8%	44.4%	21.9%	35.7%
Other	1.9%	1.3%	1.7%	9.2%	10.5%	9.8%	20.6%	30.1%	24.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Row Percents

	Origin of trip: home			Origin of trip: workplace			Origin of trip: from transit station or stop		
	Lives in TOD or within ¼ mi	¼ to 2 MI	Total	Lives in TOD or within ¼ mi	¼ to 2 MI	Total	Lives in TOD or within ¼ mi	¼ to 2 MI	Total
By car, truck, or van	56.4%	43.6%	100.0%	56.3%	43.7%	100.0%	51.1%	48.9%	100.0%
By public transit	63.6%	36.4%	100.0%	84.6%	15.4%	100.0%	76.5%	23.5%	100.0%
Walked	68.9%	31.1%	100.0%	65.9%	34.1%	100.0%	76.0%	24.0%	100.0%
Other	68.0%	32.0%	100.0%	55.6%	44.4%	100.0%	51.6%	48.4%	100.0%
Total	58.2%	41.8%	100.0%	58.7%	41.3%	100.0%	61.0%	39.0%	100.0%

Note: Most "other" modes were marked as a trip that respondents did not make. A small fraction indicated taxi as their mode.

These cross-tabulation results provide strong evidence that those living near a train station that has TOD development are more likely to walk and use public transit while being less likely to drive than those living further away. This holds for the frequency of their use of each mode and for different trip purposes. A major limitation of any cross-tabulation analysis is that it does not control for other factors that may influence travel behavior. These other factors include attitudes toward various modes of travel, socioeconomic status, household living arrangements, and details on the built environment, among others. These can be controlled for using a more complex multivariate statistical analysis.

Theoretical and Methodological Framework for Multivariate Analysis

One of the key research challenges in evaluating travel choices of those who live in and near TODs is the problem of “self-selection bias.” That is, those people who live in or near TODs live there because they prefer to use transit or prefer to walk more, compared to those who are not residents. Most analyses cannot claim to completely control for this, however, one technique that has been used is to examine the attitudes of residents as well as the length of time they have lived in their current location.[69]

Our multivariate analysis extends this line of reasoning by including a control for how long residents have lived in their current home. Our hypothesis is that those who have lived in a location for a shorter period of time will be more likely to have selected their neighborhood because of the travel choices available. Therefore, those living at a location for a shorter period of time may be more likely to use transit and to walk, all else equal. This is moderated by how the length of time one has lived in a location is affected by attitudes; that is, the various attitudes each respondent has toward their neighborhood and modal choices may also affect how long they live in a neighborhood.

The built environment around TOD and station areas is a key metric that can affect travel behavior. Two proxies often used are population density and employment density. Road network variables, such as street and intersection density are also often used in models of travel behavior; intersection data was not available for our analysis. Vehicle ownership has also been found to affect walking behavior. This can also be influenced by the built environment; denser areas tend to result in more difficult driving conditions and more expensive parking, making vehicle ownership less desirable.

Given these intricate relationships, we specify what is known as a path or structural equation model (SEM). This allows for simultaneous modeling of the many factors that influence the use of each mode of travel. Our key dependent variable is the reported frequency with which each respondent drives, uses public transit, or walks (see Figure 6 and Table 9. Figure 8 displays these relationships graphically).

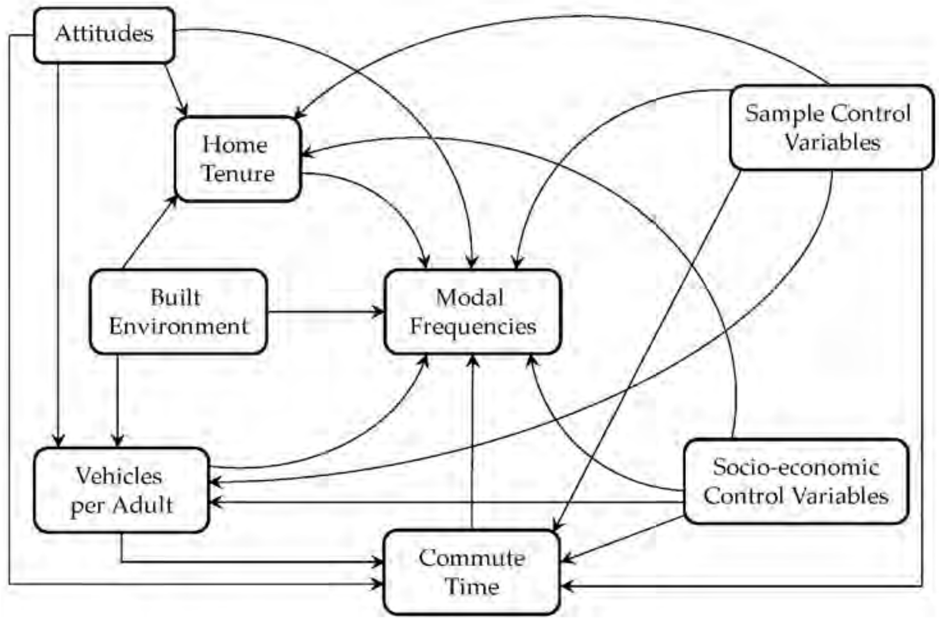

Figure 8. Framework of structural equation model
of frequency of modal usage

The modal frequencies in Figure 8 are measured by our questions on frequency of using each mode of travel (car, public transit, and walking). These are our key dependent variables and each is cross-correlated with the other, which is controlled for in our SEM analysis. These variables are also ordered, that is, they are not continuous variables; our analysis also controls for this. As these are ordered variables this also prevents us from specifying these as endogenous variables, as ordered variables cannot be included as independent variables.

Key control variables include socioeconomic variables (income and average age of those in the household). Other socioeconomic variables were tested, including the presence of children and whether the household owns a dog, but were not found to be important factors. Since the sampling strategy was stratified, we also include categorical variables for each TOD area and for where the respondent lives relative to the station (in a TOD or within a half-mile relative to further out).

We include one additional variable, which is the total commute time reported by each respondent. The choice of commute mode is partly determined by how long the commute is. While our modal frequencies are not specifically linked to commuting behavior, we restrict the analysis to those who are commuters. The time devoted to a daily commute can affect the use of other modes, for example, one can imagine a commuter who drives a long distance not walking or using public transit as frequently.

Four additional measures are controlled for using more complex interactions. These are attitudes, home tenure (i.e., how long the respondent has lived in their current home), population and employment density and local street density (proxies for the built environment), and vehicle ownership. Attitudes are a major factor affecting the use of each mode, but also play an indirect effect by how attitudes can influence the choice of where a person lives and their vehicle ownership. Our model thus links attitudes to home tenure and vehicle ownership. The built environment is also linked to how long respondents live in their home, and their vehicle ownership. It is assumed that more walkable built environments presumably lead to longer home ownership (perhaps reflecting higher satisfaction with where they live) and reduced vehicle ownership, thus indirectly affecting the frequency of using each mode of travel.

Measurement of Attitudinal Variables

Respondent attitudes toward where they live and their travel choices can influence the choice of residential location and the number of vehicles a household owns. Both are key intervening factors that influence travel choices. We would expect those who have lived in or near a TOD for a shorter period of time to be choosing their residential location partly because of their attitude toward their neighborhood and toward the travel choices available. Thus attitudes help to influence the length of time a household stays in one location, and thus directly and indirectly affects travel choices. Vehicle ownership also has an influence on the frequency of driving and use of other modes. Attitudes were measured in our survey using the questions shown in Figure 9 and Figure 10.

People's reasons for selecting a new neighborhood to live in may be different from their reasons for choosing a particular house or apartment. *Please rate each of these factors that may have attracted you to this NEIGHBORHOOD.*
[Check one for each]

	Very Important	Somewhat Important	Neither Important or Unimportant	Somewhat Unimportant	Not Important
a. Close to friends or relatives	●	●	●	●	●
b. Close to job	●	●	●	●	●
c. Close to train station or bus stop	●	●	●	●	●
d. Access to major roads or highways	●	●	●	●	●
e. Little or no traffic	●	●	●	●	●
f. Easy to park car	●	●	●	●	●
g. Good variety of shops and services	●	●	●	●	●
h. Low crime rate	●	●	●	●	●
i. Good schools	●	●	●	●	●
j. Can easily walk in my neighborhood	●	●	●	●	●
k. Close to parks or other open space	●	●	●	●	●
l. Other:	●	●	●	●	●

Figure 9. Attitudinal questions asked in survey

Please tell us how much you agree or disagree with the following statements. *[Check one for each]*					
	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
a. My neighborhood is a good place to live.	●	●	●	●	●
b. Living in my neighborhood gives me a sense of community.	●	●	●	●	●
c. I know my neighbors.	●	●	●	●	●
d. At night I feel safe walking by myself in my neighborhood.	●	●	●	●	●
e. Traffic makes it unsafe for me to walk in my neighborhood.	●	●	●	●	●
f. My neighborhood is a good place to raise children.	●	●	●	●	●
g. Most people in my neighborhood can be trusted.	●	●	●	●	●
h. My neighborhood is noisy.	●	●	●	●	●

Figure 10. Additional attitudinal questions asked in survey

In order to use this information in our analysis we used an approach known as factor analysis to simplify the attitudinal variables. This is an approach that examines the correlation structure between each of the 19 questions that we asked and provides a method to transform the 19 factors into a simpler structure. The first step in doing this is to examine the change in the value of the eigenvalue for each factor. Figure 11 shows a screeplot that suggests that five factors are sufficient to account for most of the variation in the 19 factors analyzed. Thus our factor analysis is restricted to five factors. Results are shown in Table 15 after an orthogonal rotation to make interpretation easier. Higher scores (whether positive or negative) have a high loading on that factor and indicate that the factor represents a certain subset of questions; these are highlighted in blue in the table. Loadings that are very low are highlighted in pink and have no effect on that factor.

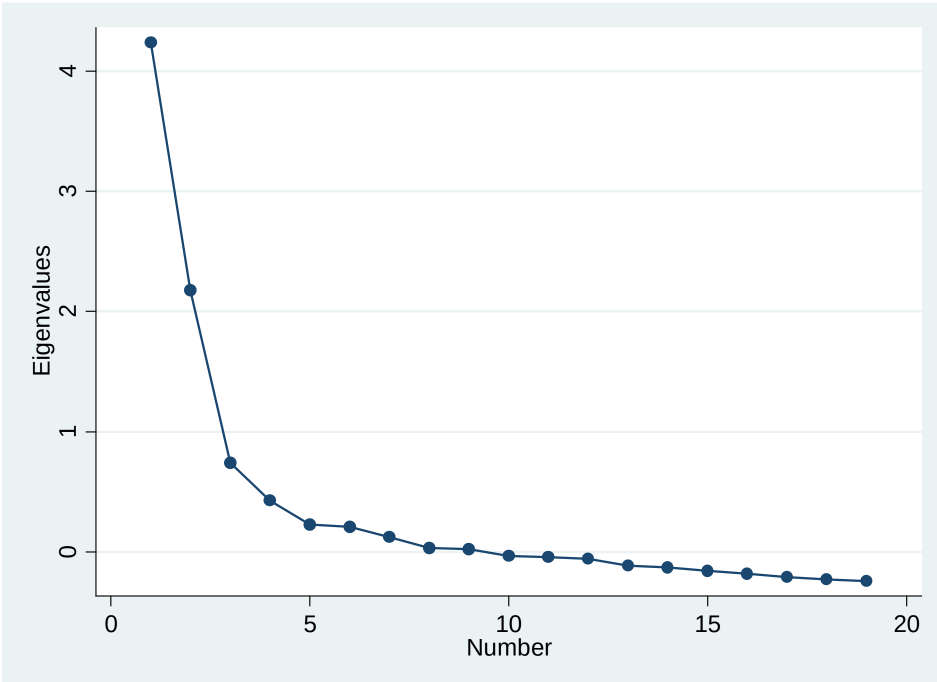

Figure 11. Screeplot of factor eigenvalues

Table 15 – Rotated factor scores

Variable Corresponding to Questions Listed Above	Factor 1: Positive Sense of Community	Factor 2: Ability to Easily Access Activities	Factor 3: Child Friendly Neighbor hood	Factor 4: Enjoys Driving	Factor 5: Distressed Community	Uniqueness
Close to friends or relatives	0.0673	0.104	0.2363	0.2692	0.1868	0.8214
Close to job	-0.0542	0.3186	0.0636	0.1632	0.0615	0.8611
Close to train station or bus stop	-0.0358	0.4415	-0.1084	0.0489	0.0155	0.7894
Access to major roads or highways	0.0402	0.2785	0.1566	0.5023	0.0013	0.644
Little or no traffic	0.0542	0.2153	0.4475	0.3227	-0.0196	0.646
Easy to park car	-0.0023	0.249	0.2349	0.5571	-0.015	0.5722
Good variety of shops and services	0.1507	0.5487	0.0859	0.2652	0.0632	0.5945
Low crime rate	0.1845	0.3813	0.4133	0.1963	-0.1132	0.5984
Good schools	0.2478	0.0445	0.5751	0.1646	0.0955	0.5696
Can easily walk in my neighborhood	0.1738	0.5371	0.1122	0.1598	-0.0271	0.6425
Close to parks or other open space	0.1662	0.4218	0.3199	0.213	0.0932	0.6381
My neighborhood is a good place to live	0.7938	0.1635	-0.1001	0.0277	-0.1034	0.3217
Living in my neighborhood gives me a sense of community	0.7226	0.0709	0.1256	0.1269	0.2599	0.3735
I know my neighbors	0.5553	-0.095	0.283	0.0957	0.3066	0.4993
At night I feel safe walking by myself in my neighborhood	0.7231	0.1002	-0.0781	-0.0775	-0.0815	0.4483
Traffic makes it unsafe for me to walk in my neighborhood	-0.2244	0.1031	0.1045	-0.1352	0.3131	0.8118
My neighborhood is a good place to raise children	0.8024	-0.0153	0.2177	-0.0081	-0.0694	0.3036
Most people in my neighborhood can be trusted	0.7823	0.0122	0.0822	0.0326	0.0129	0.3799
My neighborhood is noisy	-0.4526	0.1174	-0.0859	-0.1035	0.297	0.6751

Note: Blue shaded cells represent high loadings, pink shaded cells represent low loadings

By evaluating the loadings we can interpret the attitudes represented by each factor. Factor 1 tends to have high loadings on the questions associated with community in the neighborhood. For example, “my neighborhood is a good place to live” and “I know my neighbors”. Thus, we interpret factor 1 as representing a positive sense of community.

Factor 2 has high loadings on those questions associated with accessing activities. For example, “close to train or bus stop” and “good variety of shops and services”. Therefore we interpret this as representing a positive attitude associated with having easy access to various activities.

Factor 3 is interpreted as representing a child friendly neighborhood. High loadings occur on “good schools” and “little or no traffic”. Positive attitudes toward these attributes and the others shown in Table 15 suggest the neighborhood is viewed as child friendly.

The fourth factor has positive loadings on questions that suggest that being able to easily use a car in the neighborhood is perceived as a positive feature. Questions such as “easy to park car” and “access to major roads or highways” have the highest loadings. We define this factor as “enjoys driving”.

The final factor has relatively low loadings so is a bit more difficult to interpret. While various questions indicating that respondents feel a sense of community are high, such as “living in my neighborhood gives me a sense of community”, others that load high suggest the community has some undesirable features, such as traffic making it unsafe to walk and the neighborhood being noisy. Thus, we define this factor as a “distressed community”, that is, there are positive feelings about the neighborhood, but recognizable problems.

In all cases these interpretations are subjective and results should be interpreted with that in mind. These are used as independent variables in the multivariate model described next.

Structural Equation Model Results

Results for our structural equation model are shown in Table 16, Table 17, Table 18, Table 20, Table 21, and Table 22. These models are linked together as shown in Figure 8. These tables show the six linked models, each presented separately for simplicity. Table 23 shows relevant test statistics; these indicate a good fit to the model. The chi-square statistic should not be significant, our value has a p=0.484 which is not statistically significant. The Tucker-Lewis Index should be above about 0.95 and the model shows a value of 1.004. The RMSEA statistic is 0.000 and excellent fit is suggested at values of 0.01 or less. The number of observations is 779 reflecting a loss of some respondents due to missing data.

To investigate whether this loss of respondent data potentially affects the results, we show the mean and standard deviation of each variable for both the full sample and the analysis sample in Table 24. Those records with more missing values are respondents from the Newark Broad St. and Plainfield sub-samples, both relatively lower income areas. More missing records are from lower income respondents. On the other hand, we lose fewer respondents from those who live in TODs and those living between one-half mile and two miles have more missing variables. We also have somewhat shorter home tenures in the analysis sample, consistent with the fact that proportionately fewer TOD residents are dropped from the sample. The analysis sample also has slightly younger average household ages and respondents are more likely to be frequent public transit users. Given the richness of the controls in our data, we do not expect these omissions to affect our analysis; however, we recognize that we mainly lose more of our lower income respondents.

Turning to the specific results, Table 16 displays variables that are associated with the length of time the respondent has lived in their home. Some 20 percent of the sample has lived in their current home for three years or less, the mean is about 13 years, while the median is 8 years. A histogram is shown in Figure 12. Those who live in a TOD development have lived in their current home for the shortest amount of time, according to the model results; they are also younger households as shown by the coefficient on average age of the household. This is not surprising as the TODs in our sample were relatively new. This effect is relative to those living both near the station, but not in a TOD and those further out. The average age of the household is also highly correlated with the length of time living at the current residence.

Table 16 – Structural equation model results – length of home tenure

Dependent variable: Home tenure	coef.	z-stat
Factor 1: Sense of community	0.087	2.19
Factor 2: Easy access	0.015	0.38
Factor 3: Child friendly	-0.263	-5.50
Factor 4: Enjoys driving	0.065	1.32
Factor 5: Distressed community	-0.072	-1.28
Population density	-0.006	-0.10
Employment density	-0.014	-0.69
Local street density (within ½ mile radius)	0.125	1.26
Average age of adults in HH	1.684	13.93
Cranford dummy	0.107	0.91
Jersey City dummy	-0.152	-0.85
Metuchen dummy	0.084	0.69
Morristown dummy	-0.057	-0.43
New Brunswick dummy	0.014	0.11
Newark dummy	-0.101	-0.58
Plainfield dummy	0.127	0.86
Lives in a TOD	-0.414	-3.38
Lives within half-mile of station	-0.036	-0.52
Constant	-4.538	-6.73

Note: All continuous variables are logarithms except factor scores. Station area dummy variables are relative to Rahway. Distance from station dummy variables relative to those living from ¼ to 2 miles away. Income dummies are relative to households earning less than $25,000/year.

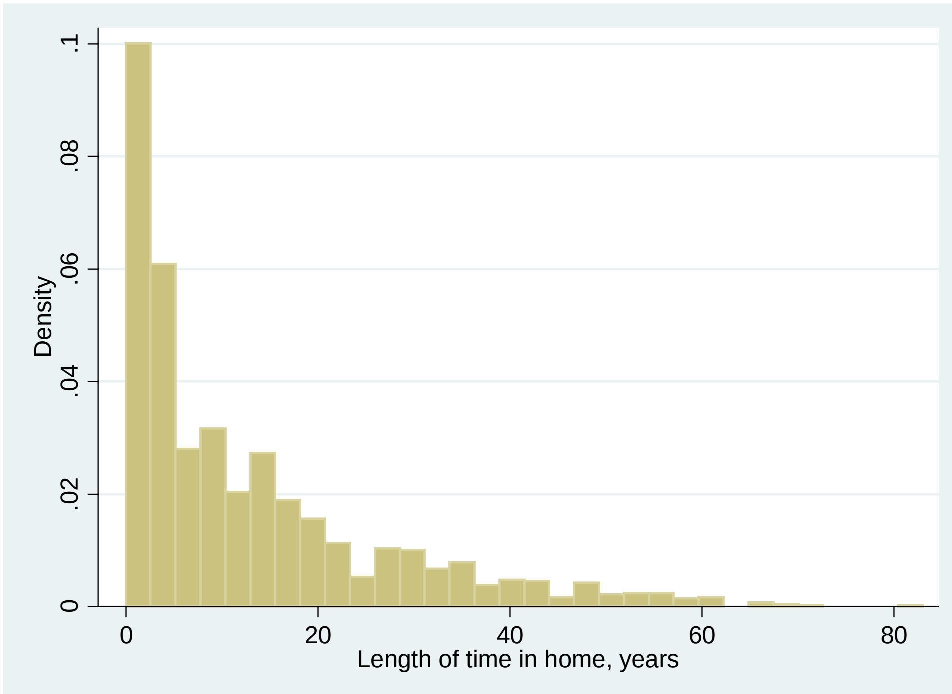

Figure 12. Histogram of home tenure

Of more interest, two of the attitudinal factors are statistically significant. Those who have good attitudes about the sense of community in their neighborhood have lived in their current home for a longer period of time. This makes sense as we would expect those who move away to perhaps have moved because of dissatisfaction with their neighborhood. The other statistically significant attitudinal factor is those who have positive attitudes about child friendly communities have lived there for a shorter period of time. This is somewhat surprising but may reflect transitory patterns of moving to neighborhoods with good schools while one has children in school.

Other variables are not statistically significant at normal confidence levels. We see a positive effect associated with local street density (normally associated with more walkable areas), but it is not statistically significant. Other built environment variables, population and employment density, show no measurable effect.

The commute time model is shown in Table 17. Those living in TODs do not have longer commutes than those living further out. Those living within a half-mile of the station have slightly longer commutes than both other groups, but the statistical significance of this effect is low. Higher income households (above $150,000) tend to have longer commutes. Of the attitudinal factors, those who feel their neighborhood is child friendly tend to have longer commutes; this may represent decisions to live in communities with child friendly amenities at the cost of a longer commute trip. Those who feel their community is distressed tend to have shorter commutes, although this is at a low level of statistical significance.

Table 17 – Structural equation model results – commute time

Dependent variable: Commute time	coef.	z-stat
Vehicles per adult	-0.019	-0.19
Factor 1: Sense of community	-0.032	-0.75
Factor 2: Easy access	0.009	0.25
Factor 3: Child friendly	0.106	2.04
Factor 4: Enjoys driving	-0.006	-0.11
Factor 5: Distressed community	-0.099	-1.58
Cranford dummy	-0.124	-0.95
Jersey City dummy	0.106	0.55
Metuchen dummy	0.095	0.72
Morristown dummy	-0.395	-2.66
New Brunswick dummy	-0.198	-1.56
Newark dummy	0.014	0.07
Plainfield dummy	-0.066	-0.42
Lives in a TOD	0.108	0.94
Lives within half-mile of station	0.121	1.52
Average age of adults in HH	-0.138	-1.13
Income 25-75K	0.019	0.16
Income 75-150K	0.130	1.18
Income over 150K	0.457	3.75
Constant	4.028	5.38

Note: All continuous variables are logarithms except factor scores. Station area dummy variables are relative to Rahway. Distance from station dummy variables relative to those living from ¼ to 2 miles away. Income dummies are relative to households earning less than $25,000/year.

Vehicle ownership is often determined by the built environment and the availability of good transit options. Our vehicle ownership submodel is shown in Table 18. Those who live close to the station tend to have fewer vehicles per household, however, those who live in TODs have as many vehicles as those living further afield. While we can only speculate, this may be because new TODs are built with ample parking availability, while those living within half-mile of the station are more constrained in the amount of space available for parking. Table 19 confirms that those in TODs have ample parking, either surface lots or enclosed structures. Those within half-mile and further out generally park in their garage or carport, their driveway or on-street. Surprisingly there is no substantive difference in on-street parking locations between these groups. The time devoted to parking is much less for those who do not live in TODs.

Table 18 – Structural equation model results – vehicles per adult in household

Dependent variable: Vehicles per adult in household	coef.	z-stat
Factor 1: Sense of community	0.019	1.82
Factor 2: Easy access	-0.001	-0.08
Factor 3: Child friendly	-0.051	-4.10
Factor 4: Enjoys driving	-0.047	-3.66
Factor 5: Distressed community	0.117	7.19
Population density	0.000	-0.03
Employment density	0.003	0.55
Local street density (within ½ mile radius)	0.005	0.15
Cranford dummy	0.061	1.75
Jersey City dummy	-0.171	-3.94
Metuchen dummy	0.025	0.77
Morristown dummy	0.056	1.40
New Brunswick dummy	-0.011	-0.31
Newark dummy	-0.123	-3.17
Plainfield dummy	-0.086	-2.24
Lives in a TOD	-0.016	-0.53
Lives within half-mile of station	-0.055	-2.49
Average age of adults in HH	0.063	1.88
Income 25-75K	0.015	0.50
Income 75-150K	0.068	2.18
Income over 150K	0.082	2.48
Constant	0.313	1.75

Note: All continuous variables are logarithms except factor scores. Station area dummy variables are relative to Rahway. Distance from station dummy variables relative to those living from ¼ mile to 2 miles away. Income dummies are relative to households earning less than $25,000/year.

Table 19 – Parking locations and times by distance from station

Parking locations	In TOD	Within ½ mi	Beyond ½ mi
Don't own a vehicle	12.7%	9.3%	7.6%
Home garage or carport	10.2%	20.6%	21.6%
Driveway	1.5%	35.1%	42.3%
On-street	2.0%	13.2%	14.3%
Surface parking lot	14.7%	12.7%	9.3%
Enclosed parking structure	58.4%	7.7%	4.0%
Data corrupt	0.5%	1.3%	0.9%
Time needed for parking			
Less than a minute	51.7%	78.3%	84.0%
1 to 5 minutes	41.5%	16.3%	11.6%
5 to 10 minutes	6.3%	4.5%	2.3%
More than 10 minutes	0.6%	0.9%	2.1%

Higher income households also own more cars than lower income households. The built environment variables have no impact on vehicle ownership. Attitudinal factors are associated with vehicle ownership, the one exception being those that value easy access, which had no statistically significant effect. Sense of community and distressed community factors both had positive associations, while factors for child friendly community and enjoys driving had negative associations. There is no intuitive pattern associated with these effects, but we include them as controls in the vehicle ownership submodel.

Our main interest is in how the three variables used to measure travel behavior, namely the frequency of driving, walking, and public transit use are associated with both proximity to the station and other controls. These results are shown in Table 20 (for walking frequency), Table 21 (for driving frequency), and Table 22 (for public transit use frequency). Each table shows both direct effects and total effects. The latter include indirect effects associated with the effects estimated by our three submodels (for home tenure, commute time, and vehicle ownership) that also affect total frequency of using each mode.

Table 20 – Structural equation model results – walking frequency

Dependent variable: Walking frequency	coef.	z-stat	Total Effects	z-stat
Home tenure	-0.092	-1.93	-0.092	-1.93
Commute time	0.078	1.93	0.078	1.93
Vehicles per adult	-0.643	-3.99	-0.643	-3.99
Factor 1: Sense of community	-0.066	-1.21	-0.089	-1.61
Factor 2: Easy access	-0.105	-2.05	-0.105	-2.04
Factor 3: Child friendly	0.274	4.08	0.339	5.17
Factor 4: Enjoys driving	0.319	4.31	0.342	4.66
Factor 5: Distressed community	-0.089	-1.14	-0.165	-2.16
Cranford dummy	0.196	1.22	0.138	0.85
Jersey City dummy	0.742	3.31	0.874	3.88
Metuchen dummy	0.392	2.47	0.375	2.35
Morristown dummy	0.676	3.64	0.614	3.26
New Brunswick dummy	0.149	0.84	0.140	0.79
Newark dummy	-0.043	-0.20	0.047	0.21
Plainfield dummy	0.256	1.42	0.295	1.60
Lives in a TOD	0.415	2.70	0.472	3.12
Lives within half-mile of station	0.518	5.18	0.566	5.68
Population density	0.055	0.75	0.056	0.74
Employment density	-0.048	-1.72	-0.049	-1.73
Local street density (within ½ mile radius)	0.268	2.04	0.254	1.92
Average age of adults in HH	-0.215	-1.20	-0.420	-2.64
Income 25-75K	0.004	0.02	-0.004	-0.03
Income 75-150K	0.026	0.18	-0.007	-0.05
Income over 150K	0.085	0.55	0.068	0.44
Walking frequency - cut 1	-0.619	-0.66		
Walking frequency - cut 2	-0.184	-0.20		
Walking frequency - cut 3	0.035	0.04		
Walking frequency - cut 4	0.717	0.79		
Walking frequency - cut 5	-0.042	-0.05		

Note: All continuous variables are logarithms except factor scores. Station area dummy variables are relative to Rahway. Distance from station dummy variables relative to those living from ¼ mile to 2 miles away. Income dummies are relative to households earning less than $25,000/year.

Table 21 – Structural equation model results – driving frequency

Dependent variable: Driving frequency	coef.	z-stat	Total Effects	z-stat
Home tenure	-0.031	-0.58	-0.031	-0.58
Commute time	-0.349	-10.29	-0.349	-10.29
Vehicles per adult	1.032	6.50	1.032	6.50
Factor 1: Sense of community	0.043	0.74	0.071	1.16
Factor 2: Easy access	0.114	1.81	0.109	1.67
Factor 3: Child friendly	-0.363	-4.60	-0.444	-5.61
Factor 4: Enjoys driving	-0.249	-3.07	-0.297	-3.53
Factor 5: Distressed community	0.184	2.04	0.341	3.71
Cranford dummy	-0.308	-1.54	-0.205	-0.98
Jersey City dummy	-0.500	-1.95	-0.710	-2.74
Metuchen dummy	-0.176	-0.87	-0.186	-0.89
Morristown dummy	0.056	0.28	0.254	1.20
New Brunswick dummy	0.016	0.08	0.073	0.34
Newark dummy	-0.563	-2.34	-0.692	-2.69
Plainfield dummy	-0.202	-0.84	-0.272	-1.08
Lives in a TOD	-0.314	-1.85	-0.355	-2.03
Lives within half-mile of station	-0.155	-1.30	-0.252	-2.07
Population density	-0.131	-1.53	-0.131	-1.50
Employment density	-0.006	-0.17	-0.002	-0.06
Local street density (within ½ mile radius)	-0.045	-0.31	-0.044	-0.30
Average age of adults in HH	-0.070	-0.35	-0.009	-0.05
Income 25-75K	0.195	1.11	0.204	1.12
Income 75-150K	0.179	1.04	0.203	1.14
Income over 150K	0.153	0.85	0.078	0.43
Driving frequency - cut 1	2.364	2.04		
Driving frequency - cut 2	-3.969	-3.43		
Driving frequency - cut 3	-3.767	-3.26		
Driving frequency - cut 4	-3.502	-3.03		
Driving frequency - cut 5	0.988	0.86		

Note: all continuous variables are logarithms except factor scores. Station area dummy variables are relative to Rahway. Distance from station dummy variables relative to those living from ¼ mile to 2 miles away. Income dummies are relative to households earning less than $25,000/year.

Table 22 – Structural equation model results – public transit use frequency

Dependent variable: Public transit use frequency	coef.	z-stat	Total Effects	z-stat
Home tenure	-0.076	-1.57	-0.076	-1.57
Commute time	0.521	16.15	0.521	16.15
Vehicles per adult	-0.912	-7.65	-0.912	-7.65
Factor 1: Sense of community	-0.018	-0.38	-0.059	-1.14
Factor 2: Easy access	-0.062	-1.37	-0.058	-1.16
Factor 3: Child friendly	0.375	5.69	0.496	7.34
Factor 4: Enjoys driving	0.233	3.46	0.268	3.68
Factor 5: Distressed community	-0.087	-1.16	-0.240	-2.85
Cranford dummy	0.148	0.99	0.020	0.12
Jersey City dummy	0.767	3.33	0.990	4.10
Metuchen dummy	0.249	1.64	0.269	1.68
Morristown dummy	0.041	0.24	-0.212	-1.13
New Brunswick dummy	-0.044	-0.27	-0.138	-0.78
Newark dummy	0.347	1.81	0.474	2.26
Plainfield dummy	-0.194	-1.10	-0.160	-0.87
Lives in a TOD	0.427	2.94	0.530	3.40
Lives within half-mile of station	0.098	1.05	0.214	2.15
Population density	0.046	0.59	0.047	0.58
Employment density	-0.049	-1.80	-0.051	-1.86
Local street density (within ½ mile radius)	0.144	1.16	0.130	1.02
Average age of adults in HH	-0.100	-0.58	-0.358	-2.12
Income 25-75K	-0.118	-0.88	-0.122	-0.82
Income 75-150K	0.068	0.53	0.074	0.52
Income over 150K	0.286	2.09	0.449	2.96
Public transit frequency - cut 1	4.116	3.27		
Public transit frequency - cut 2	2.833	2.26		
Public transit frequency - cut 3	1.948	1.55		
Public transit frequency - cut 4	2.131	1.70		
Public transit frequency - cut 5	2.367	1.89		

Note: all continuous variables are logarithms except factor scores. Station area dummy variables are relative to Rahway. Distance from station dummy variables relative to those living from ¼ mile to 2 miles away. Income dummies are relative to households earning less than $25,000/year.

Table 23 – Test statistics for structural equation model

Test Statistic	
No. of observations	779
Chi-squared	7.500
P-value	0.484
d.f.	12
Tucker-Lewis Index	1.004
RMSEA	0.000

Table 24 – Comparison of means for full sample versus analysis sample

	Full sample			Analysis sample			
Variable	No. of observations	Mean	Std. Dev	No. of observations	Mean	Std. Dev	t-stat
Cranford	1629	0.166	0.372	779	0.168	0.374	-0.15
Jersey City	1629	0.116	0.320	779	0.141	0.348	-1.70
Metuchen	1629	0.200	0.400	779	0.211	0.408	-0.59
Morristown	1629	0.133	0.340	779	0.136	0.343	-0.19
New Brunswick	1629	0.105	0.307	779	0.118	0.323	-0.95
Newark	1629	0.072	0.258	779	0.044	0.204	2.90
Plainfield	1629	0.079	0.269	779	0.060	0.238	1.68
Rahway	1629	0.130	0.336	779	0.122	0.327	0.53
Lives in a TOD	1629	0.125	0.330	779	0.151	0.359	-1.76
Lives within half-mile of station	1629	0.459	0.498	779	0.476	0.500	-0.81
Lives between ½ mile and 2 miles from station	1629	0.417	0.493	779	0.372	0.484	2.10
Factor 1: Sense of community	1375	0.000	0.946	779	-0.021	0.916	0.50
Factor 2: Easy access	1375	0.000	0.881	779	-0.014	0.832	0.36
Factor 3: Child friendly	1375	0.000	0.740	779	0.094	0.755	-2.80
Factor 4: Enjoys driving	1375	0.000	0.622	779	0.003	0.597	-0.11
Factor 5: Distressed community	1375	0.000	0.522	779	-0.003	0.523	0.12
Log of Home tenure	1607	2.106	1.103	779	1.837	1.028	5.85
Log of Commute time	1101	3.302	0.843	779	3.291	0.864	0.29
Log of Vehicles per adult	1464	0.582	0.263	779	0.584	0.254	-0.21
Log of Population density	1629	8.926	0.861	779	8.959	0.842	-0.88
Log of Employment density	1629	7.713	1.983	779	7.902	1.987	-2.19
Log of Local street density (within ½ mile radius)	1629	2.629	0.419	779	2.617	0.398	0.68
Walking frequency	1478	4.056	1.858	779	4.022	1.883	0.41
Driving frequency	1543	5.083	1.444	779	5.035	1.573	0.72
Public transit use frequency	1532	3.307	1.827	779	3.530	1.875	-2.73
Log of Average age of adults in HH	1496	3.813	0.309	779	3.706	0.268	8.57
Income less than 25K	1466	0.078	0.268	779	0.031	0.173	5.02
Income 25-75K	1466	0.272	0.445	779	0.248	0.432	1.26
Income 75-150K	1466	0.324	0.468	779	0.388	0.488	-2.99
Income over 150K	1466	0.248	0.432	779	0.281	0.450	-1.67

Walking frequency

The frequency of walking is strongly associated with proximity to the train station. Both those living in TODs and those living within a half-mile of the station walk more frequently than those living further out. Surprisingly, those who live in TODs walk a bit less frequently than those living within a half-mile of the station. This is despite controlling for other factors, including car ownership which has a statistically negative association with walking frequency.

Those who have lived in their home for a shorter period of time tend to walk more frequently. This is suggestive that they may have moved to their neighborhood because they valued walking. Those that walk more frequently also seem to have longer total commute times, perhaps because walking is part of their commute trip. Denser local street networks are also associated with increased walking frequency, a result similar to what the literature suggests. Population density, however, had no statistically significant effect, while employment density was negatively associated with walking frequency. Income and age variables had no association with walking frequency.

Results for our attitudinal factors show that those who value easy access to activities tend to walk less frequently. Those that value child friendly neighborhood attributes walk more frequently, while those with positive attitudes on our enjoy driving factor seem to also be more frequent walkers. This latter is a puzzling result, but may be due to our attitudinal factors not completely capturing the latent attitudes being measured.

Driving frequency

Variables associated with driving frequency are quite different (Table 21). Those households with higher car ownership tend to drive more frequently. Those with shorter commute times likewise tend to drive more frequently (probably because driving to work tends to reduce commute times). Average age of the household and income do not affect driving frequency.

Proximity to the train station is associated with reductions in driving frequency. Interestingly, this effect is not evident from direct associations between driving frequency but when indirect effects are included the data suggest a statistically significant association. Thus, proximity to the station, whether from living in a TOD or living within half-mile of the station is associated with reduced frequency of driving.

The only attitudinal factors associated with increased driving frequency are for valuing easy access and those that feel their neighborhood is distressed. Two other factors have strong negative associations, those that value child-friendly neighborhoods and those who enjoy driving. This latter result is surprising, but one should keep in mind that the definition of these attitudinal factors is subjective.

Public transit use frequency

The frequency with which our survey respondents use public transit is associated with how close they live to the station (Table 22). Those living in a TOD are more frequent public transit users than those living within half-mile of the station; both groups are more frequent users than those living further from the station. This suggests that those who move into TODs are likely to value the benefit of living near the station.

There are several other key influences on the frequency of using public transit. The more vehicles a household owns, the less frequently the respondent uses public transit. Those with longer commutes are more likely to use public transit (although their commutes may be longer because they use public transit). Respondents in households with income over $150,000 per year are also more likely to be frequent users of public transit, though this may be a reflection of our focus on communities served by commuter and light rail. Those in households with higher average age are less frequent public transit users; this effect is indirect, mitigated by how average age is associated with home tenure and vehicle ownership. Those living in their current resident for longer periods of time also use public transit less frequently, albeit the significance level is low.

Built environment variables do not have a major effect; there is a small negative association with employment density. Perhaps those that live in areas with denser employment can travel to jobs that are closer without using public transit.

Conclusions

The primary objective of this analysis was to examine the travel behavior of residents living in proximity to train stations and in TODs, as well as any typical built environment amenities typically associated with more walkable areas. We find strong evidence that those who live near stations and in TODs are more frequent walkers and public transit users, while also being less frequent car drivers. Those who live from one-half to two miles from the station are more frequent car drivers and less frequent walkers and public transit users.

Alternatively, the evidence for how built environment factors influence the frequency of using these three modes is more limited. In most models there is no statistically significant effect associated with population density. We find mild negative effects associated with employment density and both walking and public transit use frequency. The one built environment measure that seems to influence walking is local street network density which has a positive association with more frequent walking.

Several control variables are important to note. First, vehicle ownership affects the frequency of using all the modes. Increased ownership leads to more frequent driving and less frequent walking and public transit use. The length of time a respondent has lived in their current home tends to reduce the frequency of walking, but does not affect the frequency of using other modes. This suggests that people who have moved more recently may have chosen their home location partly because of the walkability of the area around the station. Older households also tend to walk and use public transit less frequently. Higher income increases the frequency of using public transit, but has no effect on the other modes.

The attitudinal control variables are in some cases difficult to interpret. These are composite variables calculated via factor analysis, and results should be interpreted in light of the subjective interpretation of the factor analysis. The factors tend to show opposite associations between driving frequency and with walking and public transit use frequency. This does suggest some underlying neighborhood preferences and attitudes toward each mode that these variables are controlling for. Controlling for these underlying attitudes is really the key purpose of including these variables in the model, to minimize issues associated with self-selection bias.

Social Capital

TODs have the potential to improve the livability of the community in which they are located, both for those who already live in the community and those who come to it for the amenities offered by the new development. One potential way that a community may be affected is in how residents are engaged with their community; this is one element of what is commonly referred to as social capital.

More specifically, social capital is a term that represents how connected an individual is to a community. This can range from being actively involved in community affairs and events, including those of religious organizations, schools, and any activity that others in the community participate in. It can also be a measure of social inclusion; that is, one is connected to neighbors and others within the community, either actively or passively. In our survey instrument we included questions specifically designed to capture some of these social interactions that respondents may engage in. These are listed in Table 25. Some of these were used to derive our attitudinal factors in the analysis presented on travel behavior.

Table 25 – Social capital survey questions

Have you volunteered your time for a neighborhood project or organization? (Yes/No)
Please tell us how much you agree or disagree with the following statements. [Measured on a Likert scale from strongly agree to strongly disagree] ▪ My neighborhood is a good place to live ▪ Living in my neighborhood gives me a sense of community ▪ I know my neighbors ▪ Most people in my neighborhood can be trusted

One of the key variables in the analysis, distance to station, was created using GIS from data provided by New Jersey Transit and other regional public transit agencies. This was calculated for the “study” station, which is each of the eight station areas that our sample of respondents was drawn from. Some may live closer to other stations, but the selection of the “study” station was partially due to it having TOD and/or a walkable environment, factors that we expect to be related to increased social capital.

Analysis of Social Capital

Our first social capital model analyzes the question “Have you volunteered your time for a neighborhood project or organization?” and is an ordered logit model commonly employed for yes/no questions. Results are in Table 26. We see that distance to station has no statistically significant effect. Income is not really a major factor; those in the $150-$199K household income group are most likely to volunteer. Of particular note, residents in those areas with higher population density are more likely to volunteer in their communities, confirming that one element of a compact area is associated with a social capital effect. Employment density, however, has a negative association, albeit at the 90% level of confidence. Those who use transit more frequently also seem to volunteer more, although this is also true of those using motorized vehicles. Surprisingly, those that walk more do not tend to volunteer more. This measure of walking frequency is based on our question on whether respondents walked outside for five minutes or more, as opposed to how often they travel by a given means of transportation. The latter question was asked in the context of commute trips. The former was in the public health section of the survey, and so each was likely interpreted differently (see discussion in travel behavior section).

Those who have lived in their home longer and those in single-family detached homes also are associated with more volunteering, suggesting that if TOD residents are more transient, then they may be less likely to build this measure of social capital.

One additional question was included as an independent variable. Respondents were asked how frequently they conduct various activities within walking distance of their local train station. These activities included shopping at retail stores, eating in restaurants or coffee shops, and engaging in personal business (banking, doctors, dry cleaner, etc.). While this question was based on a Likert scale we include it in the analysis as a dummy variable for whether they engaged in these activities a few times a week or more, once a week or less, relative to the reference category of never. Those who engage in activities near the station more frequently, also tend to engage in volunteer activities.

Table 26 – Social capital – binary logit model,
"Have you volunteered in your neighborhood?"

Variable	Estimate	z-statistic
Distance to nearest study station (feet)	-0.000	-0.47
Station: Cranford	0.025	0.10
Station: Jersey City, Essex St	-0.086	-0.22
Station: Metuchen	0.318	1.32
Station: Morristown	0.430	1.66*
Station: New Brunswick	0.255	0.89
Station: Newark Broad St	0.257	0.73
Station: Plainfield	0.415	1.40
Income: $25k to $49k	-0.191	-0.75
Income: $50k to $74k	0.282	1.12
Income: $75k to $99k	-0.066	-0.26
Income: $100k to $149k	0.272	1.16
Income: $150k to $199k	0.472	1.75*
Income: $200k or more	0.137	0.52
Race: Hispanic (Black or White)	0.040	0.20
Race: White (Hispanic or non-Hispanic)	0.006	0.03
Race: Black (Hispanic or non-Hispanic)	-0.340	-1.07
Race: Asian	-0.927	-2.61**
Population density (Block Group, ACS)	0.000	2.31**
Employment density (Block Group, LEHD)	-15.680	-1.88*
Q20: Ride bus, LR, subway, train, or ferry few times a week or more	0.847	3.27**
Q20: Ride bus, LR, subway, train, or ferry once a week or less	0.894	4.16**
Q20: Car, truck, van, or motorcycle few times a week or more	0.730	2.47**
Q20: Car, truck, van, or motorcycle once a week or less	0.861	2.63**
Q30: Walk several times a week or more	-0.194	-1.04
Vehicles available per household adult	0.153	1.10
Q19: Shop, eat, or conduct business at TOD a few times a week or more	0.627	2.64**
Q19: Shop, eat, or conduct business at TOD once a week or less	0.175	0.76
Length of time in home, years	0.015	2.35**
Q3: Detached single-family house	0.375	1.66*
Q3: Apartment building with 2 or more apartments	-0.296	-1.32
Average age of reported adults (ref. Q38)	0.006	1.10
Constant	-3.117	-4.78**
Observations	1228	
Pseudo-R2	0.094	
Log-likelihood	-818.980	
* p<.10, ** p<.05		

Note: Reference categories for dummy variables: Station = Rahway; Income = Less than $25k; Hispanic = No; Race: Multi-racial or other; Q20 = Never; Q19 = Never shop, eat, or conduct business; Q3 = Attached, single-family home

The second set of questions considered for measuring social capital asked the survey respondent to evaluate characteristics of their neighborhood and state their agreement or disagreement with certain statements. Analysis of these is shown in Table 27. Those living closer to their station tend to think their neighborhood is a good place to live. Controls for the station area suggest that those who most like their neighborhood are in higher income areas (with the exception of Jersey City). Newark stands out as being considered not a good place to live by respondents. Higher income respondents also think they live in a good neighborhood. Those in detached single-family homes and those households with a higher average age also are associated with thinking their neighborhood is a good place to live. Thus, distance to station has an association with the perceived neighborhood quality of a TOD area, but other factors, especially the type of home residents live in have a mitigating impact.

Those reporting that their neighborhood gives them a good sense of community also tend to live closer to the TOD train station. Some other effects are similar to those who think their community is a good place to live, especially the dummy variables for station area. The wealthier communities again have positive effects; however Newark does not show any difference with the reference variable (Rahway), in this model. Income effects tend to be less consistent and actually suggest some income groups not having a sense of community, but there is no consistent pattern. Of more interest, both Hispanic and black respondents believe their neighborhoods give them a sense of community, relative to non-Hispanic and other racial groups. Of those variables associated with compact development, areas with more employment density have less sense of community, while those who conduct activities within walking distance of their train station tend to have a sense of community. Again, those in detached single-family housing have a positive association with this social capital measure and in this case, apartment dwellers have the opposite effect. Average household age again has a positive effect.

When people know their neighbors it is considered another measure of social capital. For those who report knowing their neighbors, distance from the station is not statistically significant and station dummies are only positive for Metuchen and Cranford. Income again does not show a consistent pattern. Hispanic respondents report knowing their neighbors, while there is no difference between other racial groups. Of the key TOD-related built environment variables, population density has a positive effect while employment density again has a negative impact on social capital. Engaging in activities near the train station again has a positive effect. Surprisingly, those with more vehicles per household member tend to know their neighbors more, maybe because they are more mobile; those using their cars more frequently also have a positive association. As with our other models, those in detached single-family homes tend to know their neighbors and those in apartments do not. Older average household age also leads to knowing one's neighbors more.

Our final social capital measure is whether people believe that those in their neighborhood can be trusted. Results on this question show less of a relationship to key TOD-related variables. Distance from station has no effect and neither does population or employment density or engaging in activities near the train station (this latter is positive, but below the 90% confidence level). Those in the Cranford, Metuchen, and Morristown samples (all wealthier areas) tend to trust people in their neighborhood, while those in the Newark sample are the least trusting. There is a small income effect as those with household income above about $100,000 trust people more, but the effect is not consistent. Whites and Asians have more trust relative to other groups. Again, those in detached single-family housing have the greatest trust of people in their area and apartment dwellers the least. Average household age has a positive association.

Conclusions

In summary these results are suggestive that TOD areas may engender more social capital, as our analysis shows some strong associations. Alternatively, those who wish to live in a community with more social capital may choose to live in a TOD. While results are not consistent for all of our models, in general we find that social capital is greater for those living closer to the train station, in areas with higher population density, but with lower employment density, those respondents who engage in activities within walking distance of their train station, and those living in detached single-family homes. These results suggest that factors associated with social capital are complex but that the physical arrangement of a community may play a role.

Table 27 – Social capital – ordered probit models

	My neighborhood is a good place to live		Living in my neighborhood gives sense of community		I know my neighbors		Most people in my neighborhood can be trusted	
Distance to nearest study station (ft)	-0.000	-1.82*	-0.000	-2.56**	-0.000	-0.06	0.000	0.73
Station: Cranford	1.022	7.71**	0.826	6.78**	0.478	3.91**	0.796	6.48**
Station: Jersey City, Essex St	0.767	3.95**	0.605	3.38**	0.216	1.20	0.286	1.59
Station: Metuchen	1.043	8.03**	0.807	6.78**	0.276	2.32**	0.702	5.85**
Station: Morristown	0.862	6.23**	0.515	4.05**	0.051	0.40	0.414	3.21**
Station: New Brunswick	0.093	0.66	0.054	0.40	0.014	0.10	-0.017	-0.13
Station: Newark Broad St	-0.686	-4.05**	-0.002	-0.01	0.189	1.14	-0.420	-2.54**
Station: Plainfield	-0.198	-1.32	-0.045	-0.31	-0.032	-0.22	0.034	0.23
Income: $25k to $49k	-0.171	-1.34	-0.223	-1.84*	-0.078	-0.64	0.020	0.17
Income: $50k to $74k	0.105	0.80	-0.109	-0.89	-0.171	-1.38	0.114	0.92
Income: $75k to $99k	0.195	1.48	-0.031	-0.25	-0.220	-1.79*	0.129	1.05
Income: $100k to $149k	0.193	1.55	-0.006	-0.05	-0.120	-1.03	0.246	2.12**
Income: $150k to $199k	0.095	0.65	-0.266	-2.00**	-0.139	-1.03	0.186	1.38
Income: $200k or more	0.255	1.77*	-0.053	-0.41	0.025	0.19	0.227	1.73*
Race: Hispanic (Black or White)	0.043	0.41	0.216	2.23**	0.198	2.03**	0.088	0.90
Race: White (Hispanic or non-Hispanic)	0.148	1.10	0.099	0.79	0.101	0.79	0.248	1.97**
Race: Black (Hispanic or non-Hispanic)	0.215	1.32	0.283	1.83*	0.179	1.14	-0.152	-0.98
Race: Asian	0.130	0.76	0.251	1.58	0.233	1.45	0.399	2.49**
Population density (Block Group, ACS)	-0.000	-0.02	-0.000	-0.09	0.000	1.75*	-0.000	-0.41
Employment density (Block Group, LEHD)	-0.315	-0.08	-8.950	-2.46**	-9.448	-2.60**	0.502	0.14
Q20: Ride bus, LR, subway, train, or ferry few times a week or more	0.171	1.29	0.043	0.36	-0.011	-0.09	0.171	1.39
Q20: Ride bus, LR, subway, train, or ferry once a week or less	0.175	1.61	0.143	1.42	-0.018	-0.18	0.157	1.55
Q20: Car, truck, van, or motorcycle few times a week or more	-0.130	-0.88	-0.088	-0.67	0.253	1.92*	-0.050	-0.37
Q20: Car, truck, van, or motorcycle once a week or less	-0.049	-0.30	-0.055	-0.38	0.141	0.96	-0.047	-0.32
Q30: Walk several times a week or more	-0.085	-0.83	0.027	0.29	0.143	1.51	0.065	0.69
Vehicles available per household adult	-0.006	-0.08	0.052	0.74	0.205	2.88**	0.091	1.29
Q19: Shop, eat, or conduct business at TOD a few times a week or more	0.184	1.51	0.236	2.09**	0.305	2.69**	0.179	1.57
Q19: Shop, eat, or conduct business at TOD once a week or less	-0.049	-0.42	-0.111	-1.03	0.047	0.44	0.010	0.09
Length of time in home, years	-0.001	-0.16	-0.003	-0.86	-0.003	-0.96	-0.002	-0.48
Q3: Detached single-family house	0.337	2.69**	0.254	2.19**	0.466	4.00**	0.240	2.06**
Q3: Apartment building with 2 or more apartments	0.054	0.45	-0.356	-3.17**	-0.528	-4.68**	-0.312	-2.77**
Average age of reported adults (ref. Q38)	0.007	2.36**	0.009	3.21**	0.011	3.84**	0.014	4.69**
cut1	-1.634	-4.66**	-1.454	-4.62**	-0.753	-2.41**	-0.702	-2.23**
cut2	-0.874	-2.60**	-0.415	-1.35	0.289	0.93	-0.039	-0.13
cut3	-0.253	-0.76	0.454	1.48	0.799	2.58**	1.151	3.70**
cut4	1.265	3.79**	1.582	5.12**	2.238	7.13**	2.522	8.00**
Observations	1227		1224		1227		1227	
Pseudo-R2	0.142		0.094		0.107		0.123	
Log-likelihood	-1290.879		-1706.939		-1683.887		-1617.025	

* p<.10, ** p<.05

Note: Reference categories for dummy variables: Station = Rahway; Income = Less than $25k; Hispanic = No; Race: Multi-racial or other; Q20 = Never; Q19 = Never shop, eat, or conduct business; Q3 = Attached, single-family home.

Self-reported Health

One of the many benefits of more walkable communities and TODs is that walking activity can be greater, relative to other communities. Our travel behavior analysis clearly demonstrated that those living closer to the train station walk more frequently and drive less. Measuring the actual health benefits that residents receive is somewhat more problematic, as available resources normally do not allow direct measurement and obtaining medical records involves privacy issues.

As an alternative, our survey instrument included questions aimed at collecting self-reported health information. We considered asking direct questions about height and weight to obtain a measure of obesity, but felt that these might not be accurately reported and also would deter some respondents from completing the questionnaire. We thus opted for a less direct method of obtaining measures of self-reported health. Questions focused on whether a doctor or health care professional had provided advice or diagnosed a health condition, some of which were related to lack of physical activity. We also asked about exercise activity, both moderate and vigorous, and how frequently this was engaged in. Overall responses ranged from 91 percent for the questions on specific health problems to about 95 percent for the other questions, thus we feel that this was a good method for obtaining this information. Questions are shown in Table 28.

Table 28 – Self-reported health questions

Q. In the last year, has your doctor advised you to increase your physical activity?

- Yes
- No

Q. Have you EVER been told by a doctor or other health professional that you had...? [Check one for each]

- A heart condition
- Diabetes
- Asthma or other respiratory illness
- High blood pressure
- Obesity
- Other chronic condition, specify

Q. How many times a week do you usually do 20 minutes or more of vigorous-intensity physical activity that makes you sweat or puff and pant? (e.g., heavy lifting, digging, jogging, aerobics, or fast bicycling)?

- 3 or more times a week
- 1 to 2 times a week
- Never

Q. How many times a week do you usually do 30 minutes or more of moderate-intensity physical activity or walking that increases your heart rate or makes you breathe harder than normal? (e.g., carrying light loads, bicycling at a regular pace, or doubles tennis)

- 5 or more times a week
- 3-4 times a week
- 1-2 times a week
- Never

Analysis of Self-reported Health

Our working hypothesis is that those who live closer to the train station area or in the TOD will report that they are in better health, all else being equal. Our models control for a range of factors associated both with the built environment and individual factors that might affect health outcomes. The former include controls for population and employment density, vehicles per household, and whether respondents are infrequent walkers or transit users. These latter are specific to individual lifestyles but may also be moderated by the built environment of the respondents residential location. Other individual factors include race and ethnicity, household income, whether they engage in moderate or vigorous physical activity several times a week, and the average age of adults in the household.

This last variable requires some additional explanation. In the survey we collected data on the age distribution of those in the household, but not for the specific individual responding to the survey. Obviously it would be superior to have the age of the respondent, given the correlation between age and potential health problems.

The question from the survey is shown in Table 29, as is the number and percent of respondents for each age category. We also include a count of each category after eliminating larger households with more than three adults.

For the analysis that follows we use both the average age of adults in the household, calculated from the midpoint of our categories and using both the full sample and eliminating observations with more than three adults in the household. The reasoning for doing this is that we want to get a better estimate of the average age in each household, assuming that with more adults, there would be more variation. In our data, 431 or 26.5 percent of the sample is a household with one adult, so we have a good estimate of respondent age (there may be children in these households, but since children are not survey respondents we do not consider them in our age calculations). Another 798 of our respondents are from households with two adults (49.0% of the sample). Households with three adults comprise 10.7 percent of the sample or 175 respondents. We also estimate models using households where all adults are within the same age band. Households with two adults in the same age band total 566 (34.7% of sample), dropping to only 10 households with three adults. We feel this is sufficient to provide a reasonable estimate of the age of the respondent, and as will be seen, our results for different models clearly confirm this.

Table 29 – Survey question used to collect age data with results

Please indicate how many people in your household, including yourself, are in each of the following age categories. *[Fill in number]*				
	Full sample		Three or fewer adults households only	
	Count	Percent of sample	Count	Percent of sample
Under 5 years	223	13.7%	139	8.5%
5 to 13 years	277	17.0%	153	9.4%
14 to 17 years	199	12.2%	139	8.5%
18 to 24 years	266	16.3%	153	9.4%
25 to 34 years	451	27.7%	361	22.2%
35 to 49 years	604	37.1%	519	31.9%
50 to 64 years	607	37.3%	487	29.9%
65 to 74 years	247	15.2%	186	11.4%
75 or older	182	11.2%	129	7.9%

The models shown in Table 30 include the average age of all adults as a control variable. Associations with our key self-reported health measures (defined in Table 28) are the dependent variables. The final column also shows a model for the sum of the number of self-reported health measures that a respondent reported. These are estimated as binary logit models with the exception of the model for all health conditions, which is estimated as an ordered logit model. The key variable of interest is the dummy variables for distance from the train station (relative to living in a TOD). The results of the model estimates show that for most health conditions there is no association with distance from the train station, with two exceptions. There is a positive association for those who report that their doctor advised them to increase their physical activity, with the coefficient value being larger for those living one-quarter to two miles from the station. The model of the sum of reported health conditions also show a positive and statistically significant association for those living in the one-quarter to two mile band from the station. Both results imply that living more distant from the station is associated with worse self-reported health outcomes.

The average age of the household is statistically significant in most cases, the exceptions being those who report having asthma or obesity. This result provides some assurance that our models are providing theoretically sound results as both asthma and obesity would tend to be less correlated with age. These models were also tested using the other sub-samples to correct for the problems with our age measure (inclusion of only households with three or fewer adults and only households where all adults are within the same age band); results are in Table 31 and Table 32. In these cases, the distance variables are either less statistically significant or not at all (in the model restricted to adult household members of the same age group). However, the average adult age of the households is statistically significant in the same models.

Table 30 – Self-reported health and distance bands from train station (all respondents)

	Doctor advised physical activity	Heart condition	Diabetes	Asthma	High blood pressure	Obesity	All health conditions summed
Within quarter mile	0.562*	0.506	0.759	-0.0426	-0.0535	0.186	0.214
	(2.53)	(0.99)	(1.34)	(-0.13)	(-0.21)	(0.60)	(1.09)
Quarter to two miles	0.705**	0.737	0.758	0.176	-0.0545	0.336	0.399*
	(3.09)	(1.44)	(1.33)	(0.54)	(-0.21)	(1.05)	(1.99)
Average age of household	0.0178***	0.0571***	0.0481***	0.0000568	0.0581***	0.00516	0.0346***
	(3.86)	(7.58)	(5.64)	(0.01)	(10.86)	(0.79)	(7.98)
Cranford	-0.353	-0.758*	-0.603	-0.136	-0.318	-0.349	-0.310
	(-1.54)	(-2.01)	(-1.40)	(-0.37)	(-1.22)	(-1.08)	(-1.43)
Jersey City	-1.052**	-0.476	-0.237	-0.314	-0.421	-1.044	-0.900**
	(-2.92)	(-0.72)	(-0.34)	(-0.57)	(-0.94)	(-1.90)	(-2.73)
Metuchen	-0.350	0.0588	-0.462	0.119	-0.118	-0.292	-0.0662
	(-1.54)	(0.17)	(-1.14)	(0.34)	(-0.46)	(-0.92)	(-0.31)
Morristown	-0.312	-0.0765	-0.812	0.228	-0.283	-0.265	-0.149
	(-1.27)	(-0.20)	(-1.47)	(0.63)	(-1.00)	(-0.77)	(-0.67)
New Brunswick	-0.494	-0.564	-0.130	-0.126	-0.514	-0.498	-0.507*
	(-1.85)	(-1.27)	(-0.27)	(-0.31)	(-1.63)	(-1.32)	(-2.03)
Newark	-0.306	-0.599	-0.370	-0.286	-0.331	-0.0400	-0.298
	(-1.01)	(-1.15)	(-0.71)	(-0.64)	(-0.97)	(-0.10)	(-1.08)
Plainfield	-0.383	-0.830	0.261	0.246	0.393	0.0255	-0.263
	(-1.41)	(-1.86)	(0.61)	(0.63)	(1.36)	(0.07)	(-1.00)
Income 25-75K	0.00682	-0.323	-0.0944	0.00101	-0.228	-0.0430	0.00797
	(0.03)	(-1.09)	(-0.31)	(0.00)	(-1.08)	(-0.15)	(0.04)
Income 75-150K	0.152	0.101	-0.399	-0.118	-0.648**	0.312	0.0190
	(0.77)	(0.34)	(-1.16)	(-0.40)	(-2.98)	(1.12)	(0.10)
Income 150K and up	0.0833	-0.557	-0.891*	-0.469	-0.726**	0.0603	-0.265
	(0.39)	(-1.48)	(-1.99)	(-1.40)	(-2.99)	(0.19)	(-1.33)
White	0.0133	-0.00878	-0.768	0.350	-0.392	-0.637*	-0.247
	(0.05)	(-0.02)	(-1.94)	(0.84)	(-1.48)	(-2.14)	(-1.09)
Black	0.803**	0.179	-0.452	0.846	0.171	-0.0721	0.667*
	(2.69)	(0.36)	(-0.97)	(1.81)	(0.54)	(-0.20)	(2.41)
Asian	-0.0314	-1.014	-0.912	-0.487	-1.110**	-1.975***	-0.757**
	(-0.10)	(-1.52)	(-1.51)	(-0.85)	(-2.83)	(-3.61)	(-2.64)
Population density	0.00000663	0.0000164	0.0000144	0.00000983	-0.000000968	0.00000402	0.00000663
	(0.95)	(1.25)	(1.07)	(0.92)	(-0.10)	(0.36)	(1.03)
Employment density	0.00000408	-0.000000914	-0.00000526	-0.00000223	-0.00000206	0.00000481	0.00000287
	(1.49)	(-0.18)	(-0.88)	(-0.50)	(-0.59)	(1.22)	(1.14)
Vehicles per household	0.0798	-0.258	-0.0314	-0.000920	-0.120	-0.261	-0.0905
	(0.58)	(-1.07)	(-0.12)	(-0.00)	(-0.77)	(-1.26)	(-0.70)
Engage in vigorous physical activity	-0.279**	-0.234	-0.308	-0.0153	-0.0405	-0.373**	-0.288***
	(-2.99)	(-1.52)	(-1.67)	(-0.11)	(-0.38)	(-2.74)	(-3.35)
Engage in moderate physical activity	-0.284***	0.0143	-0.172	-0.160	-0.132	-0.0292	-0.208**
	(-3.83)	(0.12)	(-1.19)	(-1.38)	(-1.55)	(-0.27)	(-3.07)
Walk infrequently	0.161	0.412	0.695*	-0.0127	0.173	0.500*	0.256
	(0.89)	(1.58)	(2.41)	(-0.04)	(0.85)	(2.15)	(1.52)
Use transit infrequently	-0.0925	0.686**	-0.311	-0.266	0.0408	-0.0935	0.00643
	(-0.67)	(2.88)	(-1.15)	(-1.25)	(0.26)	(-0.47)	(0.05)
Constant	-1.255**	-5.357***	-4.036***	-2.091**	-2.423***	-1.161*	
	(-2.85)	(-6.49)	(-4.69)	(-3.11)	(-4.91)	(-1.96)	
Cutpoint 1							0.677
							(1.68)
Cutpoint 2							1.936***
							(4.76)
Cutpoint 3							3.098***
							(7.47)
Cutpoint 4							4.150***

							(9.69)
Cutpoint 5							5.646***
							(11.58)
Cutpoint 6							7.611***
							(9.32)
No. of observations	1319	1278	1267	1264	1302	1263	1216
Pseudo R^2	0.0785	0.179	0.164	0.0305	0.179	0.0652	0.0730
Log-likelihood	-799.4	-350.2	-275.9	-418.4	-640.4	-452.3	-1520.1
Log-likelihood (0)	-867.5	-426.8	-329.9	-431.6	-779.9	-483.8	-1639.8
Chi-square	136.3	153.1	108.0	26.32	278.8	63.12	239.4

Note: Reference categories for dummy variables: Station = Rahway; Income = Less than $25k; Hispanic = No; Race: Multi-racial or other; Q20 = Never; Vigorous activity = Never.
* p<.10, ** p<.05

Table 31 – Self-reported health and distance bands from train station, three adults or fewer households

	Doctor advised physical activity	Heart condition	Diabetes	Asthma	High blood pressure	Obesity	All health conditions summed
Within quarter mile	0.464*	0.390	0.819	-0.00496	-0.291	0.0969	0.0997
	(1.99)	(0.74)	(1.26)	(-0.02)	(-1.05)	(0.29)	(0.48)
Quarter to two miles	0.468	0.541	0.865	0.144	-0.242	0.0787	0.201
	(1.92)	(1.03)	(1.32)	(0.42)	(-0.84)	(0.23)	(0.93)
Average age of household	0.0213***	0.0634***	0.0483***	-0.00346	0.0653***	0.00656	0.0361***
	(4.25)	(7.26)	(4.97)	(-0.47)	(10.68)	(0.90)	(7.67)
Cranford	-0.225	-0.864*	-0.553	-0.280	-0.516	-0.429	-0.347
	(-0.85)	(-2.00)	(-1.14)	(-0.67)	(-1.72)	(-1.12)	(-1.40)
Jersey City	-0.873*	-0.426	-0.171	-0.469	-0.391	-0.983	-0.858*
	(-2.27)	(-0.61)	(-0.23)	(-0.81)	(-0.78)	(-1.67)	(-2.41)
Metuchen	-0.273	-0.000907	-0.286	0.0362	-0.325	-0.253	-0.0178
	(-1.04)	(-0.00)	(-0.63)	(0.09)	(-1.10)	(-0.67)	(-0.07)
Morristown	-0.219	0.0984	-1.551	0.326	-0.549	-0.164	-0.125
	(-0.80)	(0.23)	(-1.94)	(0.85)	(-1.71)	(-0.42)	(-0.50)
New Brunswick	-0.344	-0.336	-0.107	-0.301	-0.608	-0.529	-0.472
	(-1.13)	(-0.69)	(-0.20)	(-0.65)	(-1.69)	(-1.21)	(-1.68)
Newark	-0.292	-0.456	-0.284	-0.278	-0.358	-0.0213	-0.326
	(-0.85)	(-0.79)	(-0.49)	(-0.58)	(-0.92)	(-0.05)	(-1.04)
Plainfield	-0.142	-0.718	0.311	0.421	0.213	0.0813	-0.152
	(-0.45)	(-1.41)	(0.63)	(1.01)	(0.63)	(0.20)	(-0.50)
Income 25-75K	-0.0466	-0.386	-0.122	-0.00351	-0.265	-0.193	-0.0589
	(-0.22)	(-1.24)	(-0.38)	(-0.01)	(-1.13)	(-0.65)	(-0.29)
Income 75-150K	0.00410	0.00506	-0.943*	-0.256	-0.906***	-0.0241	-0.191
	(0.02)	(0.02)	(-2.34)	(-0.81)	(-3.71)	(-0.08)	(-0.96)
Income 150K and up	0.0524	-1.001*	-1.050*	-0.486	-0.993***	-0.369	-0.463*
	(0.22)	(-2.21)	(-2.10)	(-1.34)	(-3.56)	(-1.02)	(-2.08)
White	-0.0341	-0.202	-1.141*	0.182	-0.413	-0.800*	-0.328
	(-0.12)	(-0.44)	(-2.55)	(0.40)	(-1.28)	(-2.32)	(-1.19)
Black	0.861*	-0.482	-0.952	0.801	0.110	-0.360	0.590
	(2.46)	(-0.83)	(-1.79)	(1.57)	(0.29)	(-0.87)	(1.79)
Asian	-0.0152	-1.228	-1.508*	-0.594	-1.121*	-2.811***	-0.828*
	(-0.04)	(-1.59)	(-2.01)	(-0.95)	(-2.33)	(-3.48)	(-2.43)
Population density	0.00000748	0.0000222	0.0000190	0.0000120	-0.00000665	0.0000108	0.00000748
	(1.03)	(1.68)	(1.33)	(1.11)	(-0.56)	(0.93)	(1.10)
Employment density	0.00000362	-0.00000188	-0.00000638	-0.00000194	-0.00000325	0.00000491	0.00000275
	(1.27)	(-0.36)	(-1.00)	(-0.42)	(-0.86)	(1.19)	(1.04)
Vehicles per household	0.178	-0.201	0.0178	-0.0336	0.0133	-0.179	-0.0134
	(1.20)	(-0.78)	(0.07)	(-0.15)	(0.08)	(-0.82)	(-0.10)

Engage in vigorous	-0.259*	-0.294	-0.320	-0.0309	0.0327	-0.386*	-0.301**
physical activity	(-2.45)	(-1.70)	(-1.55)	(-0.19)	(0.26)	(-2.45)	(-3.12)
Engage in moderate	-0.335***	0.0665	-0.121	-0.161	-0.221*	0.00571	-0.241**
physical activity	(-3.97)	(0.50)	(-0.76)	(-1.27)	(-2.23)	(0.05)	(-3.15)
Walk infrequently	0.0415	0.337	0.765*	-0.136	-0.0671	0.381	0.0107
	(0.20)	(1.13)	(2.31)	(-0.43)	(-0.28)	(1.38)	(0.06)
Use transit	-0.156	0.640*	-0.438	-0.114	-0.135	-0.0649	-0.0314
infrequently	(-0.98)	(2.39)	(-1.40)	(-0.49)	(-0.72)	(-0.28)	(-0.22)
Constant	-1.354**	-5.401***	-3.792***	-1.692*	-2.299***	-0.920	
	(-2.74)	(-5.96)	(-3.88)	(-2.37)	(-4.09)	(-1.41)	
Cutpoint 1							0.468
							(1.04)
Cutpoint 2							1.710***
							(3.75)
Cutpoint 3							2.884***
							(6.22)
Cutpoint 4							3.911***
							(8.20)
Cutpoint 5							5.378***
							(9.99)
Cutpoint 6							7.189***
							(8.55)
No. of observations	1076	1047	1037	1036	1064	1033	996
Pseudo R^2	0.0866	0.214	0.202	0.0438	0.224	0.0725	0.0813
Log-likelihood	-639.8	-278.1	-214.9	-349.3	-490.4	-347.9	-1222.8
Log-likelihood (0)	-700.5	-354.0	-269.2	-365.3	-631.9	-375.1	-1331.1
Chi-square	121.4	151.9	108.6	32.02	283.0	54.41	216.6

Note: Reference categories for dummy variables: Station = Rahway; Income = Less than $25k; Hispanic = No; Race: Multi-racial or other; Q20 = Never; Vigorous activity = Never.

* p<.10, ** p<.05

Table 32 – Self-reported health and distance bands from train station, adults same age households

	Doctor advised physical activity	Heart condition	Diabetes	Asthma	High blood pressure	Obesity	All health conditions summed
Within quarter mile	0.414	0.469	1.802	0.153	-0.307	0.254	0.183
	(1.60)	(0.79)	(1.70)	(0.42)	(-0.98)	(0.68)	(0.79)
	0.290	0.733	1.840	0.239	-0.450	0.246	0.188
Quarter to two miles	(1.06)	(1.22)	(1.73)	(0.62)	(-1.36)	(0.63)	(0.78)
Average age of	0.0215***	0.0670***	0.0462***	-0.00509	0.0750***	0.00851	0.0391***
household	(3.87)	(7.03)	(4.13)	(-0.62)	(10.47)	(1.07)	(7.48)
Cranford	-0.240	-0.658	-0.870	0.0626	-0.541	-0.365	-0.334
	(-0.79)	(-1.36)	(-1.52)	(0.13)	(-1.54)	(-0.81)	(-1.17)
Jersey City	-0.823	-0.495	-0.233	-0.572	-0.338	-0.617	-0.868*
	(-1.93)	(-0.65)	(-0.28)	(-0.89)	(-0.59)	(-0.97)	(-2.22)
Metuchen	-0.192	0.124	-0.350	0.129	-0.499	-0.0953	-0.0256
	(-0.65)	(0.28)	(-0.69)	(0.29)	(-1.46)	(-0.22)	(-0.09)
Morristown	-0.0558	-0.0191	-1.385	0.458	-0.303	0.167	0.0327
	(-0.18)	(-0.04)	(-1.67)	(1.03)	(-0.83)	(0.39)	(0.12)
New Brunswick	-0.309	-0.316	-0.813	-0.00786	-0.863*	-0.265	-0.522
	(-0.89)	(-0.57)	(-1.10)	(-0.02)	(-1.98)	(-0.54)	(-1.61)
Newark	-0.611	-0.840	-0.213	-0.516	-0.348	-0.0803	-0.563
	(-1.54)	(-1.27)	(-0.32)	(-0.92)	(-0.78)	(-0.16)	(-1.59)
Plainfield	-0.199	-0.716	0.538	0.417	0.304	-0.0846	-0.159
	(-0.54)	(-1.25)	(0.95)	(0.85)	(0.78)	(-0.17)	(-0.45)
Income 25-75K	0.160	-0.395	-0.321	-0.0203	-0.347	-0.135	-0.0439
	(0.66)	(-1.14)	(-0.85)	(-0.06)	(-1.30)	(-0.40)	(-0.20)
Income 75-150K	0.155	0.0502	-0.970*	-0.291	-0.890**	0.0448	-0.110

	(0.62)	(0.14)	(-2.12)	(-0.82)	(-3.18)	(0.13)	(-0.49)
Income 150K and up	0.256	-0.624	-1.265*	-0.428	-0.881**	-0.216	-0.299
	(0.95)	(-1.33)	(-2.15)	(-1.07)	(-2.78)	(-0.54)	(-1.22)
White	-0.168	-0.453	-0.850	0.306	-0.416	-0.607	-0.305
	(-0.51)	(-0.88)	(-1.55)	(0.56)	(-1.10)	(-1.48)	(-1.00)
Black	0.925*	-0.377	-1.043	1.245*	0.383	0.0628	0.891*
	(2.30)	(-0.58)	(-1.60)	(2.02)	(0.85)	(0.13)	(2.40)
Asian	-0.0979	-1.836*	-1.148	-0.568	-0.755	-3.223**	-0.767*
	(-0.24)	(-2.00)	(-1.37)	(-0.78)	(-1.40)	(-2.91)	(-2.03)
Population density	0.0000139	0.0000251	0.0000263	0.0000169	-0.00000614	0.0000128	0.0000116
	(1.72)	(1.75)	(1.80)	(1.46)	(-0.45)	(0.98)	(1.57)
	0.00000246	0.000000427	-0.00000806	-0.000000862	-0.00000181	0.00000314	0.00000254
Employment density	(0.78)	(0.08)	(-1.04)	(-0.18)	(-0.41)	(0.69)	(0.86)
Vehicles per	0.189	-0.395	0.129	-0.0613	0.0996	-0.160	-0.0223
household	(1.19)	(-1.35)	(0.46)	(-0.25)	(0.54)	(-0.68)	(-0.15)
Engage in vigorous	-0.344**	-0.382*	-0.200	-0.187	0.0639	-0.465**	-0.360**
physical activity	(-2.83)	(-2.02)	(-0.80)	(-1.05)	(0.44)	(-2.66)	(-3.27)
Engage in moderate	-0.259**	0.112	-0.181	-0.122	-0.237*	0.0887	-0.182*
physical activity	(-2.72)	(0.77)	(-0.94)	(-0.87)	(-2.06)	(0.66)	(-2.11)
Walk infrequently	-0.163	0.350	1.164**	-0.230	-0.130	0.337	-0.0989
	(-0.70)	(1.05)	(3.12)	(-0.64)	(-0.47)	(1.08)	(-0.45)
Use transit	-0.0482	0.690*	-0.402	-0.0932	-0.0859	0.0364	0.00609
infrequently	(-0.27)	(2.34)	(-1.11)	(-0.35)	(-0.40)	(0.14)	(0.04)
Constant							0.894
							(1.78)
Cutpoint 1							2.089***
							(4.12)
Cutpoint 2							3.334***
							(6.43)
Cutpoint 3							4.399***
							(8.22)
Cutpoint 4							5.723***
							(9.57)
Cutpoint 5							7.351***
							(8.44)
Cutpoint 6	-1.559**	-5.441***	-5.025***	-1.899*	-2.990***	-1.627*	
	(-2.78)	(-5.29)	(-3.66)	(-2.29)	(-4.53)	(-2.15)	
No. of observations	882	860	850	846	874	846	817
Pseudo R^2	0.0840	0.237	0.230	0.0512	0.254	0.0728	0.0865
Log-likelihood	-512.3	-228.1	-163.1	-282.0	-375.6	-283.1	-974.5
Log-likelihood (0)	-559.3	-298.8	-211.7	-297.2	-503.7	-305.4	-1066.7
Chi-square	93.92	141.5	97.27	30.45	256.2	44.47	184.5

One issue is that average age of each household may be correlated with where those households locate. In particular, younger people may tend to live closer to the train station and in the TOD. Examination of our age variable and where respondents live shows a significant correlation. Those living in TODs tend to be younger, while those living further tend to be older. The correlations are shown in Table 33. We also regressed the age variable on the distance bands (relative to living in a TOD). Results show that older households are most distant while the youngest households live within a quarter mile of the station or live in a TOD. This result holds for all the various sub-samples that control for the age variable. This result is not too surprising as the TODs tend to be newer developments, and are often marketed to younger people.

These results suggest that it may be difficult to statistically separate the age of the households from the place where they live and how each affects their self-reported health. The models shown in Table 30, Table 31, and Table 32 all seem to be dominated by the age variable. To further examine this issue we also estimated models without the age variable (not shown). In these cases the distance bands were statistically significant with the largest coefficient value for the quarter mile to two mile distance band; this was true in all the models except the asthma, high blood pressure, and obesity models. Recall that asthma and obesity had no association with the age variable. This suggests that multi-collinearity is making it difficult to separate the effects of age versus distance from the station.

Table 33 – Correlations between average adult household age and distance bands for all three samples

	Average age of adults in household		
	Full sample	Households with three or fewer adults	Households with adults in same age band
Lives in TOD	-0.1913 (p=0.000)	-0.2277 (p=0.000)	-0.2375 (p=0.000)
Lives within quarter mile of station	0.0186 (p=0.4724)	0.0187 (p=0.5119)	0.0297 (p=0.3464)
Lives quarter to two miles from station	0.1110 (p=0.000)	0.1462 (p=0.000)	0.1455 (p=0.000)

Table 34 – Regression of average adult age on distance bands for all three samples

	Full sample	Households with three or fewer adults	Households with adults in same age band
	Coef. (t-stat)	Coef. (t-stat)	Coef. (t-stat)
Lives within quarter mile of station	7.605	8.781	9.419
	(6.47)	(6.85)	(6.58)
Lives quarter to two miles from station	9.240	11.286	11.915
	(7.78)	(8.62)	(8.07)
Constant	40.166	40.144	39.536
	(38.69)	(35.95)	(31.74)
Adjusted R^2	.0380	0.0574	.0597
Number of observations	1496	1229	1009

Given the correlation between the average age of adults in the household and where they live, we estimated models with an interaction term for the distance band with the average adult age of each household. In effect, this will tell us whether age has more or less of an effect on health outcomes depending on which distant band the respondent lives in. While this approach does not explicitly test the hypothesis of whether distance from the station area *per se* is associated with worse health outcomes, it tests and compares how aging affects health outcomes in each distance band independently. As before, models with the three sub-samples of our age variable are estimated; results are shown in Table 35, Table 36, and Table 37.

For five of the models presented the interacted variables are statistically significant (see Table 35). In general, we see a pattern whereby the coefficients are larger for the interaction between average age and the one-quarter to two mile distance band, implying that as age increases and one lives more distant from the train station, health outcomes are worse (with the exception of self-reported high blood pressure). However, further inspection of the 95 percent confidence intervals for each of the models shows that there is overlap between each coefficient estimate, meaning we cannot distinguish a statistical difference between each coefficient. This result holds regardless of how the average age variable is measured (see Table 36 and Table 37).

Two of the models, those for self-reported asthma and obesity, consistently do not have statistical significance for the interacted age variables. These were also not statistically significant without the interaction terms (see Table 31, and Table 32). This result is not surprising as we would not expect age to be associated with asthma or obesity.

Table 35 – Self-reported health and distance bands from train station interacted with average household age, entire dataset

	Doctor advised physical activity	Heart condition	Diabetes	Asthma	High blood pressure	Obesity	All health conditions summed
Average age of household*TOD	0.00708	0.0485***	0.0340*	0.000656	0.0622***	-0.000760	0.0294***
	(1.05)	(3.92)	(2.28)	(0.06)	(8.19)	(-0.08)	(4.75)
Average age of household*Within quarter mile	0.0175***	0.0556***	0.0482***	-0.00126	0.0583***	0.00390	0.0335***
	(3.65)	(7.13)	(5.43)	(-0.17)	(10.44)	(0.56)	(7.45)
Average age of household * Quarter to two miles	0.0211***	0.0602***	0.0494***	0.00204	0.0577***	0.00748	0.0376***
	(4.44)	(7.83)	(5.73)	(0.29)	(10.57)	(1.13)	(8.40)
Cranford	-0.316	-0.733	-0.577	-0.129	-0.308	-0.341	-0.288
	(-1.38)	(-1.94)	(-1.34)	(-0.35)	(-1.18)	(-1.06)	(-1.33)
Jersey City	-1.018**	-0.449	-0.251	-0.263	-0.378	-1.045	-0.877**
	(-2.84)	(-0.68)	(-0.36)	(-0.48)	(-0.84)	(-1.91)	(-2.67)
Metuchen	-0.308	0.0879	-0.433	0.122	-0.106	-0.280	-0.0413
	(-1.35)	(0.26)	(-1.07)	(0.35)	(-0.42)	(-0.88)	(-0.20)
Morristown	-0.302	-0.0640	-0.806	0.235	-0.273	-0.262	-0.139
	(-1.24)	(-0.17)	(-1.46)	(0.65)	(-0.97)	(-0.76)	(-0.62)
New Brunswick	-0.482	-0.554	-0.131	-0.101	-0.509	-0.492	-0.489*
	(-1.81)	(-1.25)	(-0.28)	(-0.25)	(-1.61)	(-1.31)	(-1.97)
Newark	-0.286	-0.604	-0.370	-0.282	-0.331	-0.0390	-0.289
	(-0.94)	(-1.15)	(-0.71)	(-0.63)	(-0.97)	(-0.10)	(-1.05)
Plainfield	-0.375	-0.829	0.253	0.259	0.400	0.0227	-0.256
	(-1.38)	(-1.85)	(0.59)	(0.67)	(1.39)	(0.06)	(-0.97)
Income 25-75K	0.00923	-0.330	-0.0973	0.00387	-0.228	-0.0424	0.00897
	(0.05)	(-1.11)	(-0.32)	(0.01)	(-1.08)	(-0.15)	(0.05)
Income 75-150K	0.156	0.100	-0.399	-0.118	-0.654**	0.316	0.0204
	(0.79)	(0.33)	(-1.16)	(-0.40)	(-3.01)	(1.13)	(0.11)
Income 150K and up	0.0893	-0.560	-0.888*	-0.469	-0.740**	0.0676	-0.261
	(0.41)	(-1.48)	(-1.98)	(-1.40)	(-3.04)	(0.21)	(-1.31)
White	0.00704	-0.0182	-0.781*	0.351	-0.399	-0.639*	-0.251
	(0.03)	(-0.04)	(-1.98)	(0.84)	(-1.51)	(-2.14)	(-1.10)
Black	0.799**	0.177	-0.459	0.844	0.159	-0.0692	0.668*
	(2.68)	(0.36)	(-0.98)	(1.80)	(0.50)	(-0.19)	(2.41)
Asian	-0.0429	-1.025	-0.936	-0.478	-1.116**	-1.981***	-0.763**
	(-0.14)	(-1.54)	(-1.55)	(-0.84)	(-2.85)	(-3.62)	(-2.66)

Population density	0.00000695	0.0000168	0.0000149	0.00000972	-0.00000130	0.00000423	0.00000685
	(1.00)	(1.28)	(1.10)	(0.91)	(-0.13)	(0.38)	(1.06)
Employment density	0.00000388	-0.00000117	-0.00000508	-0.00000288	-0.00000266	0.00000487	0.00000272
	(1.43)	(-0.23)	(-0.86)	(-0.64)	(-0.76)	(1.25)	(1.09)
Vehicles per household	0.0756	-0.257	-0.0376	0.00255	-0.118	-0.264	-0.0920
	(0.55)	(-1.06)	(-0.15)	(0.01)	(-0.76)	(-1.28)	(-0.71)
Engage in vigorous physical	-0.280**	-0.238	-0.307	-0.0159	-0.0393	-0.374**	-0.288***
activity	(-2.99)	(-1.55)	(-1.67)	(-0.11)	(-0.37)	(-2.75)	(-3.36)
Engage in moderate physical	-0.281***	0.0144	-0.172	-0.159	-0.134	-0.0279	-0.207**
activity	(-3.79)	(0.12)	(-1.19)	(-1.38)	(-1.57)	(-0.26)	(-3.05)
Walk infrequently	0.162	0.413	0.693*	-0.00936	0.175	0.501*	0.256
	(0.90)	(1.58)	(2.40)	(-0.03)	(0.86)	(2.15)	(1.52)
Use transit infrequently	-0.0846	0.694**	-0.313	-0.252	0.0568	-0.0966	0.00841
	(-0.61)	(2.91)	(-1.16)	(-1.19)	(0.36)	(-0.49)	(0.07)
Constant	-0.735	-4.798***	-3.320***	-2.065**	-2.486***	-0.933	
	(-1.78)	(-6.78)	(-4.59)	(-3.19)	(-5.42)	(-1.69)	
Cutpoint 1							0.440
							(1.14)
Cutpoint 2							1.699***
							(4.37)
Cutpoint 3							2.861***
							(7.22)
Cutpoint 4							3.915***
							(9.54)
Cutpoint 5							5.412***
							(11.46)
Cutpoint 6							7.377***
							(9.14)
No. of observations	1319	1278	1267	1264	1302	1263	1216
Pseudo R^2	0.0774	0.179	0.163	0.0300	0.179	0.0657	0.0730
Log-likelihood	-800.4	-350.4	-276.0	-418.7	-640.2	-452.1	-1520.2
Log-likelihood (0)	-867.5	-426.8	-329.9	-431.6	-779.9	-483.8	-1639.8
Chi-square	134.3	152.8	107.8	25.86	279.4	63.53	239.3

Table 36 – Self-reported health and distance bands from train station interacted with average household age, only households with three adults or fewer

	Doctor advised physical activity	Heart condition	Diabetes	Asthma	High blood pressure	Obesity	All health conditions summed
Average age of household*TOD	0.0137	0.0573***	0.0347*	-0.00224	0.0724***	0.00364	0.0337***
	(1.91)	(4.32)	(2.07)	(-0.21)	(8.55)	(0.35)	(5.07)
Average age of household*Within quarter mile	0.0216***	0.0624***	0.0482***	-0.00356	0.0645***	0.00582	0.0351***
	(4.13)	(6.94)	(4.78)	(-0.46)	(10.15)	(0.76)	(7.19)
Average age of household * Quarter to two miles	0.0235***	0.0660***	0.0503***	-0.00220	0.0649***	0.00723	0.0382***
	(4.55)	(7.48)	(5.14)	(-0.29)	(10.52)	(0.99)	(7.91)
Cranford	-0.178	-0.831	-0.516	-0.273	-0.510	-0.415	-0.316
	(-0.68)	(-1.92)	(-1.06)	(-0.66)	(-1.70)	(-1.08)	(-1.27)
Jersey City	-0.859*	-0.417	-0.172	-0.406	-0.361	-1.020	-0.852*
	(-2.24)	(-0.60)	(-0.23)	(-0.71)	(-0.73)	(-1.74)	(-2.41)
Metuchen	-0.214	0.0387	-0.245	0.0378	-0.315	-0.229	0.0183
	(-0.82)	(0.10)	(-0.54)	(0.10)	(-1.06)	(-0.60)	(0.08)
Morristown	-0.207	0.115	-1.533	0.336	-0.538	-0.163	-0.111
	(-0.75)	(0.27)	(-1.92)	(0.88)	(-1.67)	(-0.42)	(-0.45)
New Brunswick	-0.345	-0.330	-0.103	-0.270	-0.610	-0.542	-0.466
	(-1.14)	(-0.68)	(-0.19)	(-0.59)	(-1.70)	(-1.24)	(-1.66)
Newark	-0.271	-0.468	-0.286	-0.267	-0.369	-0.0291	-0.320
	(-0.79)	(-0.81)	(-0.50)	(-0.56)	(-0.95)	(-0.07)	(-1.03)

Plainfield	-0.143	-0.719	0.306	0.443	0.217	0.0660	-0.150
	(-0.45)	(-1.41)	(0.62)	(1.07)	(0.64)	(0.16)	(-0.50)
Income 25-75K	-0.0457	-0.398	-0.125	-0.00337	-0.267	-0.194	-0.0601
	(-0.21)	(-1.27)	(-0.39)	(-0.01)	(-1.14)	(-0.66)	(-0.30)
Income 75-150K	0.00724	0.00115	-0.943*	-0.256	-0.913***	-0.0220	-0.192
	(0.03)	(0.00)	(-2.34)	(-0.81)	(-3.74)	(-0.07)	(-0.96)
Income 150K and up	0.0575	-1.006*	-1.050*	-0.490	-1.014***	-0.365	-0.461*
	(0.24)	(-2.22)	(-2.10)	(-1.35)	(-3.62)	(-1.01)	(-2.07)
White	-0.0505	-0.218	-1.166**	0.187	-0.419	-0.813*	-0.336
	(-0.17)	(-0.47)	(-2.61)	(0.41)	(-1.30)	(-2.36)	(-1.22)
Black	0.853*	-0.484	-0.965	0.800	0.102	-0.364	0.591
	(2.44)	(-0.83)	(-1.82)	(1.57)	(0.27)	(-0.88)	(1.79)
Asian	-0.0405	-1.251	-1.539*	-0.576	-1.127*	-2.837***	-0.842*
	(-0.11)	(-1.62)	(-2.06)	(-0.92)	(-2.35)	(-3.51)	(-2.47)
Population density	0.00000796	0.0000230	0.0000197	0.0000118	-0.00000686	0.0000113	0.00000783
	(1.09)	(1.74)	(1.38)	(1.09)	(-0.58)	(0.97)	(1.15)
Employment density	0.00000377	-0.00000188	-0.00000640	-0.00000264	-0.00000369	0.00000533	0.00000283
	(1.33)	(-0.36)	(-1.02)	(-0.57)	(-0.97)	(1.31)	(1.08)
Vehicles per household	0.173	-0.201	0.0118	-0.0266	0.0157	-0.188	-0.0167
	(1.17)	(-0.78)	(0.05)	(-0.12)	(0.09)	(-0.85)	(-0.12)
Engage in vigorous physical activity	-0.258*	-0.298	-0.320	-0.0327	0.0331	-0.385*	-0.301**
	(-2.44)	(-1.72)	(-1.54)	(-0.21)	(0.27)	(-2.45)	(-3.12)
Engage in moderate physical activity	-0.333***	0.0665	-0.122	-0.161	-0.223*	0.00654	-0.241**
	(-3.95)	(0.50)	(-0.76)	(-1.27)	(-2.25)	(0.05)	(-3.14)
Walk infrequently	0.0411	0.336	0.762*	-0.134	-0.0673	0.380	0.0103
	(0.20)	(1.13)	(2.30)	(-0.42)	(-0.28)	(1.37)	(0.05)
Use transit infrequently	-0.159	0.642*	-0.440	-0.0972	-0.124	-0.0758	-0.0369
	(-1.00)	(2.40)	(-1.41)	(-0.41)	(-0.66)	(-0.33)	(-0.25)
Constant	-0.975*	-4.994***	-3.010***	-1.687*	-2.534***	-0.814	
	(-2.05)	(-6.15)	(-3.67)	(-2.42)	(-4.75)	(-1.31)	
Cutpoint 1							0.356
							(0.81)
Cutpoint 2							1.599***
							(3.61)
Cutpoint 3							2.773***
							(6.14)
Cutpoint 4							3.802***
							(8.17)
Cutpoint 5							5.270***
							(9.98)
Cutpoint 6							7.081***
							(8.49)
No. of observations	1076	1047	1037	1036	1064	1033	996
Pseudo R^2	0.0859	0.215	0.201	0.0434	0.225	0.0728	0.0816
Log-likelihood	-640.4	-278.0	-215.1	-349.5	-490.1	-347.8	-1222.5
Log-likelihood (0)	-700.5	-354.0	-269.2	-365.3	-631.9	-375.1	-1331.1
Chi-square	120.3	151.9	108.2	31.69	283.7	54.58	217.2

Table 37 – Self-reported health and distance bands from train station interacted with average household age, households with adults in same age category only

	Doctor advised physical activity	Heart condition	Diabetes	Asthma	High blood pressure	Obesity	All health conditions summed
Average age of household*TOD	0.0149	0.0608***	-0.00360	-0.00534	0.0829***	0.000556	0.0349***
	(1.83)	(4.19)	(-0.11)	(-0.44)	(8.45)	(0.05)	(4.64)
Average age of household*Within quarter mile	0.0227***	0.0655***	0.0459***	-0.00385	0.0748***	0.00804	0.0388***
	(3.95)	(6.70)	(3.95)	(-0.45)	(10.12)	(0.97)	(7.20)
Average age of household *	0.0220***	0.0709***	0.0473***	-0.00434	0.0727***	0.00959	0.0406***

Quarter to two miles	(3.82)	(7.34)	(4.16)	(-0.52)	(10.12)	(1.19)	(7.49)
Cranford	-0.210	-0.610	-0.858	0.0692	-0.534	-0.358	-0.304
	(-0.69)	(-1.25)	(-1.49)	(0.15)	(-1.52)	(-0.80)	(-1.06)
Jersey City	-0.829	-0.462	-0.252	-0.497	-0.348	-0.661	-0.882*
	(-1.95)	(-0.61)	(-0.30)	(-0.78)	(-0.61)	(-1.04)	(-2.26)
Metuchen	-0.151	0.182	-0.338	0.127	-0.484	-0.0805	0.0118
	(-0.51)	(0.41)	(-0.66)	(0.28)	(-1.41)	(-0.19)	(0.04)
Morristown	-0.0538	0.0166	-1.381	0.469	-0.294	0.157	0.0390
	(-0.17)	(0.03)	(-1.66)	(1.05)	(-0.80)	(0.37)	(0.14)
New Brunswick	-0.315	-0.307	-0.803	0.0272	-0.888*	-0.266	-0.524
	(-0.91)	(-0.56)	(-1.09)	(0.05)	(-2.03)	(-0.54)	(-1.62)
Newark	-0.587	-0.854	-0.197	-0.490	-0.372	-0.0765	-0.547
	(-1.48)	(-1.29)	(-0.30)	(-0.87)	(-0.83)	(-0.15)	(-1.55)
Plainfield	-0.203	-0.719	0.546	0.445	0.293	-0.102	-0.169
	(-0.55)	(-1.26)	(0.97)	(0.91)	(0.75)	(-0.21)	(-0.48)
Income 25-75K	0.166	-0.406	-0.321	-0.0172	-0.349	-0.130	-0.0403
	(0.68)	(-1.16)	(-0.85)	(-0.05)	(-1.31)	(-0.39)	(-0.18)
Income 75-150K	0.164	0.0430	-0.965*	-0.285	-0.901**	0.0573	-0.107
	(0.66)	(0.12)	(-2.10)	(-0.80)	(-3.22)	(0.17)	(-0.48)
Income 150K and up	0.265	-0.637	-1.254*	-0.424	-0.900**	-0.203	-0.293
	(0.98)	(-1.36)	(-2.13)	(-1.06)	(-2.83)	(-0.50)	(-1.19)
White	-0.180	-0.467	-0.848	0.304	-0.426	-0.611	-0.309
	(-0.55)	(-0.91)	(-1.55)	(0.55)	(-1.13)	(-1.49)	(-1.01)
Black	0.916*	-0.372	-1.039	1.224*	0.379	0.0687	0.894*
	(2.28)	(-0.58)	(-1.60)	(1.99)	(0.84)	(0.14)	(2.40)
Asian	-0.115	-1.839*	-1.152	-0.546	-0.776	-3.246**	-0.780*
	(-0.29)	(-2.00)	(-1.38)	(-0.75)	(-1.44)	(-2.93)	(-2.06)
Population density	0.0000142	0.0000259	0.0000265	0.0000167	-0.00000601	0.0000132	0.0000119
	(1.75)	(1.81)	(1.82)	(1.43)	(-0.44)	(1.02)	(1.60)
Employment density	0.00000282	0.000000113	-0.00000783	-0.00000173	-0.00000187	0.00000371	0.00000292
	(0.90)	(0.02)	(-1.02)	(-0.36)	(-0.43)	(0.83)	(1.00)
Vehicles per household	0.185	-0.395	0.123	-0.0528	0.0952	-0.167	-0.0301
	(1.17)	(-1.35)	(0.44)	(-0.22)	(0.51)	(-0.71)	(-0.20)
Engage in vigorous physical	-0.343**	-0.386*	-0.197	-0.191	0.0669	-0.464**	-0.358**
activity	(-2.82)	(-2.03)	(-0.79)	(-1.07)	(0.46)	(-2.65)	(-3.25)
Engage in moderate physical	-0.258**	0.111	-0.181	-0.122	-0.241*	0.0901	-0.183*
activity	(-2.70)	(0.76)	(-0.95)	(-0.87)	(-2.09)	(0.67)	(-2.11)
Walk infrequently	-0.167	0.346	1.163**	-0.229	-0.133	0.338	-0.101
	(-0.72)	(1.04)	(3.11)	(-0.64)	(-0.48)	(1.08)	(-0.46)
Use transit infrequently	-0.0555	0.699*	-0.416	-0.0652	-0.0807	0.0176	-0.00643
	(-0.31)	(2.36)	(-1.14)	(-0.25)	(-0.38)	(0.07)	(-0.04)
Constant	-1.263*	-4.942***	-3.222**	-1.798*	-3.281***	-1.381	
	(-2.32)	(-5.44)	(-3.27)	(-2.21)	(-5.16)	(-1.90)	
Cutpoint 1							0.739
							(1.51)
Cutpoint 2							1.935***
							(3.91)
Cutpoint 3							3.181***
							(6.29)
Cutpoint 4							4.247***
							(8.12)
Cutpoint 5							5.572***
							(9.48)
Cutpoint 6							7.201***
							(8.34)
No. of observations	882	860	850	846	874	846	817
Pseudo R2	0.0832	0.237	0.233	0.0506	0.255	0.0737	0.0867
Log-likelihood	-512.8	-228.1	-162.5	-282.1	-375.4	-282.9	-974.3
Log-likelihood (0)	-559.3	-298.8	-211.7	-297.2	-503.7	-305.4	-1066.7
Chi-square	93.06	141.5	98.47	30.09	256.6	45.01	184.9

These results highlight the difficulty of separating where people live and when they live in certain locations. On average, younger households live closer to the station and in TODs, while older households live at a greater distance from the station. As aging generally leads to more health issues, it is not possible to disentangle these two effects.

Control variables included in the model do not show consistent effects across models. In some cases, higher income households, white, and Asian respondents, report fewer health problems; black respondents report more, but these effects in many cases are not statistically significant in most of the models. Various control variables that measure the urban form, such as population and employment density, have no effect in all models. Infrequency of walking or using transit were expected to increase self-reported health problems, but generally show no effect, the one exception being that infrequent users of public transit report more heart conditions. Some of the dummy variables for the station are statistically significant, for example a negative coefficient for Jersey City, but this is not consistent across all models. Self-reported engagement in either moderate or vigorous physical activity is negatively associated with whether the doctor advised the respondent to engage in more physical activity and also in our ordered model of all reported health conditions, but this is generally not statistically significant for the other models.

Walking Frequency

We also estimated a model of walking frequency based on answers to how frequently the respondents walk outside for more than five minutes (this question is different from the one analyzed in the travel behavior section). Results are shown in Table 38. Only two measures are statistically significant. Those that use public transit walk more frequently and those who own a dog also walk more frequently. These results are consistent with other research on New Jersey walking frequency that used a statewide database and more detailed analysis of factors associated with walking.[70,71]

Results of this model do not show an association between distance to the station and the frequency of walking. This differs from our travel behavior analysis that showed a link between walking frequency and distance to the station. The main difference here is that the type of walking measured in this question is based on much shorter walking trips. Thus we see dog walking as a significant factor. Public transit use is also statistically significant and reflects the fact that transit users will at a minimum walk from their point of egress. However, other than the recognized health benefits of walking, we cannot draw a link to our self-reported health measures.

Table 38 – Ordered probit model of walking frequency

	Walking frequency	
	Coef.	z-stat
Distance to nearest study station (feet)	-0.000	-0.24
Station: Cranford	0.006	0.05
Station: Jersey City, Essex St	0.162	0.85
Station: Metuchen	0.048	0.40
Station: Morristown	0.167	1.27
Station: New Brunswick	0.240	1.65*
Station: Newark Broad St	-0.023	-0.13
Station: Plainfield	-0.002	-0.01
Income: $25k to $49k	0.047	0.32
Income: $50k to $74k	0.021	0.14
Income: $75k to $99k	-0.047	-0.31
Income: $100k to $149k	-0.022	-0.15
Income: $150k to $199k	0.087	0.53
Income: $200k or more	0.004	0.03
Race: Hispanic (Black or White)	-0.106	-1.05
Race: White (Hispanic or non-Hispanic)	0.061	0.46
Race: Black (Hispanic or non-Hispanic)	-0.034	-0.21
Race: Asian	-0.226	-1.36
Population density (Block Group, ACS)	0.000	0.46
Employment density (Block Group, LEHD)	1.140	0.28
Q20: Ride bus, LR, subway, train, or ferry few times a week or more	1.039	8.11**
Q20: Ride bus, LR, subway, train, or ferry once a week or less	0.211	2.06**
Q20: Car, truck, van, or motorcycle few times a week or more	-0.000	-0.00
Q20: Car, truck, van, or motorcycle once a week or less	0.246	1.52
Vehicles available per household adult	-0.031	-0.44
Q19: Shop, eat, or conduct business at TOD a few times a week or more	0.071	0.59
Q19: Shop, eat, or conduct business at TOD once a week or less	-0.120	-1.04
Households with one or more dogs	0.389	4.68**
Average age of reported adults (ref. Q38)	-0.002	-0.83
cut1	-1.409	-4.53**
cut2	-0.701	-2.28**
cut3	0.320	1.04
cut4	0.922	3.01**
Observations	1157	
Pseudo-R2	0.069	
Log-likelihood	-1635.728	

Note: Reference categories for dummy variables: Station = Rahway; Income = Less than $25k; Hispanic = No; Race: Multi-racial or other; Q20 = Never; Q19 = Never; Dogs = None.
* p<.10, ** p<.05

Conclusions

In all we find these models do not provide sufficient evidence to conclude that proximity to train stations or TODs, or the urban form characteristics we generally associate with TODs, have an association with better health outcomes, as reported by respondents. Tests of different models with different interpretations of our average age variable all provide the same inconclusive result. Age is the main confounding factor, as older households tend to live more distant from the train station and younger households live in TODs.

Our model of walking frequency shows a positive relationship with transit use and for those who own dogs. Other measures are not statistically significant. The lack of association of walking frequency with proximity to the station differs from our travel behavior analysis, most likely because the walking frequency question was phrased in the context of short walks, rather than commute trips.

Future analysis of health issues associated with TODs and train station proximity would benefit from a far more detailed examination of health outcomes and more detailed information on the travel behavior and patterns of individuals. Data on where people have resided over their lifetimes is also critical to have, as some people living in more walkable areas may have previously lived in auto-dependent areas; thus, their walking and physical activity levels may have changed over time, but their health may still be determined by a lack of physical activity in the past. A larger study to understand these issues is needed.

Safety Analysis

This component of the study examined how both traffic safety and pedestrian and bicycle safety is affected by proximity to the train station for our eight station sites. The data were collected from the statewide dataset of reported crashes in New Jersey from 2003 to 2007 known as the Plan4Safety dataset. Each crash is associated with a police-reported crash involving one or more vehicles; zero or more pedestrians; and zero or more bicycles (reported as pedestrians but flagged within the dataset). For the purposes of our analysis, a subset of the statewide data was selected. Data collected include only that from US Census block groups with centroids within two miles of the eight New Jersey transit stations that form the basis of our study (Table 39).

Table 39 – New Jersey transit-oriented development station sites

Cranford	New Brunswick
Jersey City / Essex St	Newark / Broad St
Metuchen	Plainfield
Morristown	Rahway

The dataset includes crashes that resulted in a major injury or fatality. Crash victims are compiled by their mode of travel during the crash, specifically vehicle occupant, pedestrian, or bicyclist. Vehicle occupants include both drivers and passengers. Minor injuries are not included, primarily because the quality of data associated with these tends to be relatively poor compared to data for more serious injury crashes. Table 40 details the type and location of crashes as well as the total number of each category of persons involved in crashes for the years 2003-2007.

Table 40 – Casualties within two miles of station (injuries and fatalities), 2003-2007

	Pedestrian		Bicycle		Vehicle		Total	
Location	Injuries	Fatalities	Injuries	Fatalities	Injuries	Fatalities	Injuries	Fatalities
Cranford	57	6	42	1	514	6	613	13
Jersey City / Essex St	187	6	44	0	386	6	617	12
Metuchen	46	1	10	0	599	9	655	10
Morristown	34	3	29	0	345	5	408	8
New Brunswick	125	2	57	0	384	11	566	13
Newark / Broad St	311	14	46	2	1143	18	1500	34
Plainfield	82	7	53	4	666	9	801	20
Rahway	58	8	28	1	582	10	668	19

One challenge faced when analyzing these crash data is the question of “exposure”, or the risk of being involved in a crash. In order to infer the likelihood of a crash and to compare the risks of travel between locations with different characteristics and geographies, it is necessary to know something about the level of exposure for each mode of travel in a particular location. These are data that the police do not collect, as it is not germane to their work. Police gather detailed information about the nature and location of crashes, but they do not collect robust data on the number of pedestrians, bicyclists, and vehicles on the roads.

This analysis explored alternative approaches for controlling for exposure. One of the most common means is to use total population. This is our basic exposure measure (or offset within our statistical analysis). Tests using alternative offsets, including variables such as commute mode to work (based on block groups and drawn from the 2006-2010 American Community Survey (ACS)), population density, and employment density. All gave similar results, and thus we use the more common offset of total block group population.

To perform statistical regressions, other data were assembled from a variety of sources, shown in Table 41. Measures were aggregated to the block group level when necessary. A few of the variables deserve more detailed explanation. Street Smart Walk Score was compiled from data purchased from Walk Score. These data were based on a grid of points overlaying the station area block groups and provided us with the Street

Smart Walk Score for each grid cell. The methodology for calculating Street Smart Walk Score is available on their website, and is representative of the "walkability" of the area.(72) We averaged the grid based Walk Score data to a block group average.

Road category data were based on NJDOT road classifications. These are: interstate highways and turnpikes, state highways, county highways (500 and 600 designations), and local roads. Each category was overlaid on the region of interest and GIS software was used to compute the total lengths of roads by categories for each block group. Road network densities were calculated from these variables. Distance to nearest station was also calculated from the centroid of the block group to the nearest station along the street network, a key variable for understanding whether proximity to the train station is associated with safety outcomes.

The last source of data was employment data. The US Census and ACS report employment data at place of home, but employment data at place of work is more desirable for these types of analyses as the place of work provides another distinct measure of activity. Employment data is from the Longitudinal Employer-Household Dynamics database collected by the US Census Bureau. Employment density was derived by dividing by the land area of the block group.

Table 41 – Sources of data used in analysis

Variables in Model	Source of Data	Notes
Population density	American Community Survey, 5-Year Average, 2006-2010	
Household income, median	American Community Survey, 5-Year Average, 2006-2010	
Housing units	American Community Survey, 5-Year Average, 2006-2010	
Street Smart Walk Score	Walk Score	Aggregated to block groups
Road category	NJ Department of Transportation Road Classifications	
Employment density	Longitudinal Employer-Household Dynamics, US Census, date	At workplaces
Distance to nearest station		Network distance
Land area	US Census, 2010	

Our dependent variable, which is the casualty measure, is derived for each block group. This is a count of the casualties within each block group and is a common approach to the spatial analysis of road safety data.

The base statistical model is shown in Table 43. Our dependent variable was number of crashes by mode by block group, yielding three sets of models: pedestrians, vehicles, and bicycles. The unit of analysis was Census block group. Our dataset contained 510 block groups. One block group was dropped because it was primarily parkland and waterfront with no residential population. A few other block groups were omitted from the analysis based on missing one or more of the independent variables. Our final number of observations in the model was 504 block groups. A Bayesian model that corrects for spatial autocorrelation was also estimated and is shown in Table 44.

A secondary analysis, shown in Table 45, was attempted using Walk Score grid cells as the unit of analysis. This allowed us to increase the number of observations in the dataset to 10,079 (up from the 504 block groups used in the first analysis). As with the previous analysis, pedestrian, bicycle, and vehicle models were estimated separately to measure the effects of the same demographic and urban design factors. The only change in this approach was in the unit of analysis and this allowed us to fully capture the variation in the Street Smart Walk Score rather than using a block group average. A Bayesian statistical model with this spatial structure was attempted but did not achieve convergence.

Results

Results match those of other studies of pedestrian safety analysis conducted in New Jersey.(58,73) First, income matters. Lower income areas tend to have more pedestrian casualties, all else equal. This is true for motor vehicle casualties as well, and our results show that cyclist casualties also are greater in lower income areas. Other research has been unable to identify what drives this result, both in New Jersey, and other studies internationally. One possibility is less vehicle ownership, but our models show a distinct and separate impact for household vehicle ownership; those areas with fewer vehicles have more casualties, both for pedestrians and in vehicles, similar to statewide analysis of these issues.(58) Vehicle ownership rates are not associated with cyclist casualties. Controls for road categories do not show a precise pattern; there are some indications that higher-level county and state roads are associated with more pedestrian casualties, relative to lower level roads. Those areas with more ramps and jughandles show a positive association with pedestrian casualties. Higher population density is associated with fewer casualties, for pedestrians, cyclists and drivers. Higher employment density is associated with more pedestrian casualties, but has no effect on cyclist or vehicle casualties. This is likely due to more on-street pedestrian activity in dense employment districts.

One critical variable in our analysis was distance to the transit station. Pedestrian casualties show no association with distant to the transit station, while cyclist casualties tend to increase (at a low level of statistical significance). Vehicle casualties are lower near the transit station, perhaps due to slower speeds relative to being further out.

The Walk Score variable is a measure of pedestrian friendliness and our expectation was that this would be associated with fewer pedestrian casualties with no effect on either vehicle or bicycle casualties. In the model in Table 43 we use an average of the Walk Score variable for each block group. Surprisingly, we find it is positively associated with casualties for each mode of travel. This variable may be a proxy for the exposure of pedestrians. However, since it is also positively associated with vehicle and bicyclist casualties, we cannot clearly conclude this. The Walk Score variable is correlated with population density, but omission of either of these from the pedestrian model has no effect on the results. When the population density variable was removed, the Walk

Score variable continued to have a positive effect in the pedestrian model, but became statistically insignificant in the bicycle and vehicle models.

One interpretation of these results might be that both population density and Walk Score could be proxies for road speed and pedestrian exposure, respectively. Walk Score is a composite measure of a variety of activity-generating locations, which attract high levels of pedestrians. Population density proxies for lower speeds because more space is devoted to housing people more densely and less space to wide travel lanes on roads. Pedestrians in dense urban areas would come into conflict with automobiles more frequently, but at lower speeds where they can more easily avoid harm.

One issue with modeling of crashes is that there may be spatial correlation in the data. That is, for example, how does the built environment of a given spatial unit affect the casualties in neighboring units? To account for this we estimated a Bayesian model with conditional autocorrelation.[9] The results are shown in Table 44.

The interpretation of a Bayesian model is somewhat different than a standard maximum likelihood model and allows us to examine the credible interval which shows the probability (in this case 95%) that the coefficient is within the given range. For pedestrians and vehicles we see that the distance to station variable is mostly on the positive side of the range, meaning that being closer to the station reduces casualties. The effect is stronger for vehicles. For cyclists we see the opposite effect, being near the station is associated with more casualties. These results differ from those in Table 43 since they account for spatial correlation.

One thing to note about the pedestrian model is that examining other credible intervals suggests that the coefficient will be mainly positive (-0.002 to 0.114) with a 50% probability; one can think of this as suggesting that about half the casualties are positively associated with being more distant from the station, so this result is not very strong. A similar weak result is found for the association between population density and pedestrian casualties. While the mean value of the coefficient is negative, the credible interval with a 50% probability still spans the zero value (-0.102 to 0.015)

Results for other variables, in terms of direction, are broadly similar to the model shown in Table 43.

A further regression was estimated to test the applicability of the Street Smart Walk Score as a potential measure of a variety of urban design factors using more

---

[9] This was done using Crimestat v.4.0, kindly provided by Ned Levine. Details on the model are available in Levine et al.[(214)] and Levine.[(215)]

disaggregated data (Table 45). In these models we found that distance to the train station is now not associated with any of the casualties. Population density is not associated with pedestrian casualties but continues to show a negative association with vehicle and cyclist casualties. Employment density is also not associated with pedestrian casualties but is negatively associated with vehicle and cyclist casualties. While the Street Smart Walk Score variable has a degree of correlation with the density variables it is not correlated with the distance to station (see Table 42), so this effect is not due to multi-collinearity of these two variables. This model, which uses smaller spatial units, will likely have a large degree of spatial correlation (the effect of the characteristics of neighboring areas on casualties in the area in which casualties are measured). However, we were unable to achieve convergence when estimating a Bayesian model with this data, so these results are probably not a good reflection of the underlying associations.

Table 42 – Correlations of Street Smart Walk Score with density and distance to station

	Log Street Smart Walk Score	Log of employment density	Log of population density	Log of distance to station
Log Street Smart Walk Score	1.000			
Log of employment density	0.299	1.000		
Log of population density	0.465	0.103	1.000	
Log of distance to station	-0.012	-0.031	-0.035	1.000

Note: Based on Walk Score grid cells, N=10,407

Conclusions

The factors found to be associated with pedestrian and vehicle casualties are with some exceptions similar to other research that has been conducted in New Jersey.[58] Additional variables included in this study were the distance to the nearest transit station and the Walk Score variable. As with other work, increased population density is associated with reductions in casualties, although in our case this association is weak for pedestrian casualties. From the perspective of how development around transit stations can affect safety, this is an important result, and perhaps reflects a lack of attention to reducing vehicle speeds or making areas more walkable. While increased population density tends to reduce vehicle speeds, either because more pedestrians and vehicles are present, or because the visual nature of higher density areas leads drivers to be more cautious, this is not clearly showing a strong effect on reducing pedestrian casualties. The positive result on the association of employment density with pedestrian casualties probably represents increased pedestrian activity in higher employment areas. This suggests that policy may need to be aimed at further slowing traffic through areas with higher employment density.

Lower income areas also tend to have higher casualty rates than higher income areas, a finding that is consistent with a large body of research in this area. Area-based measures of household vehicle ownership show that when vehicle ownership is lower, both pedestrian casualties and vehicle casualties are higher. The result for pedestrian casualties makes sense, in that more households will walk to activities (and take transit) and increase their exposure as pedestrians. However, the result for vehicle casualties is not intuitive. This likely suggests that some residual effect associated with these areas is not fully controlled for. Controls for road density do not show any consistent patterns, probably because this is a rather crude measure that does not account for the details of the infrastructure.

The result on the Street Smart Walk Score variable was surprising. Our expectation was that more walkable areas would be associated with lower casualties for all modes. Part of this is likely due to the Walk Score variable capturing increased pedestrian activity and so a positive effect may make some sense. This result and others were found even with a more disaggregate treatment of the data by estimating the models with the Walk Score grid as our base for spatial analysis (although we were unable to estimate this model with controls for spatial autocorrelation as it would not converge).

Table 43 – Base model negative binomial regression results – block group units

Dependent variable: Crashes within block group by mode	Pedestrians	z-stat	Bicycles	z-stat	Vehicles	z-stat
Exposure: ln(population)	1.000		1.000		1.000	
Median Household Income Quintiles						
Category 5 (highest)	-0.465	(-2.42)	-0.486	(-1.53)	-0.638	(-4.23)
Category 4	-0.410	(-2.40)	-0.212	(-0.77)	-0.390	(-2.81)
Category 3	-0.164	(-1.06)	0.420	(1.65)	-0.273	(-2.07)
Category 2	0.00371	(0.03)	0.401	(1.56)	-0.275*	(-2.16)
Category 1 (lowest, reference)	-	-				
Log of US Highway, density	-0.0371	(-1.59)	0.0345	(1.56)	0.0296	(1.82)
Log of NJ State Highway, density	0.0385	(2.92)	0.0339	(1.72)	0.0639	(5.81)
Log of County highway 500, density	0.0467	(3.67)	0.0256	(1.25)	0.0363	(3.50)
Log of County highway 600, density	0.0544	(4.90)	0.109	(5.81)	0.0344	(3.87)
Log of Ramps and jughandles, density	0.0271	(1.82)	-0.0479	(-1.95)		
Log of Interstate & NJ Turnpike Authority, density					0.0801	(6.77)
Log of Distance to nearest station	0.0631	(0.89)	-0.192	(-1.69)	0.153	(2.23)
Log of Housing Units - Without Vehicles	1.687	(2.74)	0.769	(0.77)	1.621	(3.29)
Log of Population density	-0.333	(-4.17)	-0.714	(-5.77)	-0.674	(-10.63)
Log of Street Smart Walk Score (average for block group)	0.888	(4.76)	0.687	(2.61)	0.457	(3.88)
Log of employment density	0.150	(4.50)	0.0337	(0.60)	-0.0254	(-0.96)
Constant	-9.426	(-8.92)	-1.325		1.515	
alpha	0.484		0.887		0.613	
N	504		504		504	
r2_p	0.0873		0.0947		0.0944	
ll_0	-921.0		-533.5		-1672.2	

Table 44 – Bayesian model output – block group units

	Pedestrian casualties				Bicyclist casualties				Vehicle casualties			
	Model Coef.	95% Credible Interval 2.50%	97.50%	G-R Stat	Model Coef.	95% Credible Interval 2.50%	97.50%	G-R Stat	Model Coef.	95% Credible Interval 2.50%	97.50%	G-R Stat
Variable												
Exposure: ln(population)	1.000				1.000				1.000			
Intercept	-6.150	-8,982	-3.415	1.336	0.569	-2.337	4.175	1.119	1.555	-0.160	3.361	1.050
Median household income, Q5	-0.528	-0.968	-0.112	1.031	-0.518	-1.211	0.170	1.046	-0.561	-0.869	-0.255	1.004
Median household income, Q4	-0.383	-0.744	-0.025	1.009	-0.189	-0.766	0.396	1.009	-0.313	-0.598	0.030	1.002
Median household income, Q3	-0.119	-0.438	0.199	1.003	0.403	-0.124	0.947	1.011	-0.191	-0.460	0.077	1.001
Median household income, Q2	0.096	-0.206	0.399	1.005	0.479	-0.036	1.014	1.010	-0.150	-0.409	0.110	1.000
Road density: Interstate & NJ Turnpike									0.080	0.056	0.104	1.002
Road density: US Highway	-0.030	-0.082	0.021	1.003	0.041	-0.029	0.109	1.011	0.047	0.014	0.081	1.001
Road density: NJ State Highway	0.052	0.024	0.080	1.034	0.043	0.003	0.085	1.013	0.073	0.051	0.096	1.006
Road density: County Highway (500)	0.058	0.032	0.085	1.018	0.035	-0.008	0.077	1.016	0.049	0.028	0.070	1.004
Road density: County Highway (600)	0.054	0.031	0.077	1.002	0.110	-0.444	0.149	1.018	0.039	0.021	0.057	1.000
Road density: Ramps	0.041	-0.009	0.072	1.021	-0.028	-2.072	0.025	1.012				
ln(Distance to nearest station)	0.058	-0.106	0.223	1.176	-0.233	-0.670	0.019	1.170	0.125	-0.012	0.261	1.039
ln(Housing units without vehicles)	1.080	-0.161	2.294	1.012	-0.048	-0.110	1.933	1.018	0.722	-0.306	1.769	1.001
ln(Population density)	-0.047	-0.206	0.117	1.079	-0.457	-0.079	-0.250	1.121	-0.413	-0.541	-0.271	1.022
ln(Street Smart Walk Score Average)	0.597	0.234	0.981	1.152	0.397	-0.063	0.953	1.237	0.169	-0.066	0.409	1.013
ln(Employment density)	0.181	0.117	0.246	1.024	0.049	0.003	0.157	1.128	0.013	-0.040	0.066	1.003
Model Stats												
N	504				504				504			
Average sample size	504				504				504			
Log-likelihood	-923.73				-528.74				-1527.11			

Note: The GR statistic is a measure of model convergence and should be under about 1.20. Number of sample iterations was 200,000 to achieve convergence. Burn in sample was 40,000. Estimation method was a Poisson-Gamma (negative binomial) condition autoregressive model estimated with Markov Chain Monte Carlo estimation. Distance decay function was negative exponential with α = 0.5.

Table 45 – Negative binomial regression results – Walk Score units

Dependent variable: Crashes nearest Walk Score point by mode	Pedestrians	z-stat	Bicycles	z-stat	Vehicles	z-stat
Exposure: ln(population)	1.000		1.000		1.000	
Median Household Income Quintiles						
Category 5 (highest)	0.221	(0.97)	-0.356	(-1.05)	-1.002	(-7.20)
Category 4	-0.425	(-2.21)	-0.754	(-2.54)	-0.873	(-7.08)
Category 3	-0.139	(-0.94)	-0.215	(-0.93)	-0.569	(-5.04)
Category 2	-0.356	(-2.73)	0.422	(2.25)	-0.433	(-4.08)
Category 1 (lowest, reference)	-	-				
Log of US Highway, density	-0.187	(-1.34)	-0.207	(-1.09)	0.530	(8.41)
Log of NJ State Highway, density	0.150	(1.95)	0.155	(1.33)	0.361	(4.46)
Log of County highway 500, density	0.438	(5.31)	0.267	(2.10)	0.444	(7.38)
Log of County highway 600, density	0.250	(4.12)	0.338	(3.72)	0.326	(5.00)
Log of Ramps and jughandles, density	-0.086	(-0.84)	-0.174	(-1.08)		
Log of Interstate & NJ Turnpike Authority, density					0.188	(3.87)
Log of Distance to nearest station	0.122	(1.36)	-0.012	(-0.09)	-0.076	(-1.28)
Log of Housing Units - Without Vehicles	0.382	(5.81)	0.107	(1.10)	0.109	(2.70)
Log of Population density	-0.004	(-0.07)	-0.240	(-2.64)	-0.272	(-7.46)
Log of Street Smart Walk Score (average for block group)	1.871	(11.30)	1.938	(8.14)	0.752	(16.73)
Log of employment density	-0.027	(-0.90)	-0.135	(-2.94)	-0.098	(-4.52)
Constant	-19.18	(-17.40)	-15.70	(11.52)	-7.194	(-11.75)
alpha	4.591		1.955		2.006	
N	10079		10079		10079	
r2_p	0.130		0.100		0.043	
ll_0	-2982.6		-1370.4		-7972.4	

Analysis of Residential Property Values

Introduction

Transit-oriented development seeks to intensify and diversify land uses around existing transit stations. It is thought that, if offered incentives (such as tax benefits or density bonuses), some private developers will take the lead in redeveloping transit-adjacent downtown areas, spurring increased investment around stations. One potential upshot of this process is an increase in property values near transit. Although new amenities, including increased transit accessibility, raise the cost of housing, that increase in value reflects a renewed interest in locating near transit on the part of residents, retailers and employers, and will yield increased tax revenue for local governments.

The generally accepted method for quantifying the effect of a variable, such as transit accessibility, on property values is a hedonic price model. Hedonic (from the Greek word for “pleasure”) models seek to disentangle effects of various amenities and disamenities that affect the demand for residential locations. A hedonic regression analysis makes it possible to estimate the relative influence on price of access to a school system, parks, transportation, local retail services, and the quality and size of housing, attributes that must all be purchased together. In this way we can examine how proximity to a train station is associated with increased residential property values while controlling for all the other factors that are equally or maybe even more important in determining residential housing demand.

Data and Methods

Hedonic models are typically constructed using data on individual properties. We attempted to obtain data from Multiple Listing Services maintained by REALTORS®, however, we had no success obtaining responses to our requests for data. Other data available from the NJ Dept. of Treasury reports only transactions and detail on the quantity of housing (i.e., number of rooms, etc.) are frequently missing. In lieu of micro-data, VTC obtained data from the real estate information website Zillow.com, which provided the median of their estimated market values (called "Zestimates") for each block group around our designated sample of train stations.[10] Zestimates are computed through a proprietary algorithm, which uses both public and user submitted data about the location of a property, its physical characteristics, tax assessments, and nearby real estate transactions.[(74)] Overall, the Zestimates in New Jersey have a median absolute error of 7.1 percent.[(75)] A major contribution of this study is to show that this freely available data provides reasonable results for aggregate analysis of property values.

The geographic scope of the analysis is block groups within a two mile radius of our eight sampled NJ TRANSIT Stations. The study area included five station municipalities that are designated as Transit Villages by NJDOT, namely Cranford, Metuchen, Morristown, New Brunswick and Rahway. In addition, stations in three municipalities – Jersey City (Essex Street), Newark Broad Street, and Plainfield – which have undergone some transit-oriented-type development were included in the study area as well.

The model discussed below regresses the log-transformed median Zestimate[11] for each block group using suitable control variables and our key variable of interest which is distance to the train station. The final analysis uses Spatial Error Modeling (SEM) techniques to control for spatial autocorrelation (a loss of statistically significant information due to geographic clustering). Models were estimated using GeoDaSpace software, which allows easy specification of a spatial weights matrix to account for the fact that home values in one block group are likely influenced by home values in adjacent block groups.

---

[10] Due to privacy concerns and prior data licensing agreements, data was only made available for block groups with greater than 75 individual estimates.

[11] Log-transformation of the dependent variable corrects for the skewed distribution of the Zestimates, and allows the model coefficients equation to be interpreted as expected percentage changes in the Zestimate associated with a one unit increase in the independent variables.

Two sets of network distances to train stations were calculated using ArcGIS 10.1 Network Analyst. The first model measures the distance between the block group centroids and the closest platform entrance to one of the eight TOD stations that are the focus of this study. These are designated as the “study” stations. Since we also suspected that being close to a station with direct commuter service to New York City may have a stronger influence on nearby properties than being close to TOD areas undergoing redevelopment, a second set of models was run with the network distance calculated to the nearest station with direct service to New York City. Exploratory regressions suggested that the square of the distance was also statistically significant, indicating a non-linear relationship between property values and distance to transit.

As is common in this kind of analysis, it was not possible to simultaneously include all desired control variables due to a high degree of collinearity. In particular, hypothetically important controls for the general size of housing within a block group, median number of rooms and the percentage of single-family detached housing were highly correlated with income (r=0.61 and r=0.58, respectively) as well as with each other (r=0.86). The percentage of three other types of higher density units – attached single-family units, units in multi-family buildings with fewer than 19 units, and units in multi-family buildings with greater than 20 units – were included to control for various types of housing available within each block group. The coefficients on these variables are hypothesized to be negative, since smaller housing units will be valued less than larger units, *ceteris paribus.*

Because access to public school districts of varying quality is bundled with housing, school quality is typically an important variable in hedonic analysis. In New Jersey, school districts generally correspond with municipalities, with some smaller municipalities sharing regional high schools. In order to measure the quality of schooling, each block group was assigned an average score for its district on the mathematics portion of the SAT test used for college admission. The average score for the verbal and writing sections of the test were correlated so highly with the math score (r=0.98, for both) that only one variable was necessary. High SAT scores should indicate better educational outcomes, and therefore positively influence the value of the median home in the block group. Although the educational variable was correlated with income (r=0.53), income may capture other factors outside of education, and both were included in our models due to their theoretical importance.

Local property tax rates are determined by each municipality in New Jersey, and higher tax rates would represent an additional cost to locating in a particular municipality. Since each municipality has its own method of assessing property values for taxation purposes, the New Jersey Department of Treasury publishes an “effective” tax rate, built on the assumption all districts are at 100 percent valuation, and which is designed for the purpose of comparing municipal tax rates within the state.[76] Each block group in the analysis is assigned the effective tax rate of the municipality in which it is located.

Another hypothetically important determinant of home values is access to green space and recreational parks. Nearby parks or open space might affect property values via different mechanisms and with different directions depending on size, purpose, quality and distance of a park to the relevant properties. The quality and safety of parks was not possible to measure, but in order to capture both the quantity and distance of parkland, a hybrid measure was constructed using the ArcGIS Spatial Analyst extension. The New Jersey Department of Environmental Protection makes available a dataset with the boundaries of all State and County owned parkland. Because some urban environments in our study area may have better access to smaller, municipally-owned parks, polygons representing recreational land were extracted from the Statewide Land Use/Land Cover dataset and added to this dataset, ensuring that land within State or County parks was not double-counted. A grid of 50-foot cells was created, with each cell receiving a score ranging from one to nine, with each unit representing the distance of the cell to the boundary of the nearest park. For the analysis, each block group was assigned the average score of the 50-foot cells falling within the block group. Although the score is in distance-based units, the final block group score also decreases as the quantity of nearby parkland increases, since a greater area of open space will decrease the score of more individual cells. It was hypothesized that a decrease in the average park score would be associated with an increase in median property values. Table 46 provides a summary of variables used in this analysis.

Table 46 – Variables used in analysis

Variable Name	Description	Source
Median Residential Property Value	Median value of residential property for each block group based on “zestimates” provided by Zillow.com. Snapshot of data collected in June 2012.	Zillow.com
Dist. to Nearest Study Station	Road network distance (mi) between the block group centroids and nearest entrance to closest study station.	Calculated in ArcGIS using data from NJ DOT
Dist. to Nearest NYC Station	Road network distance (mi) between the block group centroids and nearest train station with direct commuter service to New York City.	Calculated in ArcGIS using data from NJ DOT
Median HH Income (10,000s)	Income of the median household in each block group, in tens of thousands of dollars	ACS 2006-2010 5-year Estimates
Median No. of Rooms	Median number of rooms in dwelling units	ACS 2006-2010 5-year Estimates
Population Density (1,000s/sq. mi)	Thousands of persons per square mile	ACS 2006-2010 5-year Estimates
Effective Tax Rate	Effective property tax rate (in points) of the municipality in which each block group is situated	NJ Department of the Treasury
% of HU in Small Multi-family	Proportion (decimal) of housing units in multi-family structures with 19 or fewer units	ACS 2006-2010 5-year Estimates
% of HU Single-family Attached	Proportion (decimal) of housing units in single-family attached structures	ACS 2006-2010 5-year Estimates
% of HU in Large Multi-family	Proportion (decimal) of housing units in structures with 20 or greater units	ACS 2006-2010 5-year Estimates
% Black or African American	Proportion (decimal) of block group residents who are Black or African American	ACS 2006-2010 5-year Estimates
% Other, non-White	Proportion (decimal) of block groups who are non-white, and not Black or African American	ACS 2006-2010 5-year Estimates
Median Year Structure Built	Year of construction for the median housing unit	ACS 2006-2010 5-year Estimates
Violent Crime Rate (per capita)	5-year, combined average of murder, assault, rape, and robbery incidents in the municipality in which each block group is situated	Federal Bureau of Investigation, Uniform Crime Reports
Average SAT Math Score	Average SAT Math score of students in each block group's school district, as a proxy for educational quality	NJ Department of Community Affairs
Park Accessibility Score	Score (1 - 9) representing average distance of 50-foot cells within each block group to the nearest park, with each point being equal to 1/8th mi.	Calculated in ArcGIS using data from NJ Department of Environmental Protection

Results

The results from the two final models are presented in Table 47. In general, the high Pseudo-R^2 statistics for all models indicate a good fit. The significant Lambda coefficient indicates that some, if not all, spatial autocorrelation (clustering) is being controlled for in the model as well. All distance variables were significant at the five percent confidence level, and the magnitude and coefficients of control variables are as expected.

Models 1 and 2 vary only in how we define the station that is near the block group. In Model 1, this is defined as the nearest "study" station, i.e., one of the eight TOD areas that we gathered data for. In Model 2 we define the nearest station with direct service to New York City. In both cases we include a quadratic term for the distance to the station, as this gave a better fit to the models than a simple linear relationship. Both distance variables are statistically significant and have the expected effect. That is, the closer the block group to the station, the higher the average property value. The value diminishes with distance, up to a certain distance from the station, at which point it increases (for the "study" station) or diminishes at a slower rate (for the direct NYC service station). Figure 13 graphically shows these effects.

The marginal effect of distance on property values is shown at three distances in Table 48. All else being equal, block groups one mile from a study station are expected to have property values 6.3 percent lower than block groups one-half mile from the "study" station; block groups located one and a half miles from a study station are expected to have property values an additional 2.7 percent lower than those located one mile away, and properties two miles out have a small increase in value. Similar results were found using distance to stations with direct service to New York City. A change from one half-mile to one mile from the station is associated with a five percent reduction in property values. Interestingly, a change from one to two miles from a New York direct station is associated with an additional 5.6 percent reduction in property values. This suggests that the magnitude of the premium for being near a station with direct service to Manhattan is higher than the premium for being near a TOD station. The increased steepness of the slope for the TOD stations, shows that there is real value in being close to the TOD area. For both types of stations, property valuations decline with distance, but there is an increase in value for the TOD stations at about two miles, perhaps due to increased access to another station with direct service to Manhattan. These results provide affirmative evidence of a positive association between property values and transit-oriented locations.

Models 3 and 4 parallel the first two models but include the median number of rooms, while omitting the income variable due to a high degree of correlation between the two. However, the median income should capture the amount and quality of housing most residents can afford. Both median rooms and income are highly significant and positive in the models, and indicate an approximate 2.3 to 2.4 percent rise in median property values along with each $10,000 increase in block group income, or a 4.9 to 5.0 percent increase per room.

Other control variables show expected effects. The median year in which housing was constructed is significant in Models 3 and 4, and shows a slight premium (0.1%) for newer housing per year. The demographic variables indicate a strong, negative association between property values and the proportion of black and other minority residents. The analysis shows that a 10 point increase in the proportion of black residents is associated with a decline in property values of over four percent, and about two percent for other minorities. Proportions of attached and multi-family housing are generally significant and negative, since these units tend to be smaller. The average park accessibility score was also statistically significant at the 10 percent level in Models 1 and 2, indicating that an increase of one point (meaning the average 50-foot cell within the block group was 1/8th miles further from a park) was associated with a decline in the average Zestimate of approximately 2.2 to 2.3 percent. School quality, as measured by performance on the mathematics section of the SAT exam, was significant and positive, and indicated that a 10 point increase in SAT scores is associated with a two to three percent increase in median Zestimates.

In addition, several of the dummy variables for stations were significant in Models 1 and 3. Rahway is used as the reference. The Jersey City dummy variable was the most consistently significant and had the strongest positive association. For instance, block groups in the Jersey City study area are expected to have a median Zestimate between 49 and 57 percent higher than those in the Rahway study area. When distance to New York direct stations is used, rather than the "study" stations, Jersey City is the only dummy variable that remains significant. That Jersey City remains significantly different is likely explained by its comparatively high level of accessibility and geographic proximity to New York City.

Table 47 – Spatial error model results (DV = natural log of median Zestimate)

	(1)		(2)		(3)		(4)	
Variable	β	p > z	β	p > z	β	p > z	β	p > z
Dist. to Nearest Study Station	-0.236**	0.007			-0.262**	0.005		
Dist. to Nearest Study Station^2	0.073**	0.009			0.079**	0.009		
Dist. to Nearest NYC Station			-0.116**	0.002			-0.138***	0.001
Dist. to Nearest NYC Station^2			0.020**	0.002			0.024***	0.001
Median HH Income (10,000s)	0.024***	0.000	0.023***	0.000				
Median No. of Rooms					0.049***	0.000	0.050***	0.000
Population Density (1,000s/sq. mi)	0.0000	0.966	0.0000	0.975	-0.000	0.651	-0.000	0.589
Effective Tax Rate	-0.024***	0.000	-0.026***	0.000	-0.022***	0.000	-0.024***	0.000
% of HU in Small Multi-family	-0.103**	0.035	-0.085*	0.078	-0.100**	0.030	-0.076*	0.091
% of HU Single-family Attached	-0.411***	0.000	-0.391***	0.000	-0.408***	0.000	-0.386***	0.000
% of HU in Large Multi-family	-0.198**	0.014	-0.183**	0.023	-0.151*	0.078	-0.130	0.126
% Black or African American	-0.419***	0.000	-0.422***	0.000	-0.435***	0.000	-0.439***	0.000
% Other, non-White	-0.218***	0.000	-0.226***	0.000	-0.203***	0.000	-0.211***	0.000
Median Year Structure Built	0.000	0.114	0.001*	0.053	0.001**	0.011	0.001**	0.006
Violent Crime Rate (per capita)	0.001	0.126	0.001	0.222	0.001	0.203	0.000	0.302
Average SAT Math Score	0.002***	0.000	0.002***	0.000	0.002***	0.000	0.003***	0.000
Park Accessibility Score	-0.023*	0.075	-0.022*	0.084	-0.021	0.117	-0.021	0.110
Cranford Station	0.095**	0.048	0.098*	0.059	0.102*	0.062	0.099*	0.082
Essex St. Station (Dummy)	0.490***	0.000	0.456***	0.000	0.579***	0.000	0.536***	0.000
Metuchen Station (Dummy)	0.004	0.963	-0.008	0.930	-0.000	0.997	-0.012	0.909
Morristown Station (Dummy)	0.251**	0.023	0.219*	0.064	0.273**	0.041	0.238*	0.090
New Brunswick Station (Dummy)	0.046	0.517	0.020	0.776	0.030	0.698	0.004	0.957
Newark Broad St. Station (Dummy)	0.132**	0.045	0.126**	0.031	0.131*	0.072	0.123*	0.058
Plainfield Station (Dummy)	0.027	0.738	-0.043	0.758	0.026	0.781	-0.079	0.607
Lambda	0.658***	0.000	0.630***	0.000	0.700***	0.000	0.680***	0.000
Constant	9.362***	0.000	8.657***	0.000	7.988***	0.000	7.230***	0.000
N	451		451		451		451	
Pseudo-R^2	0.773		0.781		0.734		0.745	

* Significant at p < 0.10
** Significant at p < 0.05
***Significant at p < 0.001
Note: Rahway Station Omitted as Reference

Table 48 – Marginal effects of distance on log of Zestimate

Distance to Study Stations (Model 1)			Distance to NYC Stations (Model 2)		
D	β_1*D+β_2*D^2	Change	D	β_1*D+β_2*D^2	Change
0.5	-0.100		0.5	-0.053	
1	-0.163	-0.063	1	-0.096	-0.043
1.5	-0.190	-0.027	1.5	-0.1293	-0.033
2	-0.180	0.010	2	-0.152	-0.023

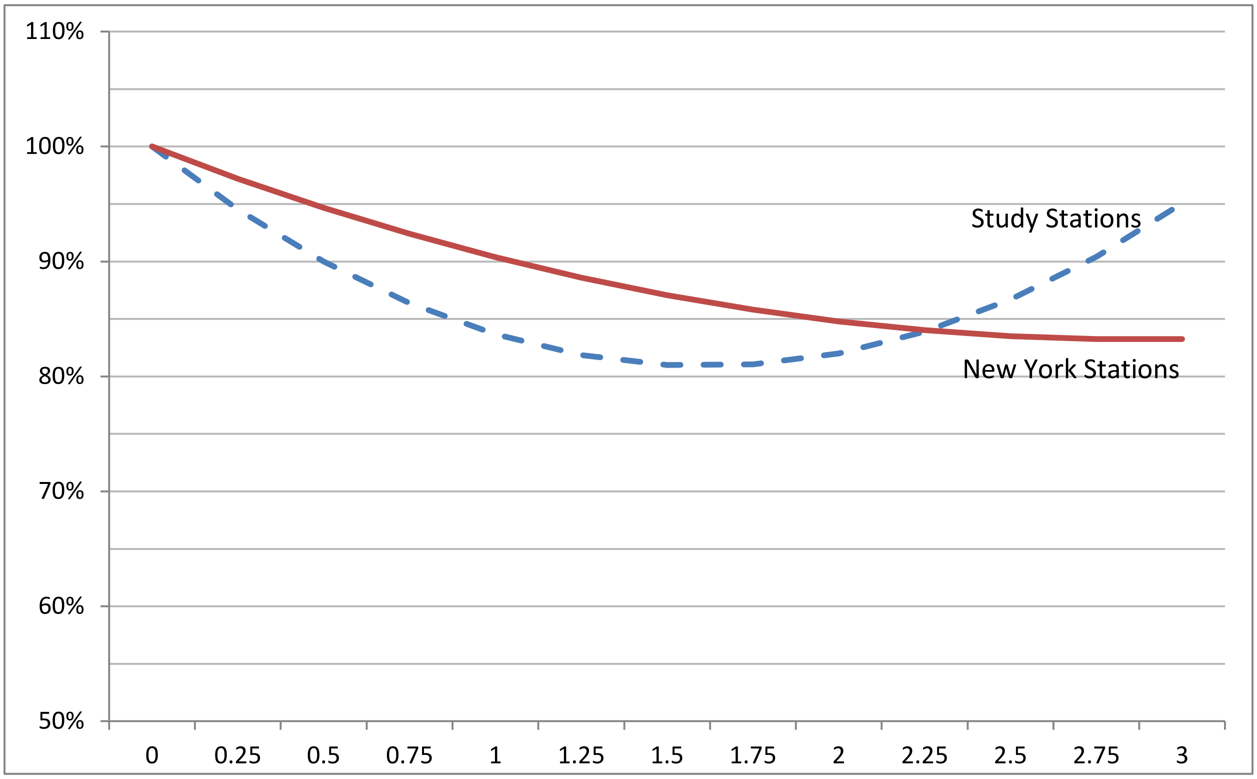

Figure 13. Expected change in Zestimate as a function of distance to transit (based on models 1 & 2)

In order to examine the robustness of our models, we also tested sub-samples that excluded block groups in three study areas. Table 49 presents results for the same model iterations as above, but exclude Newark and Jersey City, which have somewhat different transit characteristics than others areas in our data due to the additional presence of the Port Authority Trans-Hudson (PATH) service. Jersey City and Newark serve as both important origins and destinations for transit riders; Jersey City is likewise also very close to Manhattan. Very little actual property development has occurred around Broad Street Station, which serves as the center of the Newark study area. Table 50 presents results which, in addition to Jersey City and Newark, exclude the Plainfield study area (Table 12), which is also a less “mature” TOD than other study areas in terms of the amount of development around the station.

Table 49 – Spatial error model results, excluding Jersey City and Newark
(DV = natural log of median Zestimate)

	(5)		(6)		(7)		(8)	
Variable	β	p > z	β	p > z	β	p > z	β	p > z
Dist. to Nearest Study Station	-0.338***	0.000			-0.354***	0.000		
Dist. to Nearest Study Station^2	0.104***	0.000			0.103***	0.000		
Dist. to Nearest NYC Station			-0.084**	0.041			-0.114**	0.013
Dist. to Nearest NYC Station^2			0.014**	0.027			0.018**	0.011
Median HH Income (10,000s)	0.026***	0.000	0.025***	0.000				
Median No. of Rooms					0.085***	0.000	0.080***	0.000
Population Density (1,000s/sq. mi)	-0.002	0.412	-0.000	0.723	-0.001	0.514	-0.000	0.957
Effective Tax Rate	-0.021***	0.000	-0.024***	0.000	-0.018***	0.000	-0.021***	0.000
% of HU in Small Multi-family	-0.151**	0.016	-0.130**	0.035	-0.071	0.265	-0.049	0.424
% of HU Single-family Attached	-0.478***	0.000	-0.449***	0.000	-0.405**	0.001	-0.387**	0.002
% of HU in Large Multi-family	-0.171	0.124	-0.130	0.222	0.023	0.854	0.057	0.629
% Black or African American	-0.311***	0.000	-0.329***	0.000	-0.303***	0.001	-0.317***	0.001
% Other, non-White	-0.236***	0.000	-0.236***	0.001	-0.205**	0.003	-0.200**	0.004
Median Year Structure Built	0.001	0.163	0.001	0.118	0.001	0.105	0.002	0.101
Violent Crime Rate (per capita)	0.002**	0.020	0.002**	0.043	0.001**	0.034	0.001*	0.077
Average SAT Math Score	0.002***	0.000	0.003***	0.000	0.003***	0.000	0.003***	0.000
Park Accessibility Score	-0.009	0.608	-0.002	0.884	-0.022	0.257	-0.015	0.413
Cranford Station	0.101**	0.025	0.095*	0.065	0.111**	0.012	0.114**	0.042
Metuchen Station (Dummy)	-0.032	0.678	-0.056	0.575	-0.053	0.470	-0.070	0.481
Morristown Station (Dummy)	0.209**	0.036	0.180	0.126	0.179*	0.063	0.161	0.184
New Brunswick Station (Dummy)	0.050	0.437	0.011	0.873	0.016	0.788	-0.025	0.724
Plainfield Station (Dummy)	-0.018	0.792	-0.060	0.651	-0.009	0.888	-0.055	0.683
Lambda	0.599***	0.000	0.622***	0.000	0.548***	0.000	0.611***	0.000
Constant	8.115***	0.000	7.017**	0.006	6.781**	0.005	6.030**	0.032
N	267		267		267		267	
Pseudo-R2	0.805557		0.784435		0.80932		0.784532	

Table 50 – Spatial error model results, excluding Jersey City, Newark and Plainfield (DV = natural log of median Zestimate)

	(9)		(10)		(11)		(12)	
Variable	β	p > z	β	p > z	β	p > z	β	p > z
Dist. to Nearest Study Station	-0.249**	0.010			-0.272**	0.01		
Dist. to Nearest Study Station^2	0.078**	0.006			0.078**	0.01		
Dist. to Nearest NYC Station			-0.110**	0.014			-0.155**	0.001
Dist. to Nearest NYC Station2			0.027**	0.001			0.035***	0.000
Median HH Income (10,000s)	0.025***	0.000	0.023***	0.000				
Median No. of Rooms					0.084***	0.00	0.080***	0.000
Population Density (1,000s/sq. mi)	-0.024***	0.000	-0.023***	0.000	-0.022***	0.00	-0.020***	0.000
Effective Tax Rate	0.000	0.756	0.000	0.741	0.001	0.61	0.001	0.526
% of HU in Small Multi-family	-0.113*	0.056	-0.105*	0.067	-0.021	0.73	-0.015	0.798
% of HU Single-family Attached	-0.473***	0.000	-0.459***	0.000	-0.394***	0.00	-0.397***	0.001
% of HU in Large Multi-family	-0.167	0.130	-0.142	0.173	0.016	0.90	0.037	0.751
% Black or African American	-0.280**	0.006	-0.276**	0.008	-0.279**	0.01	-0.262**	0.008
% Other, non-White	-0.215***	0.001	-0.232***	0.000	-0.178**	0.01	-0.193**	0.003
Median Year Structure Built	0.001*	0.099	0.002*	0.094	0.002**	0.05	0.002*	0.055
Violent Crime Rate (per capita)	0.001	0.235	0.001	0.248	0.000	0.51	0.000	0.510
Average SAT Math Score	0.002***	0.000	0.002***	0.000	0.003***	0.00	0.002***	0.000
Park Accessibility Score	-0.037**	0.043	-0.033	0.079	-0.054**	0.00	-0.051**	0.006
Cranford Station	0.095*	0.051	0.027	0.588	0.100**	0.04	0.035	0.488
Metuchen Station (Dummy)	-0.012	0.892	0.035	0.702	-0.033	0.69	0.022	0.796
Morristown Station (Dummy)	0.235*	0.054	0.269**	0.027	0.206*	0.08	0.249**	0.043
New Brunswick Station (Dummy)	0.039	0.604	0.043	0.565	0.008	0.91	0.011	0.873
Lambda	0.686***	0.000	0.666***	0.000	0.645***	0.00	0.653***	0.000
Constant	7.389**	0.001	7.088**	0.004	5.662**	0.03	5.679**	0.038
N	216		216		216		216	
Psuedo-R^2	0.752		0.754		0.765		0.762	

These model runs are generally similar in terms of the sign and significance compared to the models estimated in Table 48. When Newark and Jersey City are excluded, access to New York direct stations becomes somewhat less important, which could be expected due to the high level of connectivity between these cities and New York. In those models, the distance to study stations curve is somewhat steeper, indicating an increase in importance, although it returns to a shape similar to the original results when Plainfield is also excluded (See Figure 14 and Figure 15). The estimated effect of park accessibility loses most of its precision in these models, but not when Plainfield is excluded. Due to the similarity of our results across models, we conclude that our results are reasonably robust.

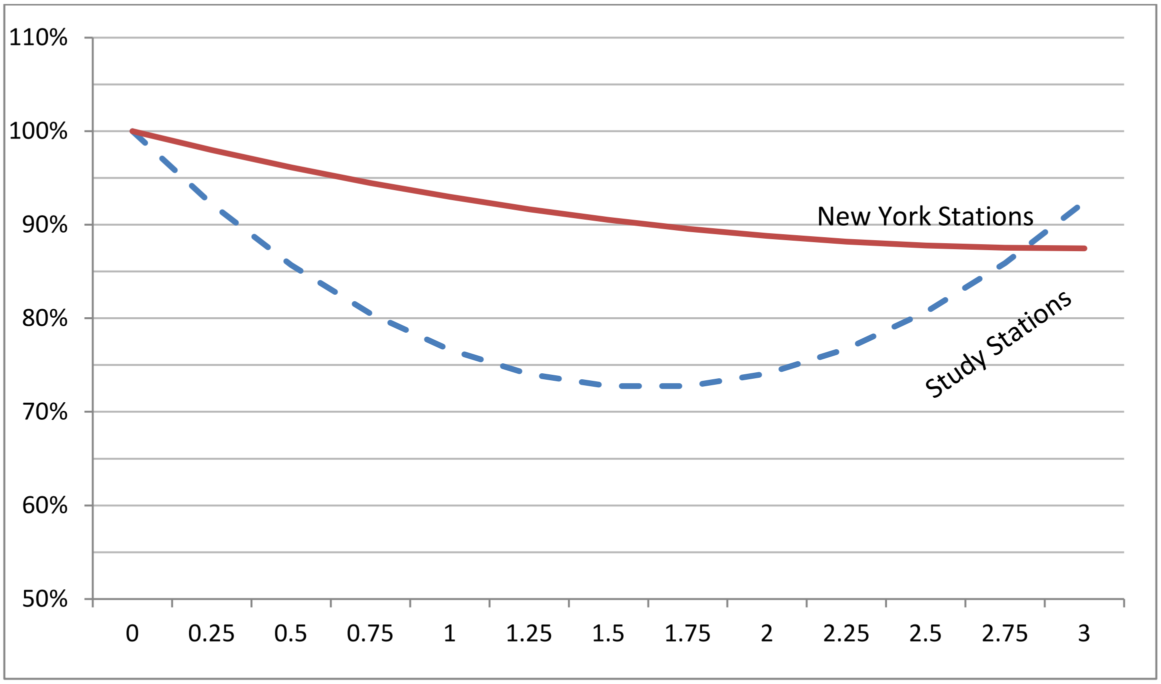

Figure 14. Expected change in Zestimate
as a function of distance to transit (based on models 5 & 6)

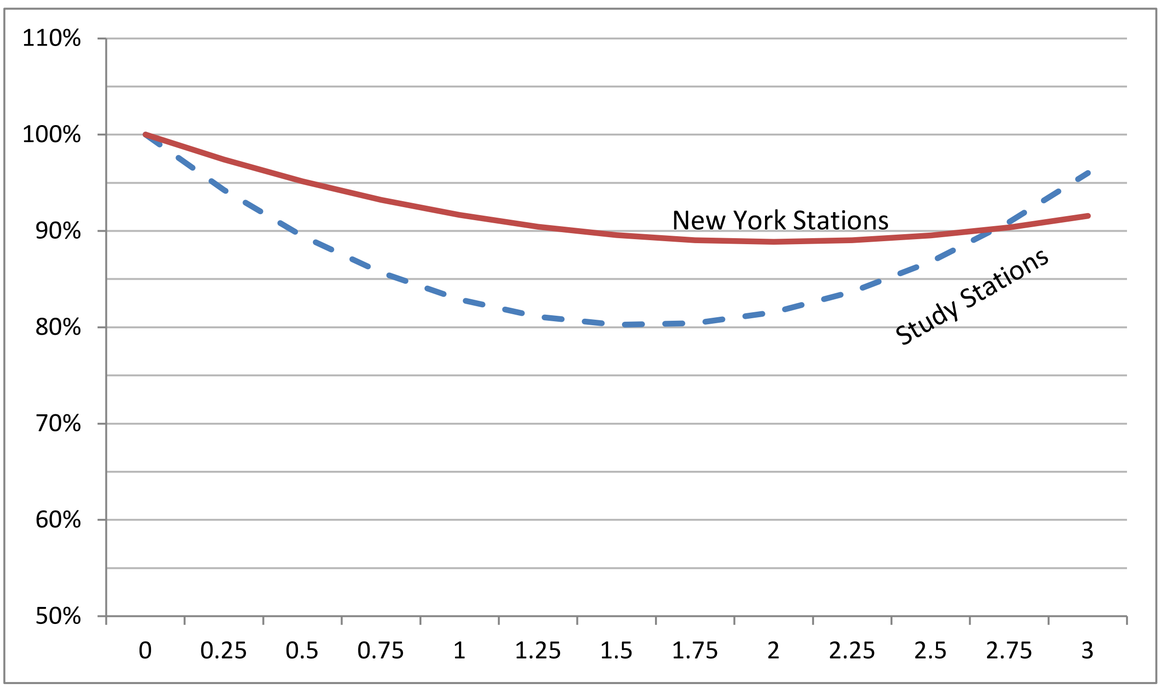

Figure 15. Expected change in Zestimate
as a function of distance to transit (based on models 9 & 10)

Conclusions

These results support our hypothesis that proximity to rail transit increases residential property valuations. In addition, as the model results closely track theoretically expected results, this study demonstrates that data from Zillow can provide a good measure of housing values, filling an important gap when individual transaction data (which we were unable to obtain) are unavailable. A notable result is that access to stations with direct New York City service is valued slightly higher than access to our “study” stations. Some of the latter include direct access to New York City (e.g. New Brunswick, Rahway, Metuchen, Newark Broad Street, and Morristown). The upward movement in housing value after about a distance of two miles from the “study” stations may be due to increased proximity to another station, with direct New York City service. Access to New York City is perhaps valued in the real estate market more than other elements of a TOD, especially at moderate distances of between two and three miles from the train station. Proximity to TOD centers is clearly also valued, but the ultimate destination of commuters and other travelers is an important element in the relationship between accessibility and value in the residential housing market.

Analysis of User-benefits

One of the main beneficiaries of more compact development near transit stations is the population that chooses to locate there to reduce their travel costs. This analysis aims to examine the relative costs of travel for residents near transit of either using transit or driving. The analysis is limited in that we use NJ TRANSIT onboard survey data, thus, our sample is only of those who currently use transit. This data was used because it provides a large sample of users with a variety of final destinations, allowing us to more accurately measure the average benefits that users receive from transit, relative to driving.

Data

The data used for this analysis was from an NJ TRANSIT onboard survey conducted over several years leading up to 2007 (Table 51). These data provide information on the origins and destinations of transit users as well as their access mode, specifically whether they walk, use a bus, or drive (or are driven) to the station. The onboard survey data were collected from 33,365 NJ TRANSIT rail users from all over New Jersey in 2007. Among these, there were 2,296 users located around the seven TOD locations shown in Table 52. The data includes information on boarding and destination stations, origin and destination municipalities and addresses, mode of access and egress, time of trip, and trip purpose. The data used in the analysis is summarized in Table 56. Table 52, Figure 16, and Figure 17 show the number of responses during the AM Peak period (5:00-9:30am) for the seven boarding stations categorized by the main disembarking stations (Newark Penn Station, Newark Broad Street, Hoboken, and New York Penn Station).

Table 51 – Key data used from NJ TRANSIT surveys

NJ TRANSIT Survey Responses
Origin City and Address
Mode of Access to Station
Boarding Station
Boarding Time
Disembarking Station
Destination City and Address
Mode of travel to Destination

Table 52 – Sample size of AM peak responses for select stations from NJ TRANSIT surveys

Origin Station	Destination Station				
	Hoboken	**New York Penn**	**Newark**	**Other**	**Total**
Cranford	3	58	96	3	160
	1.9%	36.3%	60.0%	1.9%	100.0%
Metuchen	6	507	208	16	737
	0.8%	68.8%	28.2%	2.2%	100.0%
Morristown	37	181	9	22	249
	14.9%	72.7%	3.6%	8.8%	100.0%
New Brunswick	3	223	103	29	358
	0.8%	62.3%	28.8%	8.1%	100.0%
Newark Broad St	21	98	0	1	120
	17.5%	81.7%	0.0%	0.8%	100.0%
Plainfield	3	32	100	14	149
	2.0%	21.5%	67.1%	9.4%	100.0%
Rahway	4	347	158	23	532
	0.8%	65.2%	29.7%	4.3%	100.0%
Total	77	1,446	665	108	2,296
	3.4%	63.0%	29.0%	4.7%	100.0%

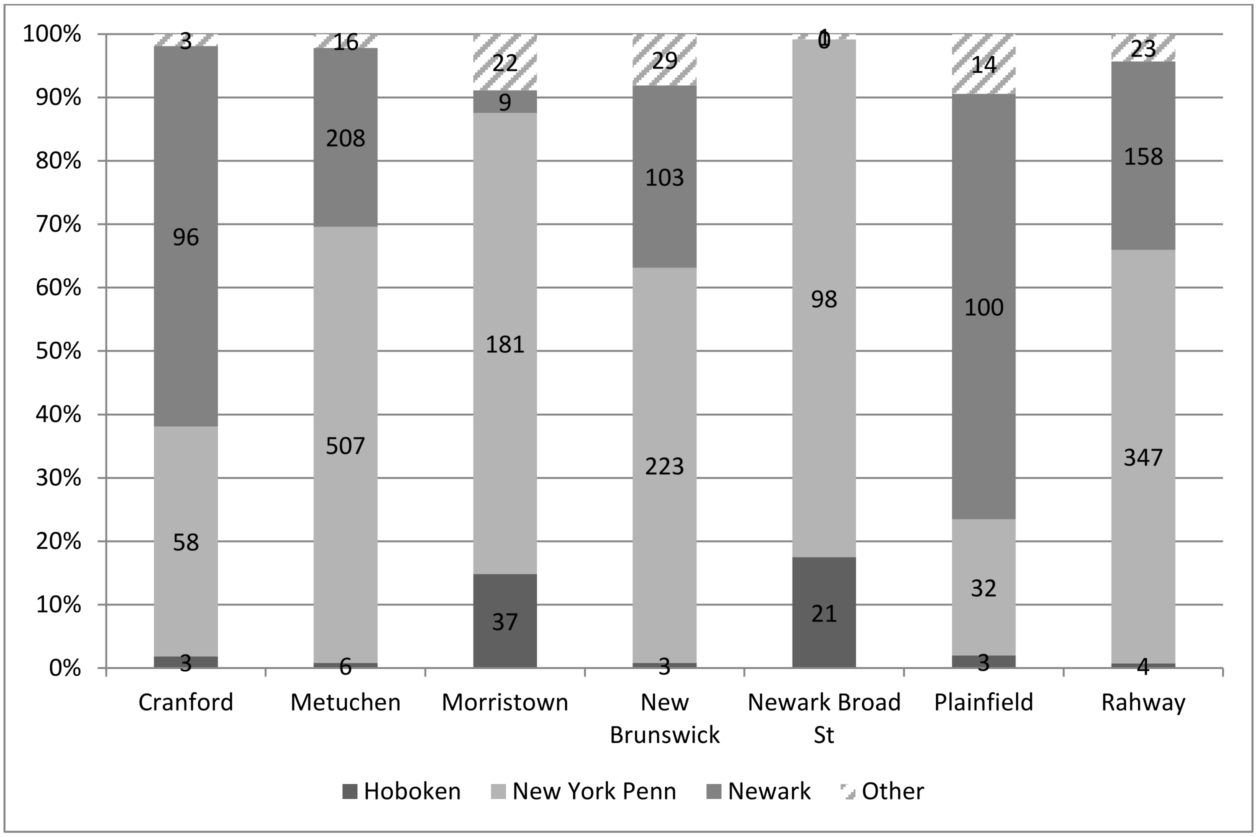

Figure 16. Size of AM peak responses for select stations from NJ TRANSIT surveys

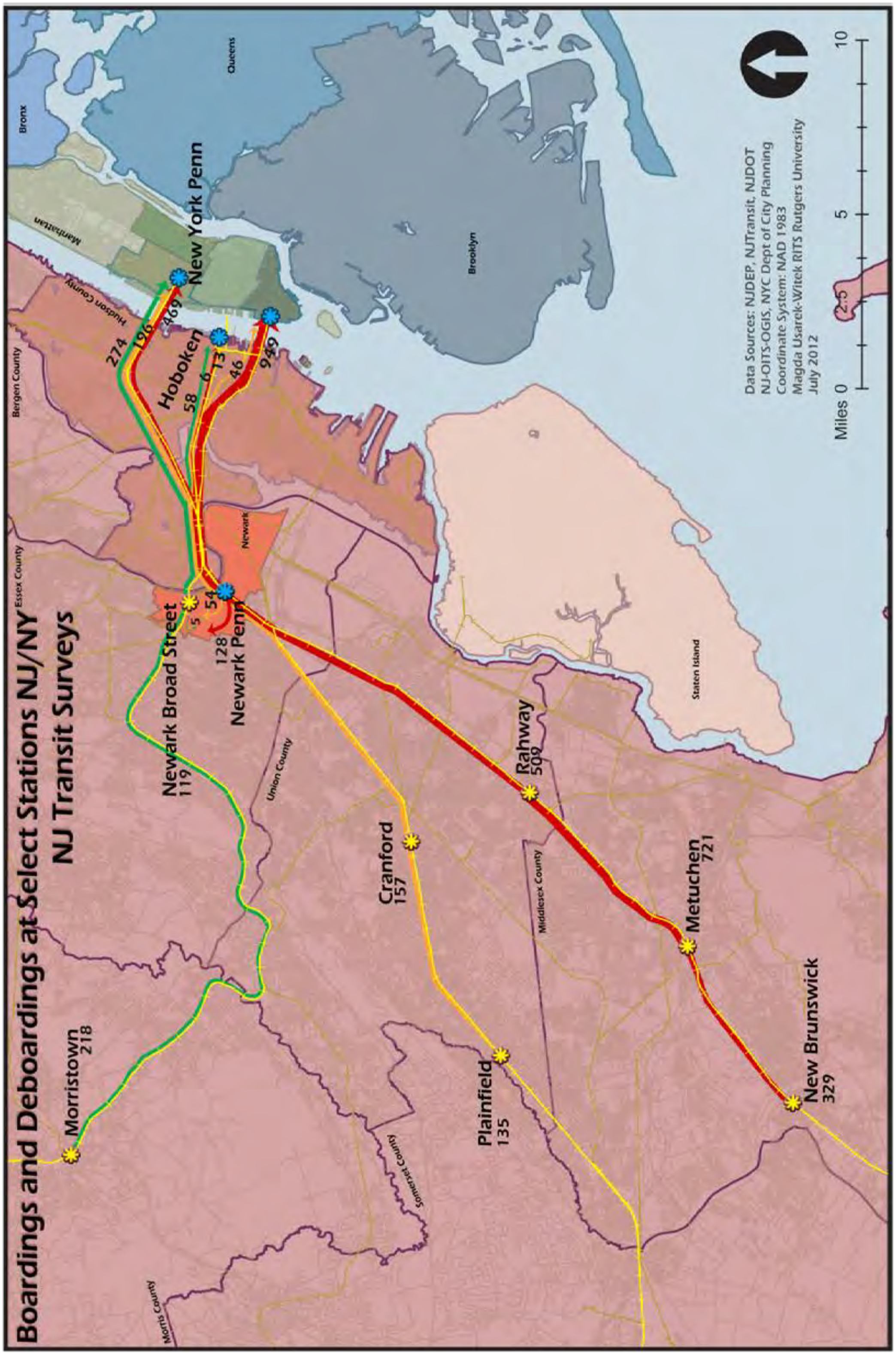

Figure 17. AM peak responses for select stations from NJ TRANSIT survey

The trip for each user is constructed assuming door-to-door journeys. Key data extracted from the survey include origin of commuters (at the municipality level) their selected train station (see Table 53), mode of access to train station (Table 54 and Figure 18), and final destination beyond disembarking station (Table 55 and Figure 20). Origin-destination (OD) pairs and modes of access with fewer than 10 responses were not included in this analysis. They are combined for each station and categorized under "other."

Table 53 – Origin of trips for selected stations from NJ TRANSIT surveys

STATION/ Municipality	# of responses	Share per station	STATION/ Municipality	# of responses	Share per station
CRANFORD	160	100.0%	NEWARK BROAD ST	120	100.0%
Cranford	114	71.3%	Newark	70	58.3%
Other	46	28.7%	Other	50	41.7%
METUCHEN	737	100.0%	PLAINFIELD	149	100.0%
Edison	294	39.9%	North Plainfield	25	16.8%
Metuchen	280	38.0%	Plainfield	83	55.7%
Piscataway	39	5.3%	South Plainfield	11	7.4%
South Plainfield	39	5.3%	Other	30	20.1%
Other	85	11.5%	RAHWAY	532	100.0%
MORRISTOWN	240	100.0%	Avenel	69	13.0%
Chester	11	4.6%	Carteret	13	2.4%
Mendham	27	11.3%	Clark	36	6.8%
Morristown	131	54.6%	Colonia	65	12.2%
Randolph	27	11.3%	Edison	29	5.5%
Other	44	18.3%	Rahway	239	44.9%
NEW BRUNSWICK	358	100.0%	Scotch Plains	20	3.8%
East Brunswick	17	4.7%	Other	61	11.5%
Highland Park	61	17.0%			
New Brunswick	74	20.7%			
North Brunswick	34	9.5%			
Piscataway	23	6.4%			
Somerset	80	22.3%			
Other	69	19.3%			

Table 54. Mode of access to train station from NJ TRANSIT onboard survey data

Origin Station	Car-Dropped	Drove alone	Walk Only	Other	Total
			Mode		
Cranford	24 15.2%	74 46.8%	53 33.5%	9 4.4%	160 100.0%
Metuchen	139 18.9%	368 50.1%	166 22.6%	64 8.4%	737 100.0%
Morristown	27 11.3%	160 66.7%	49 20.4%	4 1.7%	240 100.0%
New Brunswick	103 29.1%	126 35.6%	77 21.8%	52 13.6%	358 100.0%
Newark Broad St	13 11.8%	19 17.3%	46 41.8%	42 29.1%	120 100.0%
Plainfield	27 18.1%	67 45.0%	39 26.2%	16 10.7%	149 100.0%
Rahway	105 19.9%	224 42.4%	106 20.1%	97 17.6%	532 100.0%
Total	438 19.3%	1,038 45.6%	536 23.6%	284 11.5%	2,296 100.0%

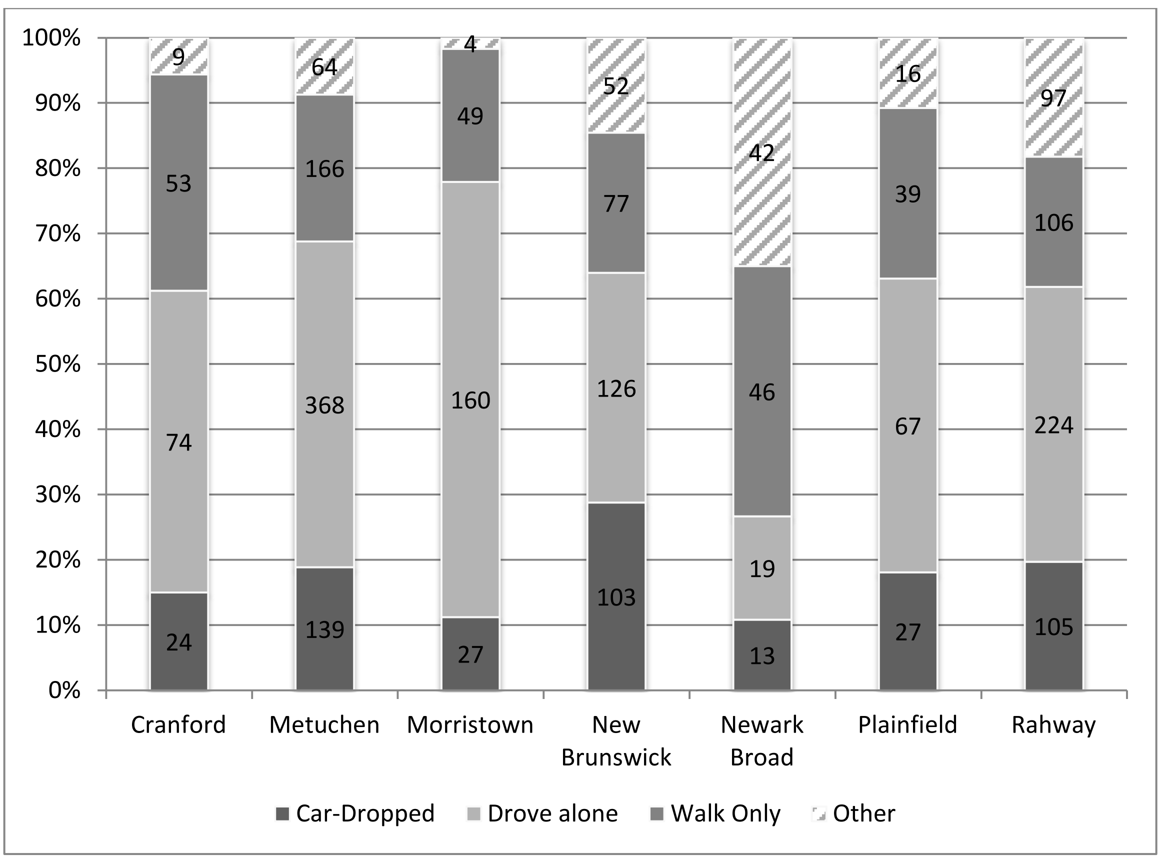

Figure 18. Mode of access to train station from NJ TRANSIT survey data

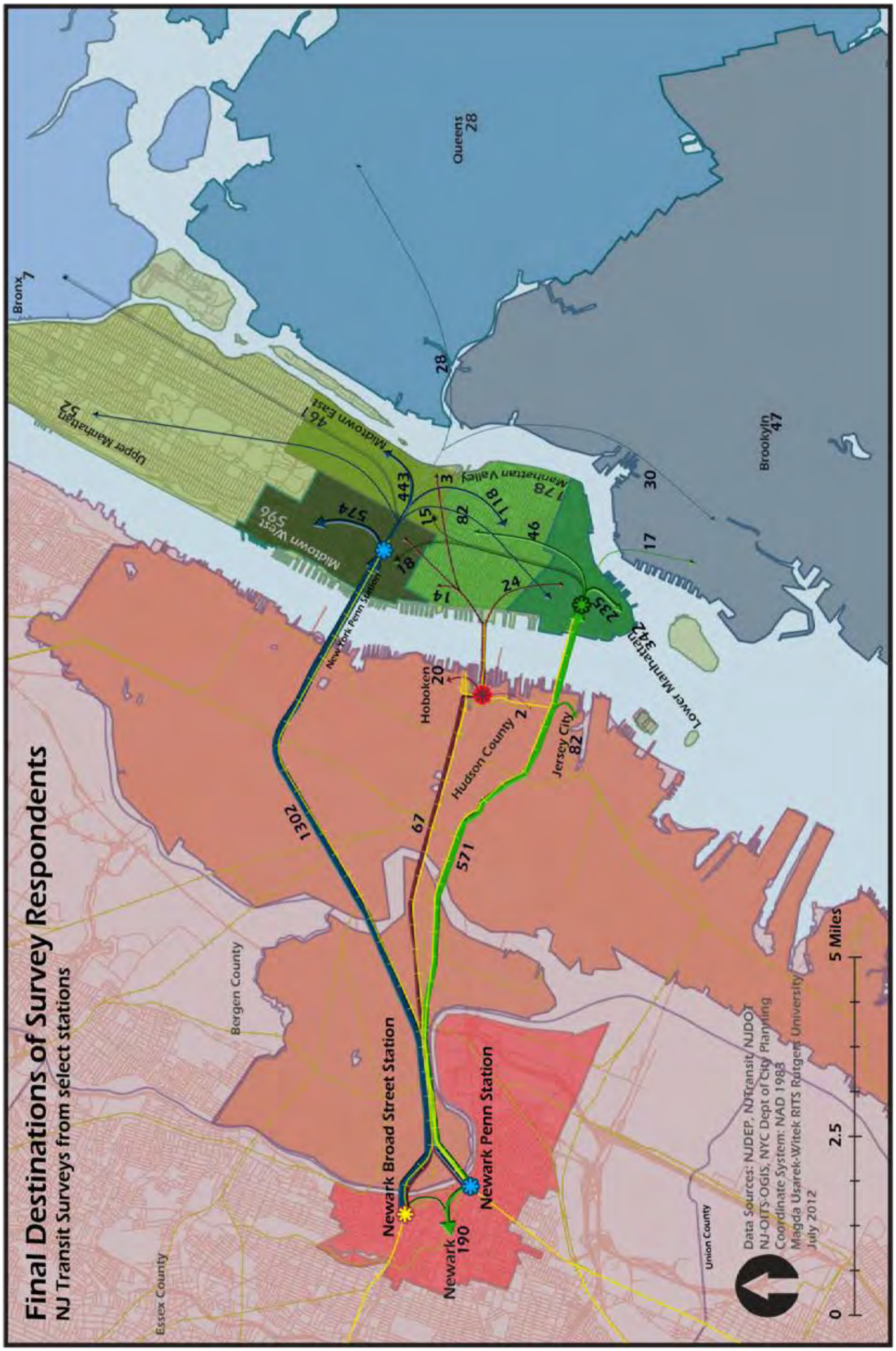

Figure 19. Map of final destinations (by zone) for respondents to/from select stations from NJ TRANSIT surveys

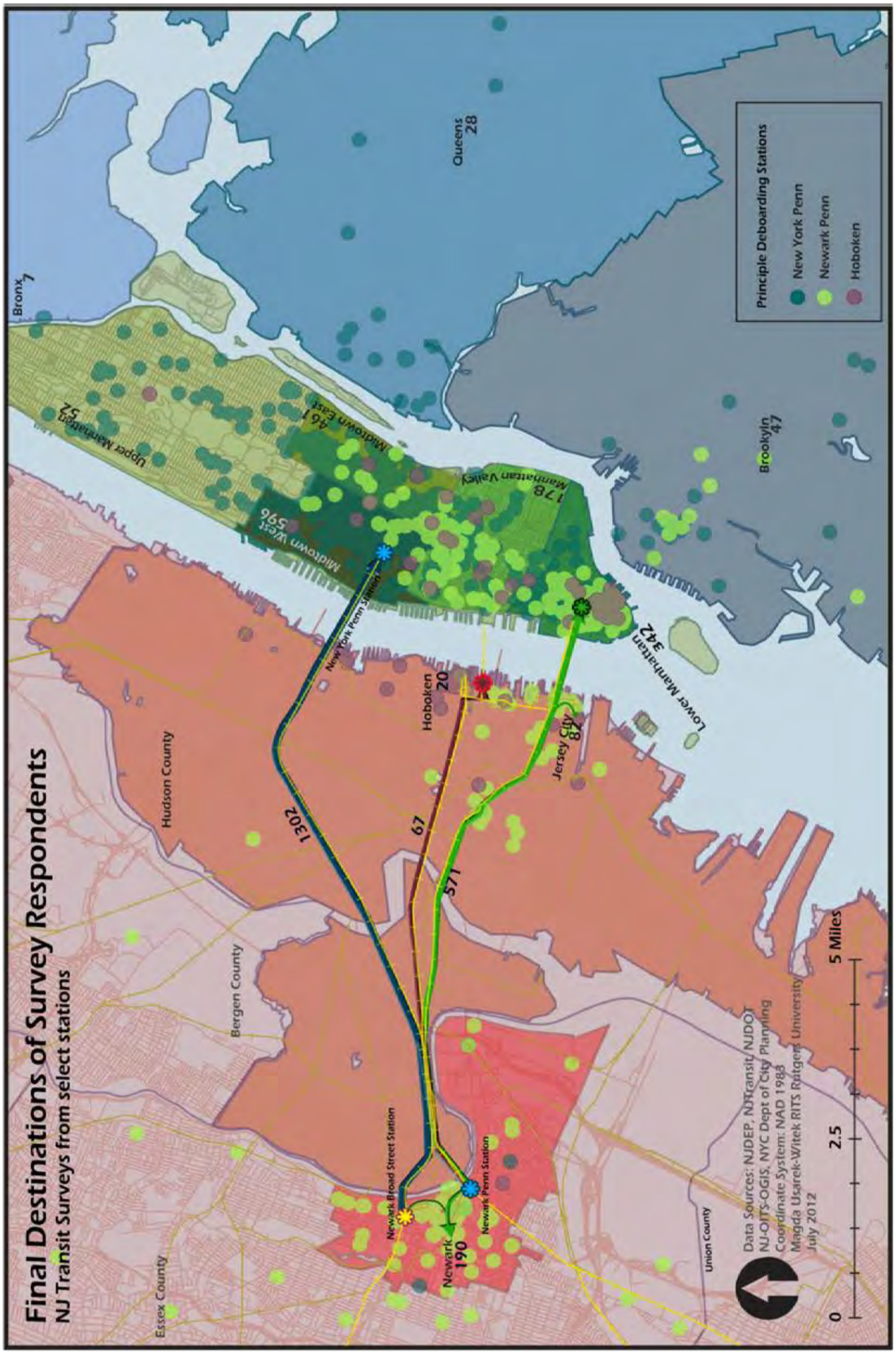

Figure 20. Map of final destinations for respondents to/from select stations from NJ TRANSIT surveys

Table 55 – Destination groupings by origin station from NJ TRANSIT surveys

Origin Station	Destination: Lower Manhattan	Midtown	Uptown	Other NY	Newark	Jersey City	Other NJ	No Response / Other	Total
Cranford	58	49	0	2	22	6	6	17	160
Metuchen	186	376	14	38	46	34	18	25	737
Morristown	46	130	3	2	8	2	13	36	240
New Brunswick	68	167	13	8	39	12	35	16	358
Newark Broad St	19	62	10	7	0	0	4	18	120
Plainfield	26	27	2	8	32	7	22	25	149
Rahway	117	246	10	29	43	21	28	38	532
Grand Total	520	1,057	52	94	190	82	126	175	2,296
	22.6%	46.0%	2.3%	4.1%	8.3%	3.6%	5.5%	7.6%	100.0%

Methodology

The basis of this analysis is to examine our station area locations and compare the user costs of using transit with driving. This includes estimates of travel time and out-of-pocket costs. An attractiveness index is developed that measures the total cost of driving from the origin to the final destination versus the same trip with transit. The attractiveness of driving to transit for each origin and destination pair is calculated by dividing total driving cost by total transit cost. Thus, values greater than one will suggest that transit is preferred over driving:

$$A_{TD_{ij}} = \frac{TDC_{ij}}{TTC_{ij}}$$

where,

$A_{TD_{ij}}$ = attractiveness of driving over transit for each TOD location, *i*, and destination, *j*.
TDC = total cost of driving for each TOD location, *i*, and destination, *j*.
TTC = total cost of using transit for each TOD location, *i*, and destination, *j*.

By weighting the trip costs from a single origin to various destinations by the number of trips to each destination, the average attractiveness can be calculated for each TOD location. In the case of rail transit, the average attractiveness can be calculated for each station based on the destinations of those that use that station.

The costs of each trip are composed of out-of-pocket costs including fares, parking fees, tolls, and vehicle operating costs (car fuel, maintenance, and the cost of owning a vehicle per distance traveled), as well as travel time costs including those associated with walking, waiting and transfers (see Table 56). Additionally, many commuters combine modes by driving to train stations or transferring to other transit lines. We assume that the majority of commuters living at or near train stations currently have the following options to access their workplaces and other destinations:

- Walk to station and use transit
- Drive to station and use transit

- Drive directly to destination

There are also other less-used options for station access such as bicycling, carpooling, shuttles, and buses. In the case of transit commuters, the mode of travel from their disembarking station to their final destination can also include a mix of walking, taking the subway or a bus, or using a taxi. Commuters utilizing buses for commuting comprise a significant number of trips, but are not considered in this study (partly because bus trip destinations are more decentralized and data was not available).

Table 56 – Major costs of travel for driving and rail transit

Driving Out-of-Pocket Costs	Rail Transit Out-of-Pocket Costs	Rail Transit Other Costs
Vehicle Operating Costs	Fares	Value of In-Vehicle Travel Time
Tolls	Parking at Station (for drive-access)	Value of Access Travel Time
Parking Cost		Value of Transfer Time
Other Driving Costs		
Value of In-Vehicle Travel Time		

By combining all of the significant travel costs for commuters, the total driving cost and total transit cost can be determined, and the attractiveness index can be calculated for each rail station location at which the trip originates.

Travel Time Estimations and Cost Assumptions

Travel time for highway users are determined using the North Jersey Regional Transportation Model–Enhanced 2010 AM Peak period estimated travel times. The AM Peak assignment provides travel times between zones for each origin-destination (OD) pair identified from the survey data, as discussed above.

Destination zones are clustered based on the definitions in table 6 and sampled to derive the average travel times between OD clusters, both from origin to final destination and for origin to train station for drive-to-transit commuters. Vehicle operating cost is determined by the cost of vehicle fuel and maintenance. Table 57 shows the average one-way travel time (mins) and vehicle operating cost ($) for origin zones clustered by municipalities and destinations clustered by zone groupings, categorized by the boarding station of transit users identified in the NJ TRANSIT survey.

Table 57 – Estimated one-way travel time (mins) based on the NJRTM-E model and vehicle operating costs ($)

Cranford Station Users	Time (m)	Vehicle Cost ($)	Newark Broad Station Users	Time (m)	Vehicle Cost ($)
From Cranford to:			From Montclair to:		
Cranford Station	7	0.26	Midtown Manhattan	80	4.04
Jersey City	57	3.64	Newark Broad Street Station	26	1.29
Lower Manhattan	81	4.22	From Newark to:		
Manhattan Valley	85	5.66	Hoboken	47	2.41
Midtown Manhattan	89	4.66	Lower Manhattan	67	2.76
Newark	29	2.00	Midtown Manhattan	72	3.26
			Newark Broad Street Station	12	0.51

Metuchen Station Users	Time (m)	Vehicle Cost ($)	New Brunswick Station Users	Time (m)	Vehicle Cost ($)
From Edison to:			From East Brunswick to:		
Brooklyn	79	5.27	Midtown Manhattan	122	7.81
Lower Manhattan	98	5.57	New Brunswick Station	24	1.49
Manhattan Valley	101	6.93	From Highland Park to:		
Metuchen Station	14	0.62	Lower Manhattan	101	6.19
Midtown Manhattan	105	6.35	Midtown Manhattan	109	7.24
Newark	51	3.46	New Brunswick Station	8	0.39
Queens	97	7.14	Newark	58	4.54
Upper Manhattan	93	6.7	From New Brunswick to:		
From Metuchen to:			Jersey City	83	5.84
Brooklyn	77	5.56	Lower Manhattan	106	6.5
Jersey City	73	4.97	Manhattan Valley	109	7.82
Lower Manhattan	94	5.72	Midtown Manhattan	114	7.23
Manhattan Valley	97	6.95	New Brunswick Station	7	0.3
Metuchen Station	8	0.34	Newark	63	4.95
Midtown Manhattan	102	6.72	Upper Manhattan	100	7.66
Newark	49	3.79	From North Brunswick to:		
Queens	93	7.32	Lower Manhattan	112	6.84
Upper Manhattan	89	6.88	Midtown Manhattan	120	7.56
From Piscataway to:			New Brunswick Station	13	0.79
Lower Manhattan	110	6.91	From Piscataway to:		
Metuchen Station	24	1.29	Midtown Manhattan	118	7.66
Midtown Manhattan	118	7.66	New Brunswick Station	21	1.07
Upper Manhattan	105	7.99	From Somerset to:		
From South Plainfield to:			Lower Manhattan	125	8.09
Lower Manhattan	114	6.34	Midtown Manhattan	132	8.71
Metuchen Station	27	1.14	New Brunswick Station	36	2.85
Midtown Manhattan	122	7.13	Newark	81	6.2
Upper Manhattan	110	7.5			

Morristown Station Users	Time (m)	Vehicle Cost ($)
From Chester to:		
Midtown Manhattan	151	9.62
Morristown Station	50	3.37
From Mendham to:		
Midtown Manhattan	134	8.93
Morristown Station	33	2.07
From Morristown to:		
Hoboken	85	5.82
Lower Manhattan	104	6.16
Manhattan Valley	102	7.47
Midtown Manhattan	111	7.39
Morristown Station	7	0.3
Newark	54	4
From Randolph to:		
Midtown Manhattan	130	8.13
Morristown Station	32	1.77

Plainfield Station Users	Time (m)	Vehicle Cost ($)
From North Plainfield to:		
Midtown Manhattan	122	6.54
Newark	63	3.84
Plainfield Station	9	0.34
From Plainfield to:		
Jersey City	103	6.46
Lower Manhattan	129	7.5
Manhattan Valley	129	8.83
Midtown Manhattan	134	7.66
Newark	76	4.9
Plainfield Station	13	0.87
From South Plainfield to:		
Newark	66	4.16
Plainfield Station	11	0.57

Rahway Station Users	Time (m)	Vehicle Cost ($)
From Avenel to:		
Lower Manhattan	78	4.2
Manhattan Valley	82	5.56
Midtown Manhattan	86	4.95
Newark	35	2.52
Rahway Station	9	0.49
From Carteret to:		
Midtown Manhattan	83	4.67
Rahway Station	19	0.93
From Clark to:		
Lower Manhattan	86	4.6
Midtown Manhattan	97	5.21
Rahway Station	22	0.65
From Colonia to:		
Lower Manhattan	91	4.75
Midtown Manhattan	99	5.52
Rahway Station	18	0.62
From Edison to:		
Midtown Manhattan	106	6.37
Rahway Station	29	1.41
From Rahway to:		
Brooklyn	62	3.92
Jersey City	57	3.64
Lower Manhattan	79	4.26
Manhattan Valley	79	4.22
Midtown Manhattan	88	4.98
Newark	33	2.28
Queens	78	5.79
Rahway Station	8	0.3
From Scotch Plains to:		
Midtown Manhattan	110	5.57
Rahway Station	45	1.57

Fixed costs incurred by drivers include highway and bridge tolls and parking costs. Tolls are selected based on NJ Turnpike E-Z Pass Peak tolls as determined by routes derived from Google Maps® for travel between the origin and destination, as well as the Port Authority of NY&NJ Peak EZ-Pass toll cost for Hudson River Crossings ($9.50). Parking costs are based on values from the 2011 Manhattan Core Parking Study by the NYC Department of City Planning,[77] and supplemented by primospot.com, a website which lists parking facilities and their monthly costs. Parking values range upwards of $500 per month in Midtown and Lower Manhattan, and between $150-250 per month at other key destinations.

Transit travel times are determined based on NJ TRANSIT scheduled travel times during the AM Peak period from origin to destination. For transit users, the NJ TRANSIT trip leg is preceded and succeeded by home-to-station and station-to-destination trip segments, respectively. Users most often travel to the station by foot or car, and their final segment is completed either on foot or on the NYC Subway or PATH train.

Walk time, wait time, and transfer time are dependent on the individual trips of users. Based on the survey data, origin addresses of those that walk to the train station are aggregated by municipality. The NJRTM-E model-based walk times were gathered for municipalities proximate to train stations, and further refined using Google Maps® estimated walk times. An average of 2.5 minutes was assumed for wait times for each leg of the trip, as well as 5 minutes if a transfer was required. A transfer was required for the following trips in our sample:

- Cranford and Plainfield commuters to destinations beyond Newark
- Commuters transferring to PATH service at Newark Penn Station or Hoboken
- Commuters transferring to New York City Subway at New York Penn Station

For drive-to-transit commuters, drive time from origin to the train station is based on survey data for origins and NJRTM-E highway assignment for travel times, and parking cost is determined by the lowest monthly parking fees listed on www.njtransit.com, for those who park at the station.

Value of Travel Time

A value-of-time assumption is required to monetize travel time into a cost. We assume first that the value of time for users is based on their average annual income. This is derived from the onboard survey data for the average of all OD pairs in the survey data. Average annual income for each OD pair used in the analysis is shown in Table 58.

Table 58 – Average annual income from NJ TRANSIT survey respondents

Station	Downtown Newark	Midtown East	Midtown West	Hoboken	Jersey City	Lower Manhattan	Manhattan Valley	Upper Manhattan
Cranford	$105,000	$147,100	$117,261	$300,000	$160,417	$159,306	$117,188	$125,000
Metuchen	$98,070	$134,205	$129,852	$100,000	$116,935	$141,813	$116,483	$118,125
Morristown	$87,083	$174,536	$152,566	$194,583	$125,000	$150,463	$114,250	$104,750
New Brunswick	$77,302	$111,041	$108,972	$46,250	$104,000	$116,529	$90,469	$83,750
Newark Broad St	-	$117,903	$86,674	$69,542	$20,000	$113,125	$126,308	$78,273
Plainfield	$79,190	$96,944	$110,000	$93,333	$132,500	$111,167	$116,364	$43,500
Rahway	$77,767	$110,420	$110,337	$68,125	$98,913	$93,327	$109,167	$81,091

Based on values reported in the literature we can derive the values for other components of travel time, specifically time spent in transit vehicles, walking time, waiting time, and transfer time. Table 59 and Table 60 list conversion factors from some of the relevant studies that have estimated values of time.

Table 59 – Monetization of walk, wait, and transfer times

Component	Function
In-vehicle travel time for transit (VoIVTT)	0.5* Hourly Wage Rate
Walk Time	1.66*VoIVTT
Wait Time	1.47*VoIVTT
Transfer Time	17.61* VoIVTT

Table 60 – Monetization of walk, wait, and transfer times

Study	Location/Type	Factor*VolVTT	Mean
Parsons Brinckerhoff Quade and Douglas Inc. (1998)[78]	Cleveland	Wait time	2.58
Barton-Ashman Associates (1993)[79]	Houston	Wait time	2.13
Parsons Brinckerhoff Quade and Douglas Inc. (1993)[80]	Minneapolis-St. Paul	Wait time (first 7.5 minutes)	4.00-4.36
		Wait time (over 7.5 minutes)	0.88-10.78
		Transfer wait time	1.58-4.36
		Transfer penalty (extra)	17.27-121.05
Parsons Brinckerhoff Quade and Douglas Inc. (1999) [81]	Chicago	Wait time	3.41
Kim (1998)[82]	Portland	Various out-of-vehicle time, work trips	1.25-2.46
		Out-of-vehicle time, non-work trips	2.67
US Environmental Protection Agency (2000)[83]	Review of 50 US studies	Walk time	2.0-2.72
Wardman (2001)[84]	Review of British studies from 1980 to 1996	Walk time	1.66
		Wait time	1.47
		Walk and wait time	1.46
		Headway	0.8
		Interchange I	17.61
		Interchange II	34.59
		Interchange III	33.08
Liu, Pendyala, and Polzin, (1997)[85]	New Jersey	Transfer Auto-to-Rail	15
		Transfer Rail-to-Rail	5
CTPS, (1997)[86]	Boston, MA	Transfer All modes combined	12 - 15

Based on these studies, the following assumptions were used:

- Value of Auto Travel Time = Average Income
- Value of Transit Travel Time = 0.5 x Average Value of time
- Value of Walk Time = 1.46 x Value of Transit Travel Time
- Value of Wait Time = 1.46 x Value of Transit Travel Time
- Value of train-to-train Transfer Time = 5 x Value of Transit Travel Time
- Value of car-to-train Transfer Time = 15 x Value of Transit Travel Time

Other travel time valuations can also be assumed and tested to examine the robustness of these assumptions on the results. This has not been done given time and budget constraints of this study.

Results

Round trip out-of-pocket, travel time and total costs are shown in Figure 21 for each study station (except Jersey City, Essex St.). The costs are calculated as a weighted average, weighted by the number of users using each station for each origin and destination pair. Since these results are based on NJ TRANSIT onboard survey data, these results show the comparison of driving costs to transit costs when transit is the chosen option. Therefore it is likely that weighted highway costs would exceed weighted transit costs for these locations based on the data used. However, this is not the case for some of the transit stations.

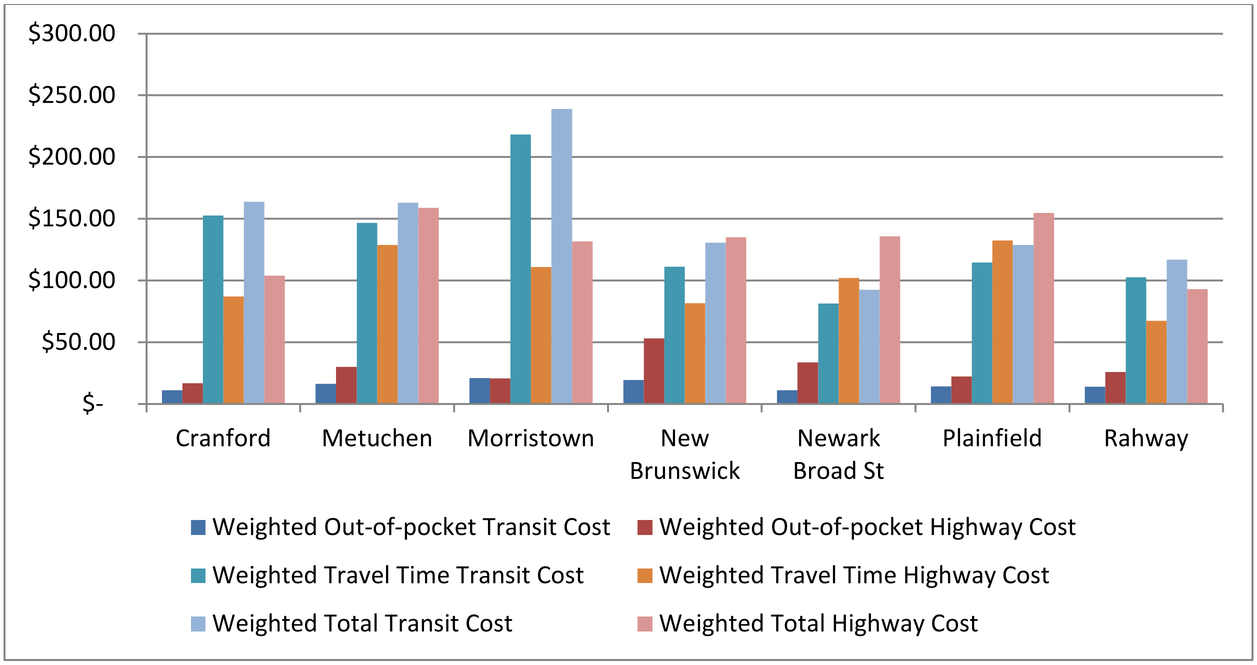

Figure 21. Weighted round trip transit and driving costs for TOD sites

The Attractiveness Index, or the ratio of total driving costs to total transit costs, is shown in Table 61 and Figure 22 for each study site. The attractiveness ration for out-of-pocket, travel time, and total costs is showing. Values greater than one suggest that transit should be the preferred mode from the selected station. The attractiveness shows the relative transit-to-driving cost for rail transit users for each of the seven stations, and can be used to compare each station's relative attractiveness as a function of the transportation network and its users. The attractiveness values are based on (i) only out-of-pocket costs (transit fare, tolls, vehicle operating cost, parking, etc.) and (ii) total costs (value of auto and transit travel time, walk time, wait time, and transfer time and out-of-pocket costs).

As can be seen, the out-of-pocket costs are highly favorable for all the stations (Morristown is essentially neutral with a value so close to one). What makes transit less preferable is the travel time costs. These are sensitive to our value-of-time assumptions. Despite this limitation, at least three station areas are generally preferable for transit.

Table 61 – Attractiveness index (drive-vs-transit cost ratio) of each TOD

TOD Station	Attractiveness ratio (out-of-pocket)	Attractiveness ratio (travel time costs)	Attractiveness ratio (total cost)
Cranford	1.52	0.57	0.64
Metuchen	1.84	0.88	0.97
Morristown	0.99	0.51	0.55
New Brunswick	2.74	0.74	1.03
Newark Broad St	3.01	1.26	1.47
Plainfield	1.57	1.15	1.20
Rahway	1.84	0.65	0.80

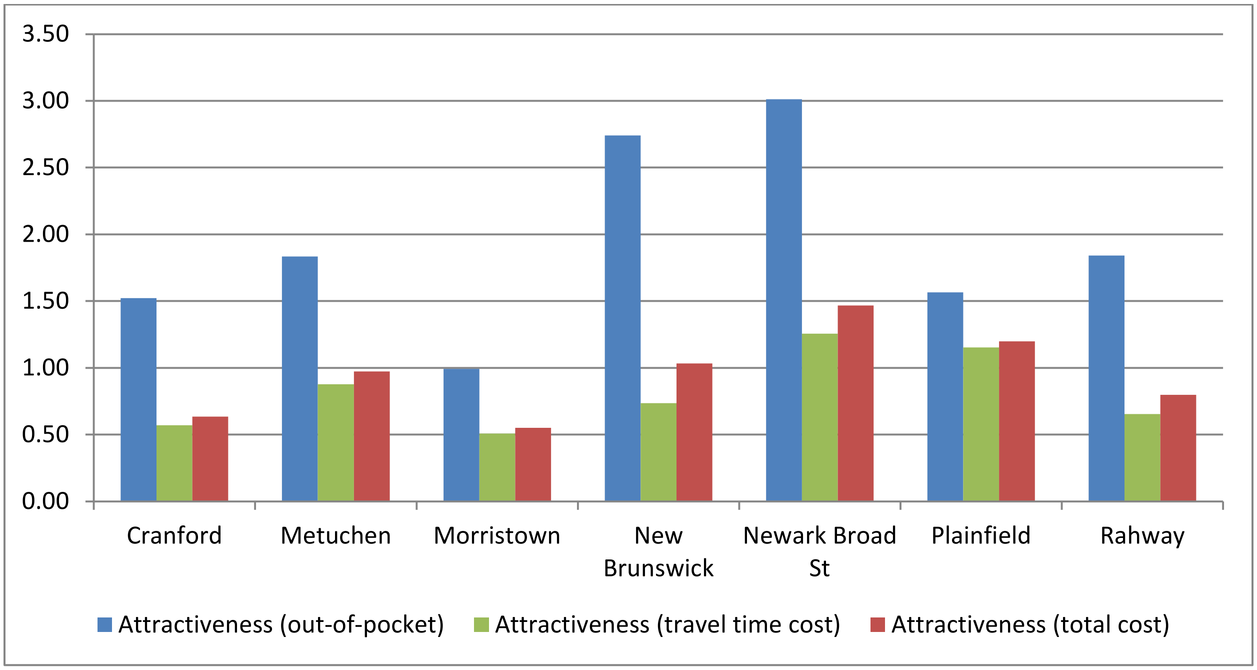

Figure 22. Attractiveness index by station

Based on the NJRTM-E output, driving travel time is roughly double transit travel time for all respondents with the exception of Newark Broad Street users, where driving travel time is approximately 3.5 times transit travel time. However, the ratio of out-of-pocket attractiveness (A_{OOP}) to total cost Attractiveness (A_{TC}) varies from station to station, indicating the difference between costs such as fares, tolls, and unrealized costs (value of travel time). These are shown in Table 62.

Table 62 – Attractiveness based on ratio of out-of-pocket costs to travel time costs

TOD Station	A_{OOP}/A_{TC}
Cranford	2.39
Metuchen	1.88
Morristown	1.80
New Brunswick	2.65
Newark Broad St	2.05
Plainfield	1.30
Rahway	2.31

The attractiveness indices of (A_{OOP} and A_{TC}) provide an evaluation metric for the effectiveness of a location for TOD. In order to validate these indices, it is important to evaluate them for other locations which have not been chosen as TOD locations, as controls for comparison. The control sites provide a set of locations for a controlled experiment to show the effect of transit availability and difference in travel time between highway and transit.

User-level Costs for Control Sites

The attractiveness indices provide an evaluation metric for the effectiveness of a location for TOD. In order to examine the robustness of these indices, we evaluate them for other locations that have not been chosen as TOD locations, to determine how they are different in these locations.

Nine control sites are shown in Table 63. These are sites throughout New Jersey, some with transit accessibility and others without transit accessibility. An attempt is made, in the choice of control sites, to incorporate locations that are geographically dispersed from the TOD locations. The attractiveness indices are analyzed for locations with a varying degree of accessibility to transit. The following are some reasons for the choice of the control sites:

- The reasoning behind the choice of Hamilton and Princeton Junction is to have train stations that do not have many housing developments thus with a lower number of walk-access trips.
- North Brunswick is chosen based on a conversation with NJ Transit staff, as this is the site of a potential new station.
- Marlboro, Vernon and Flemington are chosen to analyze sites that currently do not have ready access to transit.
- Tenafly is chosen to look at sites that currently do not have a direct access and have more auto trips to NYC.

Table 63 – List of control sites

Control Sites
Asbury Park
Fairfield
Flemington
Hamilton
Marlboro
North Brunswick
Princeton Junction
Tenafly
Vernon

Unlike the TOD locations where NJ TRANSIT onboard surveys were conducted, the control sites do not have information on the proportion of users who access each train station by walking or driving. Hence, for the control sites that have a train station in the selected town, the walk and drive-access percentages were assumed to be 40% and 60%, respectively. This scenario assumes a hypothetical situation where there is sufficient TOD at the control site to generate 40% walk-access trips. For control sites that do not have a train station in the same town, it was assumed that 100% of the users have drive-only access. Round trip out-of-pocket, travel time and total costs are shown in Figure 23 for each control site weighted according to the assumed proportions.

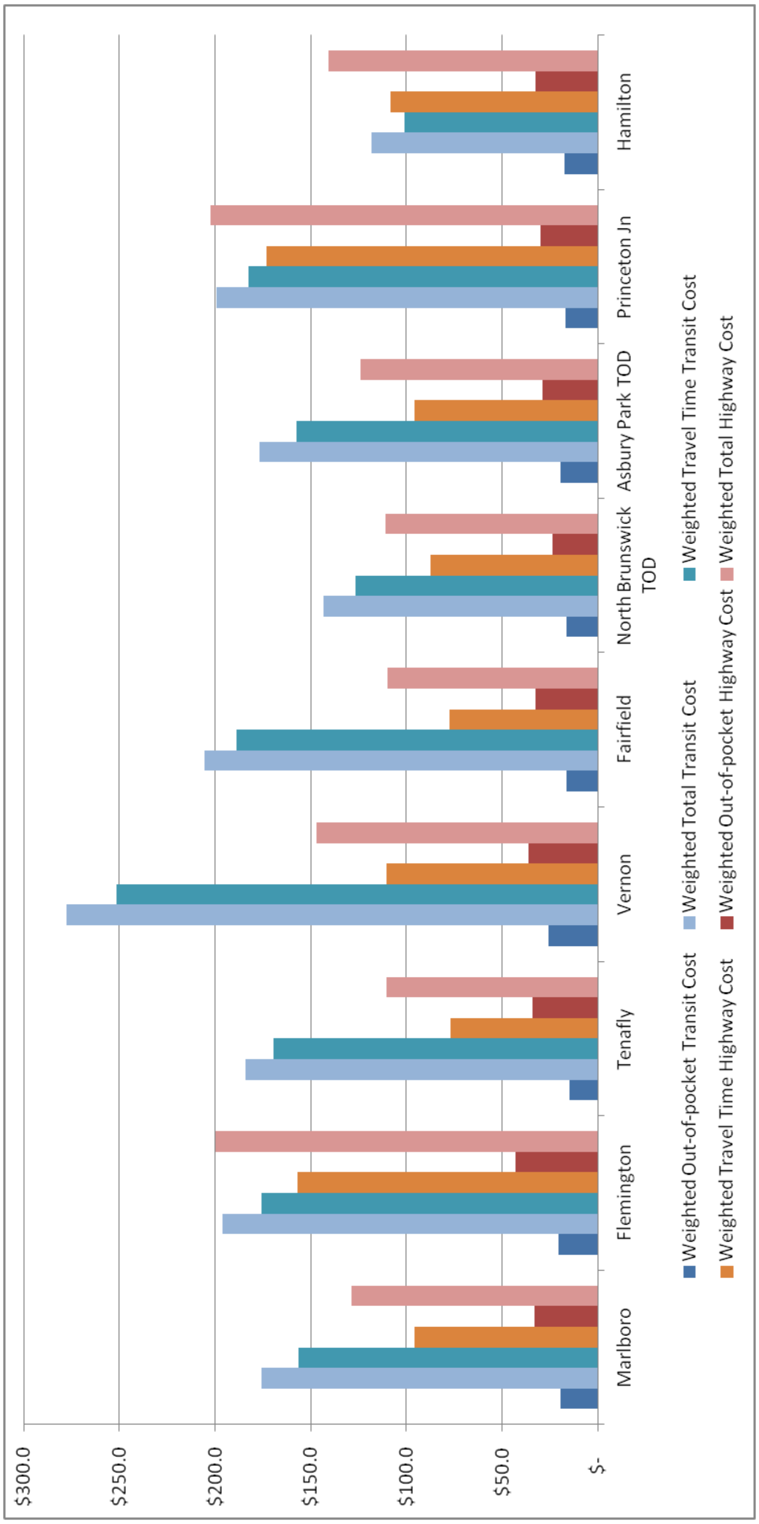

Figure 23. Weighted round trip transit and driving costs for control sites

The Attractiveness Index, or the ratio of total driving costs to total transit costs, is shown in Table 64 and Figure 24 for each control site. It is shown based on only out-of-pocket costs (fare, tolls, vehicle operating cost, parking, etc.), travel time costs, and total costs.

Table 64 – Attractiveness indexes (drive-to-transit cost ratios) for each control site

Control Site	Attractiveness ratio (out-of-pocket)	Attractiveness ratio (travel time costs)	Attractiveness ratio (total cost)
Asbury Park	1.47	0.61	0.70
Fairfield	1.97	0.41	0.54
Flemington	2.09	0.89	1.02
Hamilton	1.86	1.07	1.19
Marlboro	1.72	0.61	0.73
North Brunswick	1.44	0.69	0.77
Princeton Junction	1.76	0.95	1.02
Tenafly	2.29	0.45	0.60
Vernon	1.41	0.44	0.53

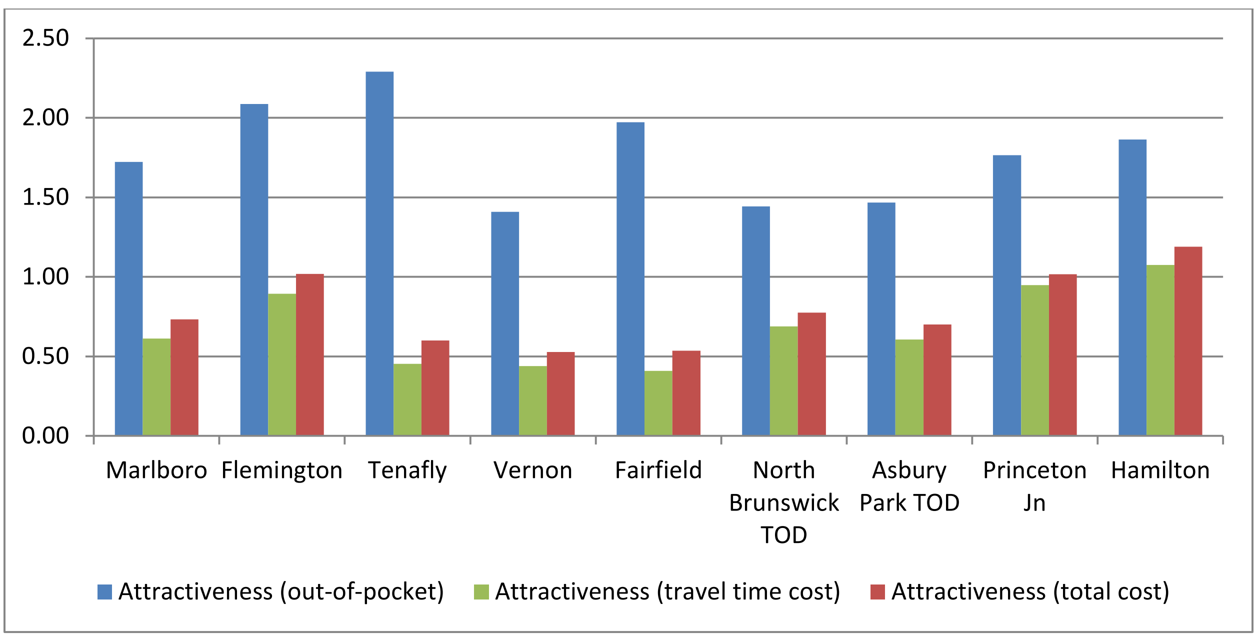

Figure 24. Attractiveness index by control site

The analysis shows that at TOD locations, the cost of using the train is significantly lower than the cost of driving for commuters (see Table 65). Thus, in addition to anticipated societal benefits there is a direct user-benefit through lower expenditure and time spent commuting. Therefore, transportation can be considered a key driver of TOD growth. However, in most cases the travel time costs lead to the total costs not being beneficial. Flemington, Princeton Junction and Hamilton are the exceptions that show these are good locations for TOD with attractiveness ratio of total costs being slightly above one.

Table 65 – Ratio of attractiveness based on out-of-pocket to travel time costs for control sites

Control Site	AOOP/ATC
Asbury Park	2.09
Fairfield	3.68
Flemington	2.05
Hamilton	1.57
Marlboro	2.35
North Brunswick	1.86
Princeton Junction	1.74
Tenafly	3.81
Vernon	2.67

Conclusions of User-benefit Analysis

The user-benefits tend to show that those taking transit have lower out-of-pocket costs than if they drive (including parking and toll costs). This holds for both our TOD study sites and the control sites selected for comparison. Likewise, both show variation in the travel time costs. In most cases the time costs associated with driving are less than for transit, and this makes the choice to drive attractive for many users. While it is hard to discern a clear pattern, it seems that those areas with lower income populations and those that are closer to Manhattan tend to favor transit. These results are very sensitive to our assumption on the valuation of travel time; there tends to be significant heterogeneity between individuals in how they value time, and we use very coarse averages in this analysis. Further sensitivity analysis would be helpful to understand how the attractiveness ratios change with differences in these assumptions.

Regional Impact Analysis

Analysis of the network-level impact of congestion relief due to TODs is an important aspect of understanding their benefits. Regional transportation planning models are a potential platform for analyzing these effects. The NJRTM-E model for the year 2010 is used as the basis for the estimation of benefits since this is the most recent network available. Based on the parameters within the model, NJRTM-E is run for base case conditions and then compared with a scenario where population shifts toward living closer to the train station area. Network traffic flows are obtained from the traffic assignment model and transit usage from the mode choice component of the model. The potential benefits of TODs (and greater transit access) in communities are estimated by the changes in various cost categories, such as congestion, vehicle operations, accidents, air and noise pollution, and maintenance costs at the network level. These are estimated using a planning tool previously developed for NJDOT, ASSIST-ME, which can post-process the outputs from the NJRTM-E model.

NJRTM-E, the planning model for the North Jersey Transportation Planning Authority (NJTPA), encompasses the transportation links from 40 counties in the states of New Jersey, New York, Connecticut and Pennsylvania that are under the purview of NJTPA. The network output is produced for 55,230 road links. The metrics such as link volume, link speed, distance, and number of lanes are used in the evaluation of network effects. ASSIST-ME was developed to estimate the reductions in various costs of highway transportation using cost reduction models specific to New Jersey, or national data if NJ-specific data is unavailable.[38]

ASSIST-ME calculates the marginal cost of all the trips generated by NJRTM-E. From this the full marginal costs (FMC) for the tested scenarios can be calculated. Ozbay et al. define a “trip” as the major output measure.[87-89] In other words, FMC is defined and calculated as “cost per trip.” Although “trip,” as a final output of highway transportation, is not as standard a measure as vehicle-miles or vehicle-hours, it has several desirable attributes (e.g., trip distance, time of day, highway functional categories on a route, degree of urbanization, topography, and climate) that enable us to better understand the policy implications of additional travelers on the road network. Moreover, the concept of a trip is a natural measure when dealing with transit costs.

NJRTM-E Model

For the purpose of transportation planning in northern and central New Jersey the North Jersey Regional Transportation Model – Enhanced (NJRTM-E) was specifically developed to satisfy the different needs of NJTPA, NJ TRANSIT, and NJ DOT. For transit network modeling, the NJRTM-E adopted existing transit networks from the NJ TRANSIT Regional Transit Model. Figure 25 shows the transit network layer in NJRTM-E. The primary purpose of the transit network is to develop estimates of the time and cost variables for peak and off-peak periods as required for the mode choice model and to load trips within the transit assignment process.[90-92]

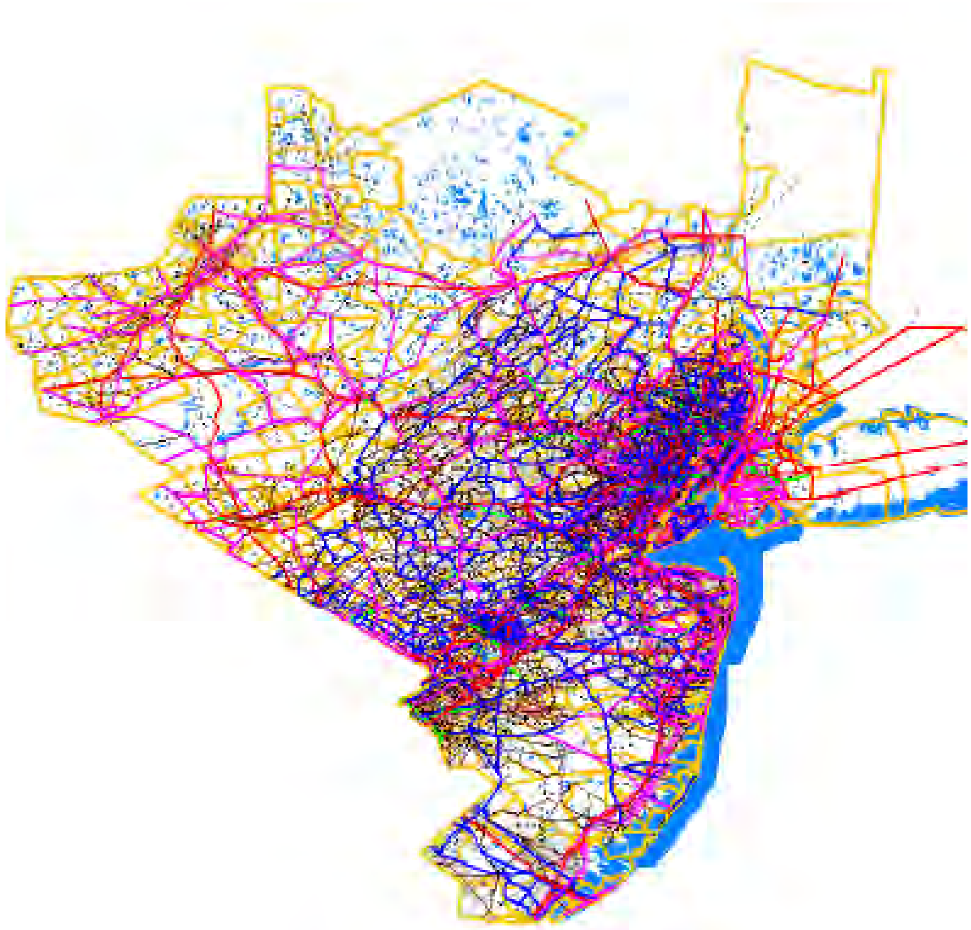

Figure 25: Transit network layer in NJRTM-E

Source: North Jersey Regional Transportation Model Enhanced - Model Development Report

The various modes of transport are included as a part of the NJRTM-E transit network. There are 10 modes representing the actual transit services provided in the region. Five modes are the non-transit modes that provide access and transfer linkages for transit users. Two different access-related modes, auto access and walk access, are used in NJRTM-E.

The NJRTM-E model is used to estimate three primary metrics to evaluate the merit of TODs:

- Number of Trips
- Ridership
- Travel time and Travel costs

Different modules in the NJRTM-E model, and their descriptions are provided in Appendix I. A comparison of NJRTM-E and NJTDFM models is also presented in Appendix I. Due to the reasons presented in the comparison, NJRTM-E is chosen for modeling the network impacts of TOD.

Value of Time

Value of time (VOT) is a critical component of both mode choice and quantification of network impacts. In the NJRTM-E model, the value of time is constant regionwide. In actuality, it varies between TOD locations. Thus, the effect of TOD in two locations, even if the development is of a similar nature, can have different impacts.

In general the VOT varies by vehicle class. For cars, Small and Verhoef conclude that the average VOT widely used in practice is about 50% of the gross wage rate.(93) Based on this evaluation, using the U.S. Bureau of Labor Statistics 2009 for New York-Newark-Bridgeport, the VOT can be estimated to range from $13.28 to $16.83/hr (using the mean hourly wages of $26.56 to $33.66).(94) The most recent empirical results obtained from travel survey data for users of Port Authority of New York & New Jersey facilities estimated VOT around $16.50/hr for E-Z Pass peak users, and around $15.15/hr for E-Z Pass off-peak users.(95) VOT for trucks can be as high as $193.80/hr, with a median of $40 and a mean of $52.80.(96) Other estimates range from $34/hr for light trucks to $55/hr for semi-trailers.(97)

However, in New Jersey (as shown in Table 66), household income at TOD locations varies greatly, thus different VOTs can be tested at different TOD sites for their effect on mode choice and shifts away from highways.[12]

[12] These VOT estimates differ from those used in the user-benefit analysis.

Table 66 – TOD site household incomes from NJ TRANSIT survey

	Demographic Characteristics			
Municipality (Station Name)	Municipal pop, Census 2009 est	Est pop in half mi, ACS 2006-09	Est HH income in half mi	Percent owner-occupied in half mi
Asbury Park	16,562	9,688	$34,998	31%
Collingswood	13,839	4,165	$69,845	71%
Cranford	22,059	3,693	$105,128	72%
Hoboken (2nd St)	41,015	23,519	$80,372	35%
Jersey City (Essex St)	242,503	8,615	$108,171	24%
Metuchen	13,096	3,863	$81,876	79%
Morristown	18,906	2,470	$57,750	31%
New Brunswick	51,579	6,965	$57,040	13%
Newark (Broad St.)	278,154	9,625	$32,614	14%
Perth Amboy	48,711	16,640	$41,167	26%
Rahway	28,998	4,946	$40,722	41%
Summit	20,696	3,718	$108,123	50%
Westfield	29,678	4,311	$97,131	63%
Woodbridge	97,917	2836	$57,419	53%

ASSIST-ME Assumptions

Various cost categories are derived using the ASSIST-ME model. These include the following:

- Out-of-pocket + Travel time (OOP + TT) costs
    - Vehicle operating cost
- Congestion cost
    - Cost of externalities (Ext.)
    - Accident Cost
    - Air pollution cost
    - Noise cost
    - Maintenance cost
    - Construction cost
    - Land acquisition cost

Table 67 shows the assumptions underlying the calculation of each cost category in ASSIST-ME. The inputs used for the calculation are also shown in Table 68. Due to the highly non-linear travel time function when volume exceeds capacity, the hypercongestion cost (cost of travel time when volume exceeds capacity) has not been included in the marginal congestion cost.

Table 67 – Cost functions to post-process model results

Cost	Total Cost Function	Variable Definition
Vehicle Operating	C_{opr} = 7208.73 + 0.12(*m*/*a*) + 2783.3*a* + 0.143*m*	m: Vehicle mileage (miles) a: Vehicle age (years)
Congestion	$C_{cong} = \begin{cases} Q.\frac{d_{a,b}}{V_o}.\left(1+0.15\left(\frac{Q}{C}\right)^4\right).VOT & \text{if } Q \le C \\ Q.\frac{d_{a,b}}{V_o}.\left(1+0.15\left(\frac{Q}{C}\right)^4\right).VOT + Q.\left(\frac{Q}{C}-1\right).\frac{VOT}{2} & \text{if } Q > C \end{cases}$	Q = Volume (veh/hr) d = Distance (mile) C = Capacity (veh/hr) VOT = Value of time ($/hr) V_o = Free-flow speed (mph)
Accident	*Category 1*: interstate freeway $C_{acc} = 127.5Q^{0.77}.M^{0.76}.L^{0.53} + 114.75Q^{0.85}.M^{0.75}.L^{0.49} + 198{,}900Q^{0.17}.M^{0.42}.L^{0.45}$	Q = Volume (veh/day) M = Path length (miles) L = No. of lanes
	Category 2: principal arterial $C_{acc} = 178.5Q^{0.58}.M^{0.69}.L^{0.43} + 18{,}359Q^{0.45}.M^{0.63}.L^{0.47}$	
	Category 3: arterial-collector-local road $C_{acc} = 229.5Q^{0.58}.M^{0.77}.L^{0.77} + 9{,}179.96Q^{0.74}.M^{0.81}.L^{0.75}$	
Air pollution	$TC_{air} = Q(0.01094 + 0.2155F)$ where; $F = 0.0723 - 0.00312V + 5.403x10^{-5}V^2$	F = Fuel consumption at cruising speed (gl/mile) V = Average speed (mph) Q = Volume (veh/hr)
Noise	$C_{noise} = 2\int_{r_1=50}^{r_2=r_{max}} (L_{eq} - 50)DW_{avg}\frac{RD}{5280}dr$ where; $K = K_{car} + K_{truck}$ $K = \frac{F_c}{V_c}\left(V_c^{4.174}.10^{0.115} + 10^{5.03F_{ac}+(1-F_{ac})6.7}\right) + \frac{F_{tr}}{V_{tr}}\left(V_{tr}^{3.588}.10^{2.102} + 10^{7.43F_{atr}+(1-F_{atr})7.4}\right)$ $L_{eq} = 10\log(Q) + 10\log(K) - 10\log(r) + 1.14$	Q = Volume (veh/day) r = distance to highway K = Noise-energy emis. K_{car} = Auto emission K_{truck} = Truck emission F_c = % of autos, F_{tr} = % of trucks F_{ac} =% const. speed autos F_{atr}=% of const. speed tr. V_c = Auto Speed (mph) V_{tr} = Truck Speed (mph)
Maint.	$C_M = 800{,}950N^{0.384}L^{0.403}$	N: Number of lanes L: Length of project (miles) T: Time between each resurfacing cycles (hour) t: Travel time of one additional vehicle (hour)

Sources: [87-89]

Table 68 – Cost categories and source of inputs for calculation

Cost Category	Inputs and Source
Vehicle Operating Cost	Vehicle mileage (NJRTM-E model output)
Congestion Cost	Volume (NJRTM-E model output) Distance (NJRTM-E model output) Capacity (NJRTM-E model output) Free flow speed (NJRTM-E model output) Value of time (based on TOD location and User destination
Accident Cost	Volume (NJRTM-E model output) Distance (NJRTM-E model output) No. of lanes (NJRTM-E model output)
Air Pollution Cost	Car Volume (NJRTM-E model output) Truck Volume (NJRTM-E model output) Speed (NJRTM-E model output) Emission rates (estimated based on MOVES model
Noise Cost	Car Volume (NJRTM-E model output) Truck Volume (NJRTM-E model output) Car Speed (NJRTM-E model output) Truck Speed (NJRTM-E model output)
Maintenance Cost	Speed (NJRTM-E model output) Distance (NJRTM-E model output) No. of lanes (NJRTM-E model output)
Construction & Land Acquisition Cost	Distance (NJRTM-E model output)

Source: E. Ozguven. 2013. Simplified Emissions Estimation Methodology Based on MOVES to Estimate Vehicle Emissions from Transportation Assignment and Simulation Models.

Analysis of TOD Station Areas

To use these tools to examine the impact of growth near train stations and of additional TODs, we assume that population shifts from more distant areas (out to two miles from the station) to areas closer to the station. The increase near the station is within a half-mile radius. Using our eight targeted TOD stations, we increase population for traffic-analysis zones within the half-mile radius by 2,000, except for Newark and Jersey City where population is increased by 10,000. The equivalent population is reduced in the outer traffic-analysis zones within a half-mile to a two mile radius.

The change in population in each traffic-analysis zone is allocated based on their population. Figure 26 shows a sample for a zonal map around Metuchen for how population is shifted from the outer zones to the inner zones. The population increase for zones within the 0.5-mile radius around the TOD station area is calculated as follows.

$$P'_i = P_i + \frac{\Delta P * P_i}{\sum_{i=1}^{j} P_i} \quad (1)$$

Where,

$P_i = Population\ for\ Zone_i(\ 1\ to\ j, number\ of\ zones\ within\ 0.5\ mile\ radius\ around\ TOD)$

$\Delta P =$

$Increase\ in\ population\ (10{,}000\ for\ Newark\ and\ Jersey\ City, 2{,}000\ for\ other\ TODs)$

$P'_i = Increased\ Population\ for\ Zone\ i$

The population decrease for zones in the half- to two-mile radius around the TOD station area is calculated as follows.

$$P'_i = P_i - \frac{\Delta P * P_i}{\sum_{i=1}^{j} P_i} \quad (2)$$

Where,

$P_i =$

$Population\ for\ Zone_i(\ 1\ to\ j, number\ of\ zones\ within\ 0.5 - 2\ mile\ radius\ around\ TOD)$

$\Delta P = Decrease\ in\ population\ (10{,}000\ for\ Newark\ and\ Jersey\ City, 2{,}000\ for\ others)$

$P'_i = New\ Population\ for\ Zone\ i$

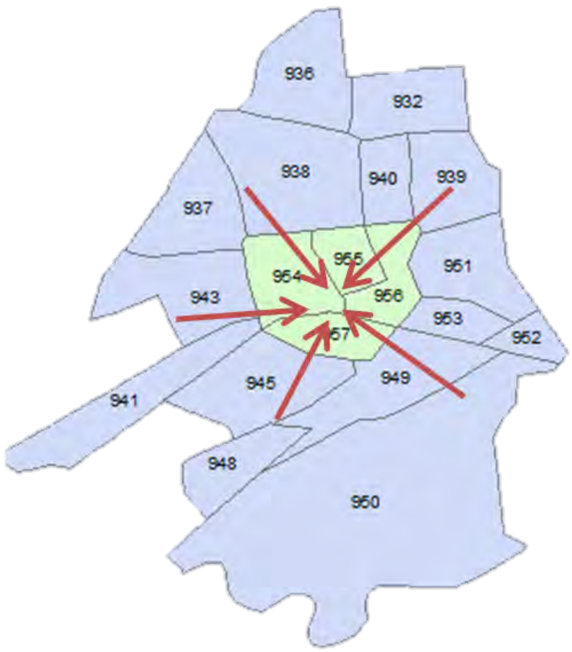

Figure 26. Zones around Metuchen within a half-mile radius and a half- to two-mile radius

Based on this estimation approach, the percent population change calculated for the inner and outer zones is shown in Table 69.

Table 69 – Population change by shift scenario for TOD zones

	0.5 Mile Radius				0.5 to 2 Mile Radius		
	Number of Zones	Population	Δ POP	Δ POP %	Number of Zones	Population	Δ POP %
Cranford	5	22748	2000	8.79%	18	92355	-2.17%
Jersey City (Essex St.)	7	26130	10000	38.27%	47	173722	-5.76%
Morristown	4	19713	2000	10.15%	8	31952	-6.26%
Metuchen	4	13938	2000	14.35%	15	69534	-2.88%
New Brunswick	7	38628	2000	5.18%	22	78138	-2.56%
Newark (Broad St)	14	29847	10000	33.72%	75	229029	-4.37%
Plainfield	2	9753	2000	20.51%	23	110811	-1.80%
Rahway	5	23880	2000	8.38%	16	63965	-3.13%

The change in population in each traffic-analysis zone is used as an input to the NJRTM-E model and the four-step model is rerun. By comparing the number of trips between the base model and this population shift scenario, the change in trips for each mode are estimated. The modes used for the analysis are the four major modes in the region namely, vehicle, rail, bus and PATH.

The total number and percent change in trips that are generated for the inner zones within a half mile of each TOD station area are shown in Table 70. These trips are based on the AM peak period. As this is a population increase within these zones, in general, all trips increased except bus trips for Cranford and Plainfield, and PATH trips for New Brunswick, Metuchen and Plainfield. In the case of PATH trips for New Brunswick and Metuchen, since the total number of trips for the base case is low, the percent change is large and these results likely reflect the inability of the model to capture small changes.

Table 70 – Total daily numbers and percent changes in trips by mode during AM peak period from 0 – 5 miles around TOD station areas for population shift scenario

TOD	Car	Rail	Bus	PATH
Cranford	12017.2	1189.6	671.8	139.5
Jersey City	9950.2	28.1	2939.7	16027.0
Metuchen	6593.4	1298.9	78.9	5.5
Morristown	10368.7	899.7	160.6	23.8
Newark BS	10756.2	721.7	6541.4	3556.6
New Brunswick	13023.1	2158.0	1244.5	3.6
Plainfield	3206.7	1008.5	128.4	0.8
Rahway	11706.5	979.7	312.9	195.7
% Change from Base				
Cranford	5.07%	14.76%	-6.34%	46.56%
Jersey City	3.67%	1.93%	0.78%	10.02%
Metuchen	8.67%	9.01%	9.66%	-38.05%
Morristown	3.88%	4.73%	4.78%	9.17%
Newark BS	11.15%	9.45%	11.22%	16.33%
New Brunswick	2.91%	6.00%	1.10%	-45.36%
Plainfield	11.01%	15.94%	-5.87%	-6.10%
Rahway	3.11%	1.35%	10.94%	8.21%

Results are shown in Table 71 for the reduction in population within the outer zones, from 0.5 to 2.0 miles distant from the train station. The key result is the drop in car usage. In spite of the decrease in population, rail trips increase for Plainfield, Rahway and Cranford. Rail trips for Morristown decrease about seven percent. All PATH trips decrease, except for Cranford, and bus trips decrease except for Jersey City.

Table 71 – Total daily numbers and percent change in trips by mode during AM peak period for a half to two Miles around TOD station areas for population shift scenario

TOD	Car	Rail	Bus	PATH
Cranford	45336.9	3277.6	3015.3	1030.6
Jersey City	32747.6	91.3	12795.5	42541.8
Metuchen	33762.5	3867.2	354.2	125.2
Morristown	21467.9	1500.6	138.0	102.3
Newark BS	33410.4	2724.6	27139.4	24109.1
New Brunswick	65293.8	3596.6	1462.1	32.1
Plainfield	50374.3	7024.0	1154.1	253.1
Rahway	28082.4	2068.1	806.1	615.1
% Change from Base				
Cranford	-1.26%	2.23%	-7.78%	11.02%
Jersey City	-1.64%	-0.01%	1.67%	-2.40%
Metuchen	-1.59%	-0.01%	-2.63%	-35.60%
Morristown	-3.69%	-7.02%	-6.76%	-7.57%
Newark BS	-1.15%	-1.31%	-2.25%	-3.19%
New Brunswick	-2.20%	0.30%	-5.61%	-40.60%
Plainfield	-1.06%	3.21%	-14.22%	-9.26%
Rahway	-0.87%	1.38%	-8.63%	-5.42%

The net change in trips when the changes in the inner zone and the outer zone are summed together is shown in Table 72. As can be seen, the shift of population closer to the train station results in net increases in rail (and PATH) ridership and reductions in car usage. Bus usage also has a net decrease, probably because the train is now more accessible.

Table 72 **–** Net change in number of trips by each mode around TODs due to population shift (network wide)

TOD	Car	Rail	Bus	PATH
Cranford	10	226	-280.1	157.9
Jersey City	-184	0.5	236.5	436.9
Metuchen	-11	107.1	-2.3	-48
Morristown	-404	-64.8	-2	-5.7
Newark BS	695	26.6	49	-268.8
New Brunswick	-1067	132.9	-68.4	-16
Plainfield	-217	364	-172.1	-23.4
Rahway	110	41.6	-38.6	-18.6
Total	-1068	833.9	-278	214.3

Total NJ TRANSIT Rail Ridership Changes

Ridership on the train at each TOD station is another metric that is useful for measuring the benefits of TOD. Changes in ridership are different from changes in the number of trips taken on the train at each TOD station location. The difference is that the ridership numbers indicate not only trips from within the TOD but also drive-access trips arising from outside the TOD area 2-mile radius.

A comparison of ridership to all destinations at each TOD train station from observed NJ Transit data and the number of boardings estimated at each station is shown in Table 73. It should be noted that since there is no NJ Transit train station at the Jersey City TOD location, the ridership for that location is not provided. Note that this observed ridership is for an average day in 2010.

Table 73 – Comparison of boardings for 2010 from observed and NJRTM-E model

TOD	2010 NJ Transit Observed Ridership	2010 Ridership from NJRTM-E Model
Cranford	1,175	1,332
Metuchen	3,920	3,946
Morristown	1,891	2,563
New Brunswick	5,467	9,590
Newark Broad St	2,451	667
Plainfield	968	4,272
Rahway	3,210	2,941

The changes to ridership at each TOD train station when there is a population shift is shown in Table 74. Morristown is the only station where a reduction is observed. The train station with the largest percent increase in boardings is Newark Broad Street.

Table 74 – Change in boardings for population shift in TOD locations

PEAK Volume	Boarding Volume for All Destinations			
Station	Base	Shifted	Difference	% Difference
Cranford	1332	1507	175	13.14%
Newark Broad St	667	758	91	13.64%
Metuchen	3946	4100	154	3.90%
New Brunswick	9590	9774	184	1.92%
Plainfield	4272	4502	230	5.38%
Morristown	2563	2535	-28	-1.09%
Rahway	2941	3003	62	2.11%

Cost Estimates from ASSIST-ME

The cost functions and inputs in Table 67 are used to estimate costs after processing the planning model output of NJRTM-E with ASSIST-ME.

The average cost estimates for the NJRTM-E output for the year 2010 for TOD to NYC trips is shown in Table 75. Average cost of travel time (TT), average cost of externalities namely, accidents, air pollution (AP), noise and maintenance costs are shown.

Table 75 – Average Costs per One-Way Highway Trip from TOD to NYC Estimated from NJRTM-E Output for 2010 (Base Case)

TOD	Travel Time	Accident	Air Pollution	Noise	Maintenance
Cranford	$ 39.94	$ 0.13	$ 0.71	$ 0.02	$ 0.01
Jersey City	$ 20.03	$ 0.10	$ 0.24	$ 0.01	$ 0.00
Metuchen	$ 47.00	$ 0.12	$ 0.98	$ 0.02	$ 0.01
Morristown	$ 49.30	$ 0.12	$ 0.97	$ 0.02	$ 0.00
New Brunswick	$ 52.80	$ 0.11	$ 1.09	$ 0.02	$ 0.02
Newark Broad St	$ 30.12	$ 0.08	$ 0.46	$ 0.01	$ 0.00
Plainfield	$ 57.42	$ 0.16	$ 0.96	$ 0.02	$ 0.01
Rahway	$ 37.89	$ 0.12	$ 0.74	$ 0.02	$ 0.01

The marginal cost estimates for the year 2010 for trips from TOD to NYC are shown in Table 76. Marginal cost refers to the cost incurred by adding one more vehicle to the trip. We assume that the additional vehicle trips will not cause link volume to exceed capacity. Hence, in Table 76, the marginal cost of congestion involves only regular congestion costs and not the hypercongestion cost mentioned in Ozbay et al. (2007).[89]

Table 76 – Marginal costs per highway trip from TOD to NYC estimated from NJRTM-E output for 2010 (base case)

TOD	OOP + TT	Externalities
Cranford	$ 39.71	$ 2.01
Jersey City	$ 19.83	$ 1.99
Metuchen	$ 46.81	$ 2.24
Morristown	$ 49.10	$ 1.78
New Brunswick	$ 52.60	$ 2.02
Newark BS	$ 29.90	$ 2.94
Plainfield	$ 57.06	$ 3.67
Rahway	$ 37.70	$ 2.22

The average cost estimates for the year 2010, with population shift, at the TOD locations for trips from each TOD to NYC are shown in Table 77. Average cost of travel time (TT) and average cost of the externalities – namely, accidents, air pollution (AP), noise, and maintenance costs – are shown. Local vehicle trips in Newark and Cranford have larger increases in marginal costs, compared to other TODs. This is likely because local links have a larger increase in traffic compared with the increase in traffic due to vehicle trips between NYC and Cranford and between NYC and Newark.

Table 77 – Average costs per one-way highway trip from TOD to NYC, estimated from NJRTM-E output for 2010, with population shift

TOD	TT	Accident	AP	Noise	Maintenance	% Change from Base
Cranford	$ 40.73	$ 0.13	$ 0.72	$ 0.02	$ 0.01	1.99%
Jersey City	$ 19.76	$ 0.09	$ 0.24	$ 0.01	$ 0.00	-1.39%
Metuchen	$ 46.97	$ 0.11	$ 1.00	$ 0.02	$ 0.01	-0.05%
Morristown	$ 49.40	$ 0.12	$ 0.99	$ 0.02	$ 0.00	0.20%
New Brunswick	$ 52.61	$ 0.11	$ 1.12	$ 0.02	$ 0.02	-0.36%
Newark Broad St	$ 30.43	$ 0.09	$ 0.47	$ 0.01	$ 0.00	1.02%
Plainfield	$ 56.70	$ 0.17	$ 0.96	$ 0.02	$ 0.01	-1.26%
Rahway	$ 37.52	$ 0.09	$ 0.75	$ 0.02	$ 0.01	-0.96%

The marginal cost estimates for the NJRTM-E output for the year 2010, with population shift, trips between each TOD and NYC are shown in Table 78.

Table 78 – Marginal costs per one-way highway trip from TOD to NYC estimated from NJRTM-E output for 2010 with population shift

TOD	OOP + TT	Externalities	% Change from Base
Cranford	$40.50	$2.15	2.22%
Jersey City	$19.55	$1.94	-1.49%
Metuchen	$46.78	$2.54	0.56%
Morristown	$49.20	$1.44	-0.47%
New Brunswick	$52.40	$2.48	0.50%
Newark Broad St	$30.19	$3.28	1.91%
Plainfield	$56.34	$4.03	-0.59%
Rahway	$37.35	$2.03	-1.37%

Benefit for Train Users

The previous section presents the analysis of average transit and highway costs for the TOD locations. The cost of a transit trip by train is lower than the cost of a highway trip. The cost savings for round-trip travel from the TOD to NYC by train vs. car are shown in Table 79. These costs show the benefit the user incurs by choosing to travel by train for their commute from the TOD location. In the calculation of yearly benefit, we assumed 260 workdays.

Table 79 – Benefit of using a train instead of a car for commutes to NYC ($ per user)

TOD	Benefit per Round Trip using OOP	Benefit per year using OOP	Benefit per Round Trip using OOP + TT	Benefit per year using OOP + TT
Cranford	$5.79	$1,505.61	-$59.64	-$15,506.44
Metuchen	$13.71	$3,564.47	-$4.22	-$1,097.50
Morristown	-$0.16	-$42.38	-$107.34	-$27,909.43
New Brunswick	$33.83	$8,796.13	$4.37	$1,136.20
Newark Broad St	$22.57	$5,868.58	$43.34	$11,269.34
Plainfield	$8.06	$2,095.41	$25.72	$6,687.42
Rahway	$11.84	$3,077.91	-$23.61	-$6,139.86

From Table 79, it can be inferred that a worker in Cranford who commutes by train instead of car can save about $6 per day and $1,500 per year. However, if we consider the total travel time from Cranford, the estimated benefit is negative. The train travel from Cranford involves transfer at Newark Penn Station, hence, the total travel time includes the wait, walk, and transfer times. The value of time for wait and transfer times is greater than 1. Hence, the value of travel time from Cranford is lower for highway travel than train travel. Thus, there are no benefits for the user to travel by train instead of car. However, for Metuchen, New Brunswick, Newark, and Plainfield there are significant positive benefits.

Note that a transfer is required for users traveling from Cranford or Plainfield to New York, whereas there is no transfer required for users traveling to Newark. The percentage of transit trips to Newark from Plainfield is 25%. The same from Cranford is only 11%. This means that the effect of transfer time and its value will affect 89% of transit trips from Cranford and only 75% of trips from Plainfield. Additionally, the value of time for users in Cranford is 45% higher than for those in Plainfield. As a result, the benefits calculated based on OOP + TT are much lower for Cranford when compared to Plainfield.

By contrast, for New Brunswick, the savings in out-of-pocket costs for a user, who commutes by train as opposed to by car, is $34 per day; the total benefit (out-of-pocket savings + travel time cost) is $4.40 per day. Thus, the yearly benefit when considering the total cost to the user is $1,140 per year.

Net Marginal Benefit for the Population Shift

The net trip changes from the population shift estimates are shown in Table 72. This effect can be quantified as the increase in the highway costs if these new trips, traveling by train, are using the highway had the TOD not been implemented. Each of these new trips can be seen as an additional trip to the existing highway network equilibrium. Thus to quantify the impact of trip change we estimate the marginal cost of the population shift scenario. Marginal benefit due to the increase in PATH trips can be estimated in a similar way. Moreover, if there is a reduction in the number of vehicle trips to NYC due to the population shift, this will be assumed to be the marginal benefit for TODs.

The marginal costs for each TOD, shown in Table 76, are used to quantify the benefits due to new rail trips to NYC. Since there are no new train trips from Jersey City and Morristown for the scenario with new trips estimated from the population shift, the increase in costs is zero for those TODs.

From Table 80, Table 81 and Table 82, the following points can be made for the marginal cost benefit:

- Plainfield has the maximum benefit of $16,167 for the increase in rail trips
- Morristown has no net benefits due to a decrease in the number of rail trips
- Cranford and Jersey City (Essex St.) have a marginal benefit due to the increase in PATH trips of about $5,259 and $2,584, respectively
- Plainfield has the maximum benefit due to a decrease in vehicle trips to NYC with an amount of $2,396

Table 80 – Total net marginal highway costs if new AM peak period train trips to NYC use highway (daily benefits)

TOD	Marginal Benefits due to OOP + TT Rail
Cranford	$8,472.13
Jersey City	$ 0.00
Metuchen	$2,072.75
Morristown	$ 0.00
Newark Broad St	$2,476.02
New Brunswick	$2,688.91
Plainfield	$16,166.81
Rahway	$1,020.54

Table 81. Total net marginal highway costs if new AM peak period PATH trips to NYC use highway (daily benefits)

TOD	Marginal Benefits due to OOP + TT PATH
Cranford	$5,259.59
Jersey City	$2,583.85
Metuchen	$ 0.00
Morristown	$ 0.00
Newark Broad St	$ 0.00
New Brunswick	$ 0.00
Plainfield	$ 0.00
Rahway	$ 0.00

Table 82 – Total net marginal highway benefit due to decrease in AM peak period vehicle trips to NYC (daily benefits)

TOD	Marginal Benefits due to OOP + TT Vehicle
Cranford	$ 0.00
Jersey City	$ 0.00
Metuchen	$1,825.59
Morristown	$343.70
Newark Broad St	$ 0.00
New Brunswick	$1,262.40
Plainfield	$2,396.52
Rahway	$1,131.00

Conclusions of Regional Analysis

This analysis attempted to examine how focusing population around transit stations can lead to benefits for the transportation system. Our scenario shifted population currently living within 0.5 to 2.0 miles from the station to live within a half mile of the station. In general, we find that this leads to increased use of the train and reductions in vehicle usage. Thus, we see increased financial benefits for the transit agency from increased revenue, commuter cost savings particularly for NYC trips, and some minor reductions in external costs. All these results are highly sensitive to assumptions embedded within the model and should be interpreted with care. The changes modeled are relatively small for a regional travel demand model that is generally used to estimate larger regional changes in the transportation system. The cost model (ASSIST-ME) is also limited by the use of fairly rigid assumptions; in any case, external cost changes, while providing the expected effect, are likely within the noise of any reasonable estimate.

CONCLUSIONS

Development around transit stations provides many benefits to residents and communities. Our research finds a multitude of benefits and these can lead to stronger communities and better transportation options for residents.

The planning and development community in New Jersey is a strong supporter of TOD. Areas around the many train stations in New Jersey offer ample opportunities for redevelopment, and more intense development that can provide the benefits we examined in this report. Residents of TODs and areas near the stations see the development as beneficial for the most part. One concern shared by planners and residents is a lack of retail establishments that cater to residents' day-to-day needs. Most TOD areas have retail that focuses on entertainment, restaurants, and specialty stores that attract out-of-town visitors. While this is a useful economic niche to fill and can create a vibrant street life, there is a desire by both planners and residents to see more practical retail establishments in areas near train stations.

As station areas attract people, they also attract cars. Our key informant interviewees indicated that they saw this as a potential problem as this led to increased congestion within the TOD area. Of course, congestion is also an indication that people wanting to be in that location. Residents saw street traffic quite differently—mainly as a safety issue—noting the difficulty of crossing streets within the retail area and near the station. Our case studies partially supported this; for example, Morristown Station is surrounded by high-speed streets, and focus group participants indicated these were quite dangerous to cross and even more dangerous for bicycle travel. This suggests that planners and traffic engineers should carefully consider the needs of pedestrians in these TOD areas. Many of the streets are designed to enhance traffic flow at the expense of pedestrians, leading, if not to safety problems, to a need for more time to safely cross the street. The benefits of TOD can be enhanced if care is taken to simultaneously improve the pedestrian environment and slow the speed of traffic in areas with high levels of pedestrian activity. The municipalities and counties in which these streets are located should apply Complete Streets principles that consider the needs of all road users and prioritize station access areas for redevelopment, as should NJDOT if these are state-owned roads.

Three detailed case studies were conducted for the communities of Cranford, Morristown, and Rahway. Each has pursued a strategy of station area development that includes some TOD and each has had both different reasons for and different approaches to development. Cranford sought to develop derelict properties and provide a mix of housing in the community beyond single-family homes as the population aged; Morristown has been redeveloping for some time and built a new TOD adjacent to the station; Rahway has done extensive redevelopment with TOD and a focus on an arts district. All of these communities have had success in their own way and also have various shortcomings.

While each of these three communities came to TOD for unique reasons, all have gained from the endeavor. Each has been able to add new population to populated areas that were essentially built-out. Each has expanded the type of housing stock available to residents, allowing some residents in each community to live car-free or car-light. Each has been able to convert underperforming properties into those that provide improved revenues to the community. All three have expanded the amount of retail space available within the community, though not all have had success in fully utilizing the new retail space. Better pedestrian access and safety is needed in Morristown and Cranford; a better mix of retail is needed in Rahway. But all have been successful at improving their community.

There is a rich literature that has examined the link between travel behavior and the built environment that generally finds more compact and transit-accessible areas lead to more walking and transit use and less driving. Our results, based on our survey of eight TOD areas and the areas surrounding them, find this same effect. In general, those who live closer to the transit station tend to walk more, take public transit more, and drive less, relative to those who live beyond a quarter mile (up to two miles) from the station.

Our analysis was based on both simple cross-tabulations of distance from the TOD with frequency of using each mode of travel and a more complex structural equation model. The latter model is often considered to be a method of determining causal inferences, that is, a model where one can say that A causes B, although we hesitate to make this claim. At a minimum, we have controlled for a range of factors that also influence the modes people choose to use, in particular, individual attitudes of respondents to their neighborhood, how long they have lived in the neighborhood, built environment measures, and a range of socioeconomic factors, including income and vehicle ownership.

Our results show a clear pattern: that those who live closer to the station are more likely to walk, use transit, and drive less than those living further afield. Increased local street density (a proxy for the built environment) also increases walking frequency; however population density has no statistically significant effect, while areas with higher employment density tend to have less frequent transit use and less frequent walking, a result that surprised us. Vehicle ownership is an important factor, those with more vehicles drive more and walk and use public transit less. Also, those with longer commute times use transit more frequently and also walk more frequently, relative to those who drive. This result may be due to the fact that transit trips typically take longer and may be commute trips to New York City.

These results demonstrate one of the primary benefits of TOD and development near train stations. Since those living closer to the train station drive less they also create fewer negative impacts associated with driving (such as pollution, noise, and congestion). Their increased use of public transit benefits the finances of the transit agency and their increased propensity to walk can have health benefits.

Our survey gathered data on five potential indicators of civic engagement or social capital. These included whether respondents had volunteered in their neighborhood, whether they think their neighborhood is a good place to live, whether their neighborhood gives them a sense of community, whether they know their neighbors, and whether most people in their neighborhood can be trusted. With these data we estimated five models that controlled for other factors that might influence social capital. Our key variable of interest was the distance to the train station, but we also were interested in built environment measures and the type of housing respondents lived in.

Results were somewhat mixed. We found that two of our indicators were positive if respondents were more likely to live closer to the station. Higher employment density tended to be associated with reduced social capital on two of our indicators, while population density had a positive effect on two. Living in a detached single-family home was associated with more social capital, while those living in apartments had a negative association.

These results are somewhat suggestive that social capital may be associated with more compact living if that can occur in single-family housing. Older households also tended to be associated with more social capital, so this could partially reflect that TOD residents tend to be younger and new to the neighborhood and possibly more transient. Our focus group analysis found evidence that people appreciated the interactions with neighbors that a walkable environment enabled; this is certainly a form of civic interaction that might be considered an increase in social capital. This is clearly an area that could benefit from further research to fully understand whether there are social capital benefits of TODs and more compact neighborhoods.

One of the benefits of more compact and walkable neighborhoods is their potential to increase the physical activity of residents, through increases in walking activity. While our analysis shows that walking increases for trips oriented toward commuting, shorter walks are not sensitive to distance from the train station, but are more frequent for frequent transit users.

We were unable to determine if proximity to the station had any impact on self-reported health outcomes. To measure potential health outcomes, the survey instrument elicited self-reported responses on five chronic conditions (heart condition, diabetes, asthma, high blood pressure, and obesity) and also on whether the respondent's doctor had advised them to increase their physical activity. Our key variable of interest was distance to the train station. However, we found that those living closer to the station tend to be younger households and the age of the adults in the household was strongly associated with self-reported health outcomes; the only exception was asthma and obesity, which had no statistically significant association. This finding made it impossible to separate the effects of age and the effects of where people live on their self-reported health. This is an area that needs further research to fully understand how increased walking activity of those living closer to the station can be translated into actual health benefits.

Our safety analysis follows approaches commonly used to link the spatial characteristics of an area with the probability of a casualty. These models account for spatial correlation, that is, how adjacent areas may affect casualties in a given area. Analysis was done for pedestrian, bicycle, and vehicle casualties within the two mile radius surrounding our eight designated station areas.

The Bayesian analysis, which provides the best results, shows a very weak association between pedestrian casualties and proximity to the station. More bicycle casualties tend to occur near the station, while the opposite is true for vehicle casualties. Our results may partially reflect where pedestrian and bicycle activity occurs, as our measures of exposure are not ideal. The reduction in vehicle casualties closer to the station may be due to slower road speeds near the station, as opposed to speeds on roads that are more distant.

Thus, while areas around train stations do not appear to strongly influence pedestrian casualties, this may be due to a lack of suitable pedestrian amenities that increase safety. Pedestrian activity is undoubtedly more intense near stations. More densely populated areas show a weak association with fewer pedestrian casualties, while increased employment density is associated with increases, again, this latter result may reflect inadequate pedestrian amenities in areas with more pedestrian activity. There is a clear benefit of fewer vehicle casualties associated with station areas and increased population density.

We also included the Street Smart Walk Score in our safety models but found this to be associated with more casualties in all cases. This is a counterintuitive result and may simply reflect increased activity and exposure in areas with a higher score.

An increase in the value of property in TOD areas reflects an increase in demand to live near stations. This may be due either to a desire to have good rail access for commuting or other travel or to the other attributes of living in a walkable neighborhood. Our analysis was aimed at looking at both these effects.

In estimating a hedonic model of residential property values we used a block group average of Zestimates supplied by the online site Zillow. The distance from the centroid of each block group to both the TOD study station and to any alternative station with direct access to New York City was calculated using GIS. Other key control variables typically used in hedonic analysis were included in the model. Our results show a diminishment in property value the further from the station a block group is located. The reduction is less for proximity to New York City direct service stations than for other

TOD stations, suggesting that access is more highly valued than the other attributes of a walkable neighborhood. In both cases, however, there is clear value associated with proximity to the stations. The benefit of this to local municipalities is primarily through increased property tax valuations, but this also demonstrates that there is demand for housing, including new TODs, that are proximate to these stations.

One benefit of TODs is that those living near the train station have lower out-of-pocket commute travel costs than those who live further out and are dependent on driving for work trips. Our modeling work showed the increased frequency of using transit for those who live closer to stations. Our user-benefits analysis examined the relative travel costs for commute trips for those living near the station and found that the dollar cost of using transit is generally less than the total dollar cost of driving (which includes parking costs). Travel time costs, on the other hand, tend to diminish the dollar cost savings that commuters receive from transit. This varies by station; those stations closer to Manhattan and with lower income populations have lower travel time costs. These results are highly sensitive to assumptions made on the value of travel time, and alternative assumptions on how commuters' value driving versus transit may change these results. But this demonstrates further benefits to transit users of TODs in that their commute out-of-pocket costs are reduced.

We used the NJRTM-E model for North Jersey to estimate how more concentrated development near each of our target train stations would affect the transportation network, both the highway and rail network. Our input assumptions relied on moving population from the outlying (one half to two miles) area around each station to the inner zone (within a half mile of each station). Comparisons were to a base level model run and focused on changes in highway travel and transit use.

Overall results suggest that there is an increase in transit usage and a decrease in vehicle usage. Most of the increase in transit usage is from increased commuter rail trips. Some differences in bus usage and PATH system usage were generated by the model, with some areas seeing an increase and others a decrease. The ridership increases are a clear benefit for NJ TRANSIT as it leads to increased revenue for the system; users also benefited directly from reduced commuting costs. Vehicle usage also decreases. Other costs were estimated using the ASSIST-ME model. These included costs associated with the highway network, including congestion, accidents, air pollution, noise, and maintenance costs. The overall change in costs from the base case was very small and probably not statistically significant given the limitations of the model.

Our main findings are that increased development near train stations in New Jersey can lead to a wide range of benefits for transit users, residents of the area, and the municipality that develops TODs. These range from increased interaction among neighbors and those within the community, more walking activity with consequent health benefits, less driving with potential pollution and other costs, and increased tax revenue for the municipality from increased property values. Safety benefits can also occur but require making areas safe and walkable for pedestrians, something reiterated by our focus group participants. Finding ways to attract a greater variety of convenient retail establishments to station areas was seen as a challenge.

Policy Recommendations

Given the benefits that individuals and communities can achieve by focusing development near existing trains stations, a focus on policies that support this development is needed. Some of this already exists in New Jersey, particularly through the existing Transit Village Initiative that has designated 28 municipalities as Transit Villages to date. Supportive policy for TODs includes changes to existing zoning ordinances that make it difficult or impossible to focus development near train stations. The Transit Village Initiative requires municipalities to have supportive zoning regulations before designation as a Transit Village.

More is needed to improve the pedestrian environment even in areas that have successfully developed near their train station. Coordinated approaches are needed between NJDOT, NJTRANSIT, counties, and municipalities to provide safe and convenient access to stations. The Complete Streets initiative is one way to help facilitate the needed changes, and many municipalities have already adopted Complete Streets policies. Some 16 of the 28 Transit Villages have adopted Complete Streets policies. Additional funding is often needed to effectively change the street environment around stations. All stakeholders should work cooperatively to identify funding mechanisms to improve the walkability around transit stations; consideration of alternative performance measures other than traffic flow should be considered.

Successful development near stations will boost transit ridership, in particular on trains with service to New York City. Peak-hour trains are already near capacity on many routes. Better and more frequent service can make new developments more attractive to residents, while deteriorating service would be a detriment to future development. Budget constraints are an issue, but can be solved with increases in the gasoline tax and consideration of a dedicated funding source for NJTRANSIT, perhaps a fraction of any increase in the gasoline tax. New Jersey currently has one of the lowest gasoline taxes in the nation, and by far the lowest in the region, thus there is ample room to increase gasoline taxes if there is political courage to do so. This can also provide a funding source for walkability improvements near train stations.

Future Research

While this study greatly increases our understanding of the benefits of TODs and development near train stations, it also reveals areas that will require additional research.

One key criticism of much of the station area development that has occurred is the lack of adequate retail establishments that provide convenient day-to-day shopping possibilities for residents. This is a difficult issue for developers as large shopping centers on the edge of town, or even more distant, provide discount shopping and a wide range of options. This makes it difficult for smaller-scale grocery, hardware, pharmacy, and other retail establishments to compete. Online shopping is also making it difficult for all retailers to compete.

We see value in conducting additional research to better understand what conditions and locations might lead to better retail establishments around train station areas and within new TODs that are mixed use. A comparison of the socioeconomic and built environment in these areas to those of areas with a variety of retail may provide insights into impediments to more diverse retail and how that retail can better serve the needs of the community. Other uses, such as ground-floor offices, personal services, religious uses, and community-oriented services may fit better in some station areas, and understanding the appropriate mix and how this improves the quality of life for residents could be explored.

Our analysis of the social capital of TODs yielded results suggesting that those living closer to train station areas have more social capital. The social capital questions on our survey were somewhat limited due to space constraints; there are more comprehensive social capital survey procedures that could be implemented to investigate this issue in more detail. Our self-reported health questions were unique, and we are not aware of others using this approach. However, given our inability to factor survey responses for the influence of age vs. residential location, this approach was not successful. More research is needed to measure actual health outcomes of residents who live closer to TODs but also to understand the full range of their physical activity and the history of where they have lived previously, and how this may affect current health.

Our analysis of traffic safety provided results that are generally consistent with more detailed studies of New Jersey and other areas. More densely populated areas tend to have fewer crashes. One limitation of pedestrian and bicycle safety research is finding proper controls for exposure. More detailed data collection is needed to obtain measures of pedestrian and bicycle activity and exposure in station areas versus those areas that are less walkable. This will provide a basis for more detailed study of the safety issues surrounding more intense development.

Finally, we recognize that TOD need not just occur around train stations. NJ TRANSIT has a large bus network, which is also supplemented by a variety of express commuter bus services into Manhattan. The potential for increased development near established bus “hubs” with direct service to Manhattan could be substantial. Are there barriers to this sort of development; if so, what are they? What additional benefits might communities obtain by enhancing both bus service and encouraging TODs? These questions have not been adequately addressed in previous literature and New Jersey offers a unique case for studying the potential of bus-oriented TOD.

APPENDIX A: CASE STUDIES

Cranford, NJ

Background

Located on the banks of the Rahway River, Cranford Township lies at the center of Union County, New Jersey. Cranford's population in 2010 was 22,625. Nearly five square miles in area, it is 20 miles west of New York City.[98] Residents have direct access via train to Newark, and from there, further connections to New York City, Philadelphia and points southeast on the shore. This ideal location and an attractive downtown have drawn residential and commercial development near its train station, making it an ideal case study for the benefits a train station can have on a community. As this case study will demonstrate, over 60,000 ft^2 of commercial space and 177 new residential units have been built in Cranford transit-oriented developments (TOD), helping create a vibrant, pedestrian-friendly downtown anchored by the train station.

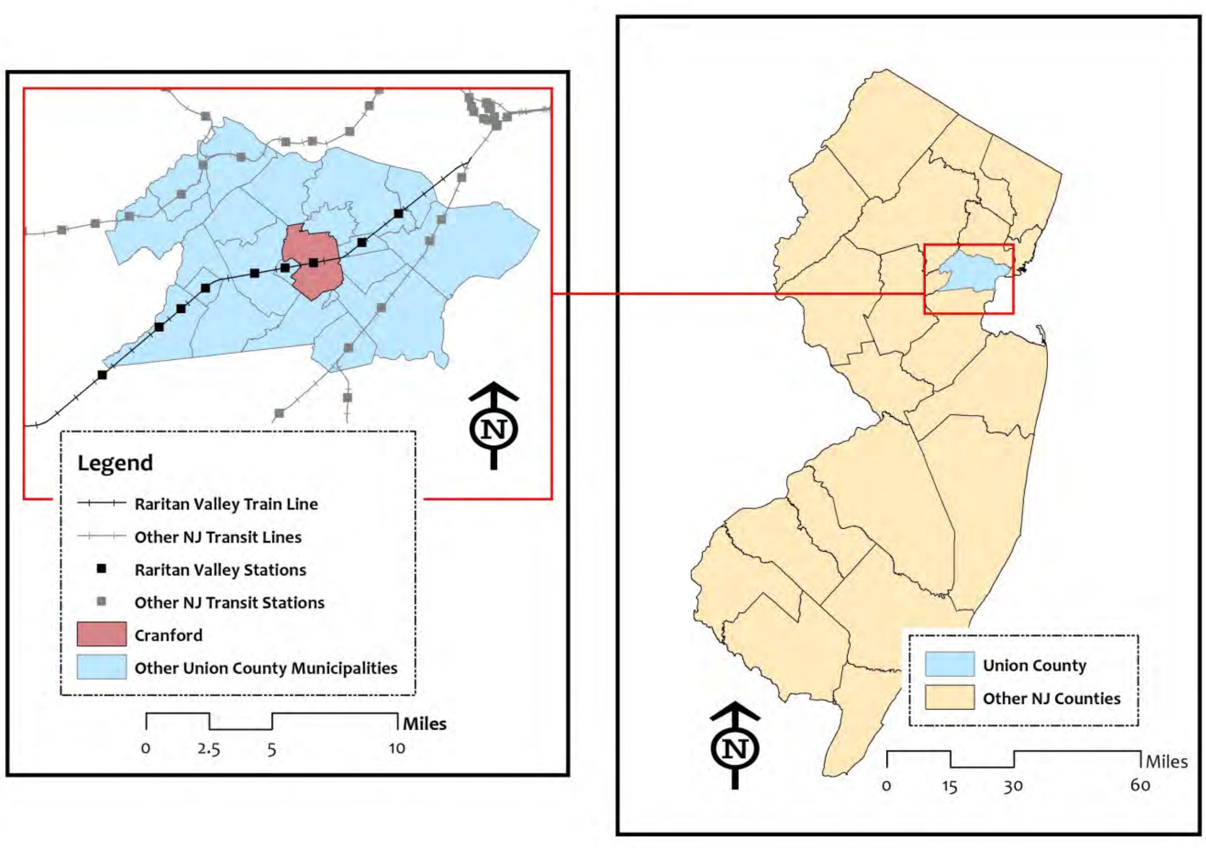

Figure 27. Location of Cranford and Union County, New Jersey

Sources: New Jersey Office of Information Technology,
Office of Geographic Information Systems

Demographics

Cranford is more affluent than both Union County and New Jersey, with a median household income of $107,052, compared with $69,811 for the state and $66,791 for the county.[99] New Jersey's unemployment rate, at 9.9 percent,[100] is higher than the nation's, which is at 8.1 percent (both numbers reflect the August 2012 unemployment rates).[101] The educational services and healthcare industries is the largest employment sector, with 2,809 jobs. Other important sectors include finance, professional, and manufacturing.[99]

Cranford's demographic profile shown below demonstrates that, while Union County is more diverse than New Jersey as a whole, Cranford is far less diverse than either (see Table 83). Nearly 92 percent of Cranford's population is White. Just three percent of its residents report their race as African American and three percent as Asian. Ethnically, about less than six percent consider themselves Hispanic or Latino. Additionally, women (52%) outnumber men (48%).[98]

Table 83 – Total population of Cranford, Union County and New Jersey by race and Hispanic origin

Race	Cranford		Union County		New Jersey	
White	20,781	91.8%	329,052	61.3%	6,029,248	68.6%
Black or African American	592	2.6%	118,313	22.1%	1,204,826	13.7%
Asian	643	2.8%	24,839	4.6%	725,726	8.3%
Other Races	256	1.1%	47,739	8.9%	591,791	6.7%
Two or More Races	353	1.6%	16,556	3.1%	240,303	2.7%
Total	22,625	100%	536,499	100%	8,791,894	100%
Hispanic or Latino (of any race)	1,474	6.5%	146,704	27.3%	1,555,144	17.7%

Source: 2010 Census, Profile of General Population and Housing Characteristics: 2010. Table DP-1.

Over a quarter of all Cranford residents are under 20-years-old. The smallest age cohort is between the ages of 20 and 29 (8%). The rest of the age cohorts are in the double-digits, between 10 and 16 percent. This suggests that there are few young adults living in Cranford, but many families with children, as well as retirees. This demographic pattern reflects those of Union County and New Jersey, except that Cranford has a larger elderly population and a smaller young adult population (see Table 84).[98]

Table 84 – Total population of Cranford, Union County and New Jersey by age

Age Cohort	Cranford		Union County		New Jersey	
19 Years and Under	5,856	26%	144,616	27%	2,291,204	26%
20 to 29 Years	1,863	8%	66,414	12%	1,094,377	12%
30 to 39 Years	2,580	11%	72,935	14%	1,145,041	13%
40 to 49 Years	3,729	16%	83,707	16%	1,354,434	15%
59 to 59 Years	3,474	15%	73,720	14%	1,240,303	14%
60 to 69 Years	2,194	10%	46,661	9%	831,514	9%
70 Years or Over	2,929	13%	48,446	9%	835,021	9%
Total	22,625	100%	536,499	100%	8,791,894	100%

Source: 2010 Census, Profile of General Population and Housing Characteristics: 2010. Table DP-1.

Cranford residents commute primarily by car, despite access to a NJ TRANSIT train station (see Table 85). Over 75 percent of residents drive alone to work, which is more than both Union County and New Jersey. Still, public transportation use is higher, at 11.5 percent, than in the county or the state; this is likely because of the train station. Despite this high level of public transit commuting, over 98 percent of all residents own at least one car, and over 80 percent own at least two cars.[(99)] This indicates that a car is required to access other services in town (see Table 86).

Table 85 – Commute mode split

Commute Mode	Cranford	Union County	New Jersey
Drove alone	75.6%	67.2%	71.5%
Carpooled	5.8%	9.8%	9.0%
Public transportation (excludes taxicab)	11.5%	9.9%	10.6%
Bicycle	0.2%	0.3%	0.3%
Walked	1.5%	3.5%	3.3%
Other means	1.7%	6.4%	1.7%
Worked at home	3.7%	2.8%	3.5%
Total	100%	100%	100%

Source: American Community Survey, 2006-2010 5-Year Estimates, Table B08014

Table 86 – Vehicles available

Number of Household Vehicles	Cranford	Union County	New Jersey
0	1.4%	6.7%	6.7%
1	14.5%	28.1%	22.7%
2	51.0%	40.2%	41.6%
3 or more	33.1%	27.2%	29.0%
Total	100%	100%	100%

Source: American Community Survey, 2006-2010 5-Year Estimates, Table B08014

History of Cranford

Cranford was incorporated in 1871, but its history extends back to the Revolutionary War period. Cranford's namesake was a ford in the Rahway River connecting two mills built by John Crane, hence, "Crane's Ford." During the Revolutionary War, these two mills provided food for the colonial army. The Cranford Station, on what is now NJ TRANSIT's Raritan Valley Line, was built as early as 1865. The structure has been replaced at least three times since then, with the current station rising in the mid-1930s.(102)

The Rahway River and the Cranford train station became the focal points of development in Cranford; by 1885, 76 residents commuted every day from Cranford to New York City. Development concentrated around the station and the river, leading Cranford to become first a recreation center and then a commuter suburb, which created a dense downtown business district. The town's proximity to the Rahway River, however, caused occasional severe flooding until the 1970s, when the town dredged the river and built detention basins.(102)

Today, Cranford is pursuing plans and policies to improve the town's quality of life. Since the 1980s, it has pursued strategies to keep development downtown and provide pleasant aesthetics and commercial and recreational opportunities for residents and visitors alike. The Cranford Downtown Management Corporation (DMC), charged with revitalizing and marketing Cranford's Special Improvement District (SID), uses the taxes raised by the SID to make downtown capital improvements. Within the SID and the immediate area, there are more than 250 businesses, as well as nearly 1,000 apartments and condominium units.(103) The DMC also assists and provides grants to business owners to help them promote their businesses and improve their aesthetics.(104)

Transit Service

Cranford Township is served by NJ TRANSIT bus and rail lines. The train station is located on South Avenue East, just off the Garden State Parkway. Tickets can be purchased from one of two ticket vending machines or from the ticket office. Parking is available on-street, in a garage, and at surface lots. The type of parking varies; some require permits, though most have pay-per-hour parking. On-street parking around the town is available as well. Bicycle parking and lockers are also available at the station.

For those who want to easily connect to New York City and other parts of New Jersey, Cranford offers a centralized location, as riders can take the Raritan Valley Line to Newark and connect to many places in the tri-state area on other train lines available there. To reach New York City, riders must switch to other NJ TRANSIT lines or the PATH train. From Newark, riders can also connect to trains that stop at Newark Liberty International Airport, the Jersey shore, and other points north and south. This means that passengers can access recreational sites, job opportunities, and fly out of New

Jersey without driving.[105] Table 87 details the stop frequency of the Raritan Valley Train Line. The Raritan Valley Line runs between Newark Penn Station in the east and High Bridge to the west. For both peak and off-peak times, the price for a one-way ticket to Newark or a connection to Hoboken, is $4, while a ticket with a connection to New York City is $8. The ride to Newark takes 20 minutes.[105]

Table 87 – Train and bus stop frequency in Cranford Station – weekdays

	Eastbound			Westbound		
Train Line or Bus Route	AM	PM	Total	AM	PM	Total
Raritan Valley Train Line	12	13	25	6	18	24
Bus Route 56/57	0	6	6	7	0	7
Bus Route 58	8	14	22	10	13	23
Bus Route 59 (South Ave./ Union County College)	18/4	31/5	48/9	19/5	5/30	49/10
Bus Route 65/66	7	18	25	9	19	28
Bus Route 113	49	12	61	7	47	54

Source: NJ TRANSIT

Five bus lines serve Cranford Township. The Route 56/57 combined line runs from Elizabeth to Winfield or Linden, depending on the route number. Route 57 does not stop in Cranford, but Route 56 does stop at the Cranford Business Park. Stopping only in the morning in the westbound direction and in the evening heading east, it serves Cranford residents commuting from Elizabeth to the Cranford Business Park.[105]

Route 58 connects Elizabeth to Union County College in Cranford. With a terminus at Union County College, this line primarily moves students from Elizabeth, Roselle Park, and Kenilworth to and from the Union County College campus in Cranford. Route 59 serves local stops throughout Union County and Newark. Along with Route 113, Route 59 stops at the Cranford Station, allowing for train connections. Route 66 (of the combined route 65/66) makes limited stops at Union County College on weekdays. Finally, Route 113 is the only NJ TRANSIT bus that provides Cranford a direct (and often nonstop) connection between Cranford and New York City. On weekdays, its high morning and evening frequency caters to commuters working in New York City. Cranford appears to be the biggest pool for these commuters, since the only two stops used by every bus are the Port Authority and Cranford Stations.[105]

Since 1999, ridership on the whole Raritan Valley Line has increased by 24 percent (see Table 88 below). The largest jump came between 2004 and 2008, likely due in part because of the recession and rising gas prices. Since then, however, there have been moderate drops in ridership, though levels are still well above the 1999 level. Ridership has not dropped below 20,000 since 2005.[106]

Average weekdays boardings at Cranford Station mirror this trend. Ridership increased the most 2005 and 2008, but has leveled off since then, with yearly changes of about 1 percent. Since 2005, it has not dipped below 1,000 boardings, remaining around 1,100 for the past five years.[106] That ridership on the Raritan Valley Line and boardings at Cranford have increased in the past decade without dropping back down is encouraging, suggesting that people may be moving closer to stations as they increasingly ride the train to work.

Table 88 – Raritan Valley Line average weekday ridership and Cranford average weekday boardings

Year	Raritan Valley Line	% Change	Cranford Station	% Change
1999	17,200	--	1,068	--
2000	18,600	8%	1,123	5%
2001	20,000	8%	1,154	3%
2002	18,250	-9%	1,025	-11%
2003	17,250	-5%	959	-6%
2004	18,150	5%	986	3%
2005	19,450	7%	1,029	4%
2006	20,850	7%	1,070	4%
2007	21,150	1%	1,125	5%
2008	22,950	9%	1,172	4%
2009	22,550	-2%	1,189	1%
2010	21,600	-4%	1,175	-1%
2011	21,250	-2%	1,189	1%
2012	21,800	3%	1,264	6%
% Change, 1999-2012		27%		18%

Source: NJ TRANSIT

TOD Development

In 2003 the New Jersey Department of Transportation designated Cranford a Transit Village under its Transit Village Initiative. A Transit Village is a municipality that has "demonstrated a commitment to revitalizing and redeveloping the area around their transit facilities into compact, mixed-use neighborhoods with a strong residential component." To receive the designation, a municipality must meet a set of criteria, which include identifying existing transit available in the municipality, adopting a TOD redevelopment plan or zoning ordinance, identifying specific TOD projects, identifying pedestrian and bicycle improvements, and identifying efforts that contribute to the municipality's sense of place, such as cultural and arts events. The Transit Village Task Force and the NJDOT Commissioner designate Transit Villages; the number varies each year.[107]

Cranford had already undertaken some of these transit village requirements by 2000, when, with a Smart Growth award from the New Jersey Department of Community Affairs, the DMC conducted a visioning process that included a year-long survey of residents about development, parking, and zoning, and public space improvement and culminated with a Vision Plan. Since then, the town has received a number of grants to improve the downtown. In 2003, Cranford received a grant of $200,000, which was used to conduct a parking, traffic, and pedestrian study, demonstrating its commitment to making the downtown safe and attractive. Other grants have included those to add lighting and decorative fencing, to improve pedestrian access, and for the renovation and construction of public plazas.(103) These efforts have proven attractive to residents; in conjunction with these improvements, one new TOD—Cranford Crossing—has been built, and another—Riverfront at Cranford—is under construction. Both are adjacent to the train station. When these TODs are completed, they will add a combined total of 177 multi-family housing units and 62,000 ft^2 of retail and office space.

Figure 28. Location of Cranford Crossing and Riverfront at Cranford Station

Source: Bing Maps; TIGER/Line Shapefiles (US Census Bureau)

Cranford Crossing

After designation as a Transit Village, redevelopment efforts began immediately, starting with the proposal for Cranford Crossing, the town's largest downtown redevelopment project. Completed in 2006, Cranford Crossing is a mixed-used development designed with 50 for-sale condominium units, 22,000 square feet of retail space, and a 310-space municipal parking garage.(108) The development sits adjacent to the Cranford Train Station, giving commuters a short walk to either entrance. New Jersey Future awarded Cranford Township and the developer, Westminster Communities, a 2005 Smart Growth Award for its Cranford Crossing development, although the project did not go through without difficulties.(109) Originally conceived as an ownership opportunity, Cranford Crossing's units are now rentals. Additionally, the town and the current owner, Morgan Properties, clashed over the parking garage design, project timing, architectural elements, and whether or not to allow office tenants. In the end, the town allowed a limited number of office uses.[110,111]

Figure 29. Cranford Crossing as seen from Cranford Station platform

Riverfront at Cranford Station

The second TOD project is Riverfront at Cranford Station, a commercial, retail, and residential development located directly across from the train station's southern entrance. The project was under construction by developer Garden Commercial Properties in summer 2012. The development replaces a strip of rundown stores, including a gas station with environmental cleanup issues and the former Holt Machinery factory.[112] The development will contain approximately 20,000 ft^2 of retail space, 20,000 ft^2 of office space, and 127 residential units. It will front three streets, with 107 ground-level parking spaces that will be hidden from the street. When finished, Riverfront at Cranford Station will be twice as large as Cranford Crossing, with about two times the number of residential units, commercial space but with fewer additional parking spaces.[113] Like Cranford Crossing, the development is a public-private partnership; thus the townspeople are allowed to influence the design of the streetscape for consistency with existing form. [112]

Figure 30. Riverfront at Cranford Station, under construction (Spring 2012)

Retail conditions

In the last 15 years, the health of Cranford's commercial areas has improved. After commissioning DANTH, Inc., to assess the business district, the town realized it had opportunities to build larger stores south of the train station where few were located, prompting Cranford to view the train station not as a divider of the district but as its centerpiece. Hence, when the town began to pursue both the Cranford Crossing and Riverfront developments, retail became part of both projects. The 2000 Vision Plan, by clarifying what the community wanted for their town, helped lead to almost $20 million in business investment over the next few years. Improvements included building renovations and the opening of new stores.[114]

Cranford's retail establishments have thrived since then. According to the summary of the 2011 Annual Report published by the DMC, 15 new stores, restaurants, and offices were occupied, and five existing businesses relocated to larger spaces. At the end of 2011, downtown Cranford had a commercial occupancy rate of 97 percent. Sixteen new businesses signed leases in 2011.[104] Additionally, both Cranford Crossing and Riverfront have contributed to commercial space by adding more ground floor retail beneath their multi-family units.

<u>Station Area Conditions</u>

Despite progress made in revitalizing the area surrounding the train station, the station is in need of improvement. A visit to Cranford by the authors in 2012 revealed signs that were in need of replacement or yellowed by the sun. There was standing water on the stairs to the westbound platform, and the hallways that run underneath the station felt vacant and unwelcoming. However, the waiting room was friendly and well-appointed, with touches of community present, including a book exchange for commuters to donate and withdraw paperback books for reading on the train.

Integration of Station into Surrounding Area

From north of the rail line, Eastman Street and North Union Avenue converge underneath the train tracks, while North Avenue crosses both of these streets before they converge, creating a small triangular plaza with angled parking. Named Eastman Plaza, it contains a now-iconic clock and circular seating area that have come to symbolize downtown Cranford. The point at which these roads and their southern equivalents pass under the Raritan Valley line is the focal point of density and orientation for the downtown, rather than the Cranford Station itself. The north side of the train line has more retail activity than the south side, with many restaurants, a coffee shop, banks, and other shops. South of the tracks are the Cranford Hotel and some retail on the ground floor of Cranford Crossing.

Walkability Assessment

In 2010, a research team from the Voorhees Transportation Center at Rutgers University conducted walkability audits on several Transit Villages to assess the progress of the Transit Village Initiative. The team found Cranford to be amenable to walking, with many of its streets respectful of human scale and providing adequate, inviting facilities. It was rated particularly high for an attractive streetscape, with trees, awnings, and little graffiti, as well as for pedestrian-oriented land uses, with a high density of stores and minimal parking. Some possible improvements include repairing pedestrian crossings and installing curb ramps.(115)

A site visit in spring 2012 confirmed many of the pedestrian amenities that Cranford continues to offer; however, the area directly north of the station could benefit from several improvements. Pedestrian crossings along North Avenue at Alden Street and at North Union Avenue are long and undermine an otherwise pleasant pedestrian environment. Additionally, diagonal parking located to the north of the station and a surface parking lot adjacent to the south station entrance diminish the quality of the pedestrian experience in the immediate station area.

Improvements to some of these locations are in process. Subsequent to the publication of the 2010 report, Cranford received a $500,000 grant from the New Jersey Department of Transportation in 2011 to be used for the construction of pedestrian walkways across North Avenue to the train station, as well as for landscaping improvements. The grant is a direct result of Cranford’s Transit Village designation.(116)

Figure 31. North Ave entrance to Cranford Station (inbound)

Parking

The Cranford Police Department operates on-street and off-street parking. Cranford has 17 municipal parking lots. Each lot is different as to cost, permitting, and length requirements. The city's only parking garage is located at Cranford Crossing. On-street metered parking is also available on most streets throughout the downtown. The cost of parking is $0.25 per half-hour, with most lots free on Sundays. Drivers can also buy permits for varying length stays for some of the lots.[102]

Bicycle Facilities

Cranford lacks the bicycle amenities that are necessary to increase bicycle use. Although Cranford's Master Plan requires bike racks for all major developments, this is often waived. The Master Plan calls for the reevaluation of the requirement.[117] The town does not have any striped bike lanes. Bike parking at the train station is derelict, with abandoned bikes chained to rusting racks and insufficient parking space for bicycle commuters. Cranford does, however, have a local bike store, Cranford Bike Shop, which offers bicycle purchase and repair.[118]

Built Environment

Land Use

Figure 32 shows a map of land use in Cranford, from a dataset courtesy of the New Jersey Geographic Information Network. Since the dataset was created before 2007, prior to completion of the TODs, Cranford Crossing and Riverside at Cranford were still classified as “altered land.” Yet the map does illustrate a development pattern that shows a strong commercial core near the train station around which high- and medium-density housing clusters.

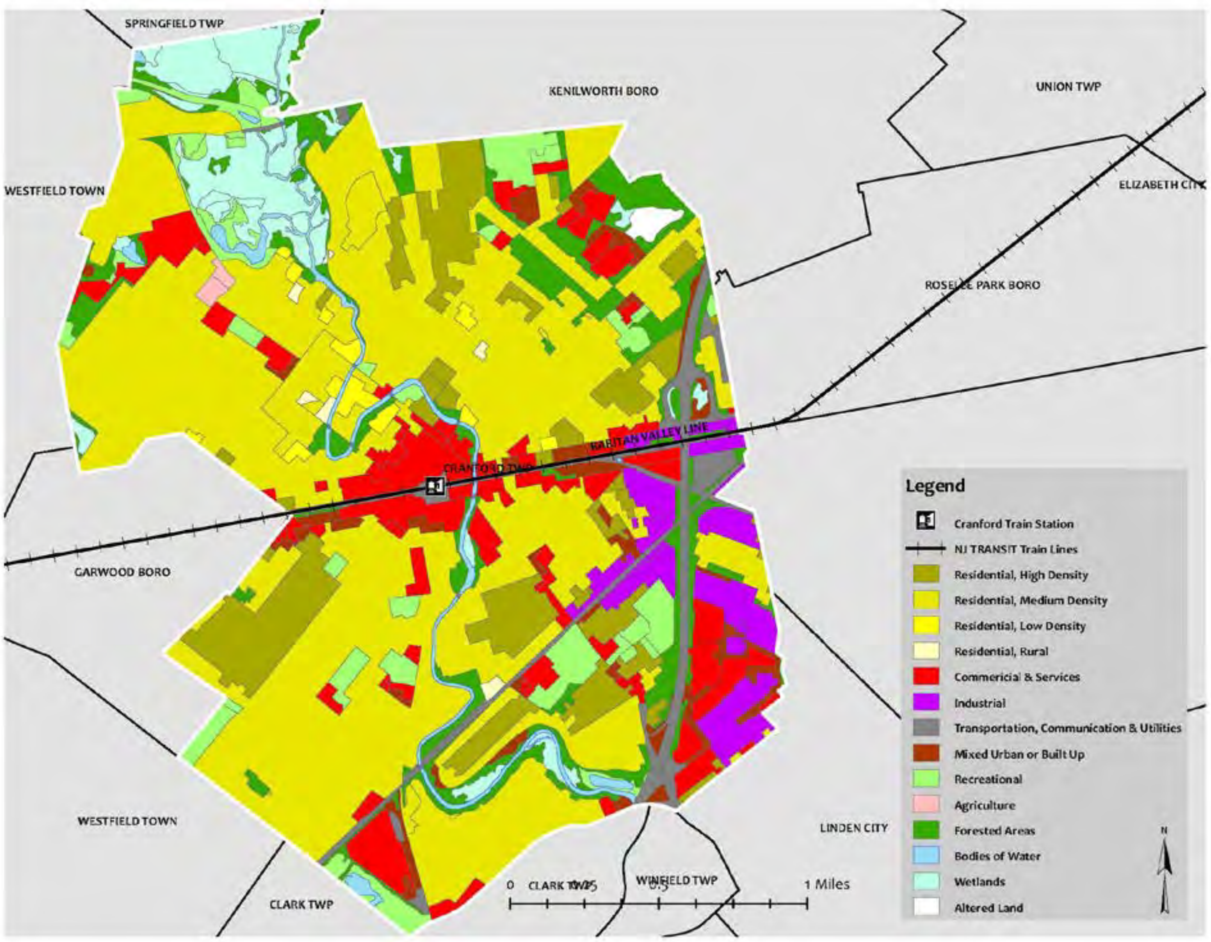

Figure 32. Land use in Cranford

Source: NJ Department of Environmental Protection;
NJ Geographic Information System, 2007

Zoning Conditions

In 2009, Cranford adopted a new Master Plan, in which the city updated its zoning, to include an increase in multi-family residential zones. The new zoning, as well as the rest of the plan, demonstrates Cranford's commitment to transit-oriented development. Its vision for 2020 includes goals to concentrate dense residential development in the Downtown Core, with less dense residential uses further out from the Core. Overall, Cranford's Master Plan reflects its commitment of TOD and mixed-use development to bring people and amenities into a concentrated area, such as a downtown or around a train station where automobile use is not necessary for everyday activities and errands or necessary for traveling outside of the community.[(117)]

Additionally, the plan's residential goals acknowledge that a variety of housing stock options are needed and that the higher density housing options should be located nearest to the train station and downtown. Cranford does, however, attempt to protect separated land uses by placing boundaries and transition areas between commercial and residential areas and limiting higher density development in residential zones, all of which helps to protect the character of Cranford. None of these are diametrically opposed to TOD and mixed-use development. Instead, they encourage or enforce a community where strictly low-density residential zones surround a commercial, mixed-use, and high-density residential center.[(117)]

Redevelopment and Rehabilitation Districts

Cranford supports TOD through a number of zoning and land use strategies. The Master Plan has designated three redevelopment districts and one rehabilitation district. The districts include Cranford Crossing Redevelopment District (CCRD), Riverfront Redevelopment District (RRD), 555 South Avenue East Redevelopment District (SRD), and the Western Gateway Rehabilitation District (WGRD). By 2009, redevelopment plans had been prepared for Cranford Crossing, Riverfront, Western Gateway and 555 South Avenue East.[(117)] These districts allow for exceptional or complex land use combinations that might otherwise clash with the zoning plan.

The RRD permits the Riverfront at Cranford Station development project that is now under construction; it allows for mixed-use development. The Master Plan also acknowledges the complications of redeveloping so close to the Rahway River, which produced substantial flooding after Hurricane Irene in August of 2011.[(119)] The WGRD, unlike the other redevelopment districts, is not intended to replace older or defunct development with new development; rather, the intention is to refurbish and redesign the development that exists at the Township's western edge. Housing there is meant to be built at a lower density than the rest of downtown. While the development districts are intended to produce a certain kind of development, the rehabilitation district is intended to eliminate the potential for strip mall development at this location. According to the 2009 Master Plan, the five-acre SRD, which is meant to include Cranford's affordable-housing provision, is currently tied up in affordable-housing litigation.[(117)]

Nearby Housing Stock

The 2010 census counted 8,816 housing units in Cranford, of which 8,583 (97.4%) were occupied. Of those, 1,589 were rented.[98] The 2006-2010 American Community Survey documented 6,473 single-family detached houses, and 1,873 buildings with two or more units in the structure. The median value of all the owner-occupied units is $481,000.[99] The housing nearest the train station is mostly high-density, and decreases in density further away.

The census tract in which the train station is located has the highest number of renter-occupied units of all Cranford tracts, 43 percent. Less than half of the housing is single-family detached, 20 percent contain two units, and 16 percent have 20 or more units. Throughout all of Cranford, housing is generally older, most was built before 1980. This is especially true in the tract with the train station, where 45 percent built before 1940. The median monthly rent is $1,220 – lower than the town-wide average of $1,372 – of which over 60 percent pay more than $1,000. The median value of owner-occupied units is $495,400, higher than all of the other census tracts in Cranford.[98]

Aesthetics

Through the DMC, Cranford has taken a proactive approach to improving community aesthetics. The DMC conducts a Business Grant Program, which includes grants for aesthetic improvements. The latter incentivizes improving aesthetics by funding attractive signage, awnings, or façade enhancements. In 2012, the DMC proposed recommendations for new design guidelines for new developments. Following its adoption, the DMC will publish a Design Handbook to assist business owners in producing attractive designs that meet regulations.[104]

The DMC has also been directly involved in street beautification. The DMC received $6,000 from the Clean Communities Program in 2011 for downtown aesthetics maintenance; a 2012 proposal was approved for $7,325. They also partnered with Green Thumb Garden Club and Cranford High School. With the former, they developed a landscaping plan for 2012 to install brick sidewalk planters four times a year; with the latter, they worked with graduating seniors to clean, repair, and repaint downtown benches. The DMC also purchased additional baskets for Victorian poles and pedestrian railings on Walnut Avenue. For 2012, the DMC has planned numerous public art projects. They have several thousand dollars dedicated to painting art on street benches, creating a mural at the Cranford train station, and tile art inside the station.[104]

Livability Assessment

Cranford has a long history of social organizations. The Cranford Dramatic Club began operation in 1919 and constructed its own theater in 1957, where it has remained since. The club puts on four productions per season.[120] The Cranford Historical Society, founded in 1927, conducts student programs, and educational tours, scouting groups, and adults, as well as a research library. The Society also participates in public events, such as marching in the Cranford Memorial Day Parade.(121)

The Cranford Jaycees, in existence for more than 50 years, awards student scholarships each year, participates in local events such as the Halloween Parade, Tree Trimming and Lighting, and a yearly Easter Egg Hunt. They also put on their own signature event, the Firecracker 4 Miler on the Fourth of July.(122) The Cranford Junior Woman's Club also offers a scholarship to high school seniors. The Cranford Newcomers' Club welcomes women new to the area with regular meetings and activities for members.(123) The Hanson Park Conservancy was founded in 2004 by Cranford Citizens to maintain Hanson Park and the Cranford Canoe Club. The Cranford Canoe Club rents canoes to visitors over the summer, and hosts events such as canoe races.(124) Cranford also has active chapters of the Rotary Club and United Way.(102)

These organizations, located downtown and easily accessible by public transit, help draw new residents. The variety of activities and organizations for all ages makes it an attractive place to live for all demographics. They support the success of TODs, providing activities that keep residents and their financial resources in Cranford.

Cranford also has many amenities downtown, many of which are within walking distance from the train station. These include schools, churches, a movie theater, restaurants, a dentist, a pharmacy, and a bank. One important amenity that is missing is a grocery store. Within the downtown are a few convenience stores, but one must look beyond Cranford to reach standard supermarkets. The nearest is a Pathmark in Garwood, a 15 minute walk from the train station (0.7 miles), but it is along a county highway, CR610. It is also accessible via NJ TRANSIT buses. Nor does Cranford support a farmers market. The nearest farmers markets are the Roselle Park Farmers Market (2.4 miles away) and the Westfield Farmers' Market (2.6 miles). The latter is located in that town's train station parking lot, making it accessible from Cranford by train.(125) This seems to be a common shortcoming among towns with TODs. They have many upscale amenities, such as hair salons, cafés, boutique clothing stores, and jewelers, but lack more basic amenities so that residents still require cars for their daily needs.

Conclusions: Benefits of TOD

Economic

Cranford's coordinated development efforts have enabled the town to thrive economically. Cranford Crossing and the upcoming Riverfront at Cranford Station have added a total of 177 new units, as well as 62,000 ft^2 of retail. This has brought not only new residents to the downtown, but also new retail. The addition of commercial space within the TODs keeps residents downtown and creates attractions for out-of-towners, drawing them to the downtown and encouraging them to patronize the businesses. The train station acts as a magnet around which the retail and office space gather, benefiting from the foot traffic of commuters and visitors accessing the station. The local businesses also contribute to the strength of the town's economy by providing employment to residents, enabling them to walk to work if they live downtown. The high downtown business occupancy rate, as discussed earlier, is a testament to the desirability among store owners and shoppers of a vibrant downtown.

Environmental

Cranford's two TODs are built on brownfields near the train station, replacing dilapidated properties. The town updated its zoning to allow mixed-use and multi-family developments by using redevelopment zoning overlays. Developing on brownfields in the center of town is more environmentally-friendly than developing greenfields that are further away. Residents in multi-family housing require fewer land resources per resident compared with single-family housing. Finally, TOD residents, if they use the train frequently, emit less gasoline pollutants than their car-driving counterparts.

Health

The Centers for Disease Control, among other organizations, recognizes that urban design plays an important role in the health of a community. It recommends that housing, commercial, and recreation facilities be built close together to enable walking and biking between them. Communities should provide residents with the ability to be physically active as a regular part of their daily lives, as well as provide access to recreational green space and fresh fruits and vegetables. Cranford has actively pursued walkability through its redevelopment districts, acquiring downtown beautification grants, and creating a Master Plan with goals that emphasize a dense, walkable downtown.

Cranford boasts a number of these characteristics. Cranford Crossing and Riverfront, located downtown and in close proximity to the station, allow residents to walk to nearby stores, restaurants, offices, and some recreational areas. Parking is minimal, allowing for just one car per unit, with many expected to walk, bicycle, or use transit. By rezoning downtown to allow for mixed use, Cranford also makes it easier for people to walk. By doing so, active transportation becomes part of residents' daily lives.

Challenges

Cranford has faced some challenges implementing its TOD vision. Since the town had initial conceptual designs for the projects, committing the TODs to public-private partnerships meant finding a developer whose visions meshed with its own. As discussed earlier, Cranford struggled with lawsuits and complaints from developers and residents regarding the design and potential impacts of the developments. These setbacks were costly for the town, especially when, as was the case with Cranford Crossing's parking garage, the town had to spend more money on rising development costs than it initially anticipated.[126] By partnering with developers to build structures they desperately want downtown, towns are susceptible to the same problems developers face, particularly unexpected costs and lack of tenant interest. While TODs can be immensely beneficial for improving a community's quality of life, municipalities must be mindful of the consequences they may encounter with these projects.

Lessons Learned

The influx of new residents attracted by Cranford's TODs has contributed to its revitalization. The town is substantially built-out, so redeveloping underperforming and/or derelict properties downtown is a wise growth strategy. Support from the local government meant that potential projects encountered a receptive audience. The support of the DMC especially, with its investments in streetscape aesthetics, community events, and the business district, provided an environment that allowed the TODs to work seamlessly with the rest of the downtown. Cranford's willingness to alter zoning to accommodate TODs signals its enthusiasm.

Cranford's growth has not always been easy, however; as described above, legal barriers had to be overcome, as did community concerns. But the city's investments in TOD have begun to pay off as more people see the numerous benefits of living in a Transit Village like Cranford. Easy access to locations in New Jersey and beyond, and to live, work, and play opportunities downtown, make the town an enjoyable place to live.

Next steps for TOD

Looking ahead, Riverfront at Cranford Station will be a substantial step forward for TOD in Cranford, adding 127 new residential units, along with 40,000 ft^2 of commercial and retail space, bringing the total from new TOD construction to 177 units and 62,000 ft^2, respectively. Its completion will add a second anchor of commuter-centric residences to the southern side of Cranford Station, adding liveliness and activity to the less-densely developed half of the downtown. Additionally, the planned pedestrian improvements on North Avenue should strengthen the connection between the busier half of downtown Cranford and Cranford Station. Other multi-family developments are under consideration, although they are not located as close to the train station. Cranford's establishment as a Transit Village and its commitment to increasing housing and commercial opportunities around the station has paid off and will continue to do so if more people find that living in a TOD is a desirable lifestyle choice.

Morristown, NJ

Background

Morristown is an incorporated town of 2.93 square miles of land and the seat of Morris County. The State Plan designates Morristown as a regional center, marking it an area for intensive development around a major public transit hub.(127) As of 2010, the town was home to 18,411 residents living at an average density of 6,285 persons per square mile.

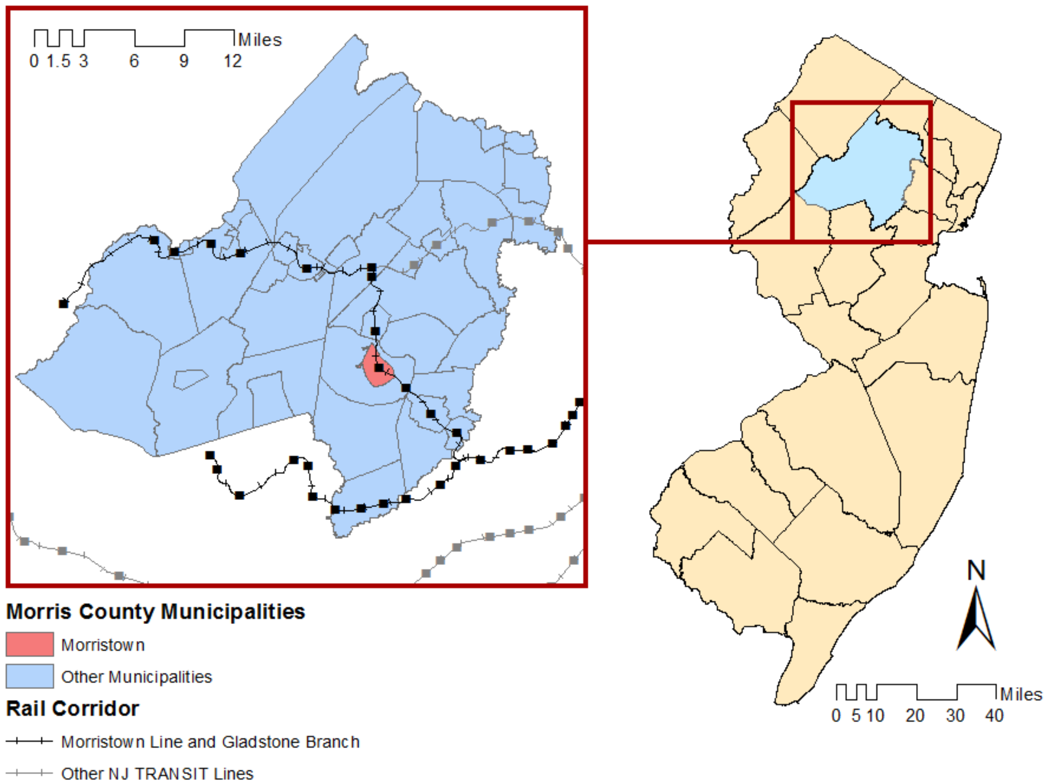

Figure 33. Location of Morristown and Morris County, New Jersey

Source: New Jersey Office of Information Technology,
Office of Geographic Information Systems

Demographics

The median income in 2010 was $64,279, about 8 percent less than the statewide median of $69,811. Males make up slightly more of the population (51.1%) than do females (48.9%). Table 89 provides an overview of the racial breakdown of Morristown's population as compared with Morris County and the state of New Jersey as a whole.

Whites make up a smaller proportion of Morristown residents than residents of Morris County or of New Jersey as a whole. Although the percentage of Black or African American residents of Morristown is similar to the state's, it represents nearly five times the percentage of Blacks in the county. In addition, Morristown has a large Hispanic and Latino community, which forms more than a third of the total of the population. A resident of Morristown is about three times as likely as the average resident of Morris County, or about twice as likely as the average New Jerseyan, to have identified as either Hispanic or Latino. While Puerto Ricans, Dominicans, Mexicans and a variety of South American nationalities comprise most of New Jersey's Hispanic and Latino Population, the Hispanic population of Morristown hails largely from Honduras (10%), Columbia (6.7%) and Guatemala (4.4%).[98]

Table 89 – Total population of Morristown, Morris County and New Jersey by race and Hispanic origin

Race / Origin	Morristown		Morris County		New Jersey	
White alone	11,507	62.5%	406,683	82.6%	6,029,248	68.6%
Black or African American alone	2,572	14.0%	15,360	3.1%	1,204,826	13.7%
American Indian and Alaska Native alone	117	0.6%	805	0.2%	29,026	0.3%
Asian alone	799	4.3%	44,069	9.0%	725,726	8.3%
Native Hawaiian / Other Pacific Islander alone	11	0.1%	106	0.0%	3,043	0.0%
Some Other Race alone	2,732	14.8%	14,910	3.0%	559,722	6.4%
Two or More Races	673	3.7%	10,343	2.1%	240,303	2.7%
Total	18,411	100%	492,276	100%	8,791,894	100%
Hispanic or Latino	6,277	34.1%	56,482	11.5%	1,555,144	17.7%
Not Hispanic or Latino	12,134	65.9%	435,794	88.5%	7,236,750	82.3%
Total	18,411	100%	492,276	100%	8,791,894	100%

Source: 2010 Census, Summary File 1

Table 90 presents a similar comparison for the age of Morristown residents. Morristown has a relatively similar demographic profile to Morris County and the state of New Jersey, with two notable exceptions. Morristown has only three-quarters the proportion of school-aged children as either the County or the state. More dramatic, however, is the comparison of residents aged 25 to 34. Morristown has more than twice the percentage of younger adult residents as the County and a greater proportion than the state by a factor of nearly 1.8.[98]

Table 90 – Total population of Morristown, Morris County and New Jersey by age

Age Cohort	Morristown		Morris County		New Jersey	
17 Years and Under	3,233	18%	117,695	24%	2,065,214	24%
18 to 24 Years	1,786	10%	34,829	7%	767,228	9%
25 to 34 Years	4,268	23%	51,794	11%	1,109,801	13%
35 to 44 Years	2,796	15%	72,187	15%	1,238,297	14%
45 to 54 Years	2,373	13%	85,379	17%	1,379,196	16%
55 to 65 Years	1,845	10%	62,237	13%	1,046,165	12%
65 Years or Over	2,110	12%	68,155	14%	1,185,993	14%
Total	18,411	100%	492,276	100%	8,791,894	100%

Source: 2010 Census, Summary File 1

Morristown residents own vehicles at a much lower rate than that found in the county or the state. Nearly half of all households own only one personal vehicle, and nearly 15 percent of households own zero vehicles, which makes the typical household “car light” if not car-free (Table 91). Nonetheless, the mode split for commuters in Table 92 shows that personal vehicles make up the vast majority of residents’ commute trips (78%). Current estimates show only four percent of residents commute to work using public transport, which is less than half the rate of transit use for the state as a whole (11%). However, the percentage of residents choosing to walk to work (10%) is about three times as large as the statewide share of pedestrian commute trips (3%).[99]

Table 91 – Vehicle ownership in Morristown

Number of Household Vehicles	Morristown	Morris County	New Jersey
0	14.7%	2.8%	6.7%
1	47.8%	15.6%	22.7%
2	30.3%	47.1%	41.6%
3 or more	7.1%	12.2%	29.0%
Total	100%	100%	100%

Source: American Community Survey, 2006-2010 5-Year Estimates, Table B08014

Table 92 – Commute mode split in Morristown

Commute Mode	Morristown	Morris County	New Jersey
Drove alone	62.9%	79.9%	71.6%
Carpooled	14.8%	7.7%	9.0%
Public transportation (excludes taxicab)	4.4%	4.4%	10.6%
Bicycle	0.7%	0.2%	0.3%
Walked	10.4%	2.0%	3.3%
Taxicab, motorcycle, or other means	3.4%	1.0%	1.7%
Worked at home	3.4%	4.7%	3.5%
Total	100%	100%	100%

Source: American Community Survey, 2006-2010 5-Year Estimates, Table B08006

According to the Census, Morristown was home to 8,172 housing units in 2010, nearly 91 percent (7,417) of which are occupied. Renters occupied the majority of Morristown’s housing units (61%), a rate about 2.4 times that of renters in Morris County (25%) and 1.8 times that of renters in the state (35%). Of vacant homes, nearly 58 percent were available for rent and 29 percent were for sale only.[98]

Much of the growth in Morristown housing, retail and office space has been within new transit-oriented developments. Data from the Department of Community Affairs (DCA) detailing issued building permits and certificates of occupancy indicates that from 2000-2011, 916 new housing units have been authorized for construction. From 2004 to 2011, 586 units, or more than 95 percent of new housing units authorized, have been for those located in multi-family buildings. Collection of these more specific data began in 2004. In addition, building permits authorized a total of 57,130 ft^2 of new retail space and 184,636 ft^2 of office space since 2000. It should be noted that building specifications for individual TODs in Morristown indicate that more retail space has been built during this time period, with over 72,000 square feet in the Epstein's Rehabilitation Area alone. DCA data also show no new A-2 classified, nonresidential space, which covers restaurants and bars with certificates of occupancy. It may be the case the tax assessment professionals reporting to the DCA have not counted all ground-floor retail and dining in mixed-use facilities, leading to an underreporting of new retail space in Morristown.(128)

History of Morristown

Morristown was first settled by the English in 1715 and has a rich and storied colonial history. The town is best known as the headquarters of George Washington's revolutionary forces during the bitter winters of 1776 and 1779. Both Washington's Headquarters at Ford Mansion and Fort Nonsense, which functioned as a retreat for soldiers, are preserved and are prime attractions at Morristown National Historical Park.(129)

Morristown was incorporated in 1740 as the governmental seat of Morris County, and the modern political unit was formed by an act of the New Jersey State Legislature in 1865, which carved the Town of Morristown from the surrounding Morris Township. An economy of small farms served as the basis of the early community, but discovery of rich iron deposits led to considerable economic growth through the processing of iron ore and later steel mills. As Morristown's industry grew, it became an important center for trading and manufacture as well. Famously, Samuel F.B. Morse and Alfred Vail developed their revolutionary telegraph technology at the Speedwell Iron Works.(129)

During the 19th and early 20th century, industry and commerce in Morristown benefited tremendously through the construction of new transportation infrastructure projects. In 1801, construction began on the Morris Turnpike, a toll road connecting Elizabeth, Union County to Newton, Sussex County. The year 1831 marked the completion of the Morris Canal. The canal became the primary conduit for transportation of cargo between the Delaware and Hudson Rivers for nearly forty years.(129) Around the same period, track was laid for the Morris and Essex Railroad. The railroad precipitated a residential boom in Morristown during the gilded age. Wealthy families from New York City built many large mansions, allowing them to enjoy a rustic, town-and-country lifestyle while still having easy rail access to New York City. This trend continued through the mid-20th century as upper- and middle-class families sought refuge from deteriorating urban centers, securing Morristown's status as a desirable suburb of New York City. Through a series of acquisitions, this rail line was first operated by the Delaware Lackawanna and Western Railroad, then by the Erie Lackawanna Railroad, and, later, as a part of the national Conrail system during the 1970s and 1980s. After the dismemberment of Conrail, the right of way was transferred to NJ TRANSIT, which continues to provide commuter service along this same route, known once again as the Morris and Essex line.(130)

During the 1960s, the towns of Morris County began to see substantial growth as a result of a massive expansion of surface transportation routes. An expansion of Interstate 80 and the construction of Interstate 287 provided Morristown and other municipalities with high-speed automotive links to the greater New York metropolitan area. This dramatic increase in accessibility was accompanied by rapid residential growth, leading to a crisis in Morristown. During the 1970s and 1980s, aging and inadequate infrastructure could not support the levels of growth that were occurring and a moratorium on new development was declared until a new sewage treatment facility could be constructed. Morristown thus lost out on the real estate boom of the 1980s to other municipalities. However, by the 1990s the moratorium was lifted and development pressure increased. The Morristown Partnership, a public-private partnership, was established to administer a downtown special improvement district and had major success in improving the image of Morristown.(131) In addition, NJ TRANSIT's 1996 introduction of Midtown Direct service on the Morris and Essex Line spurred growth and development. This new service eliminated the need to transfer to PATH trains in Hoboken, shortening the commute to midtown Manhattan from Morristown by 20 minutes.(132)

In the 21st century, Morristown continues to grow and function as a regional center. The strong central business district that surrounds the Morristown Green, redevelopment efforts, and vertical growth have contributed to an overall development pattern that has a more urban look and feel than many suburban communities. The new economy is dominated by professional services and retail, though many of the small, family-owned storefronts continue to disappear, just as in the rest of the country. The town has retained much of its historic character and has regained its status as a prestigious place to live and work.(133)

In December 1998, NJDOT and partners selected Morristown to be among the first participants in the new Transit Villages Initiative. The agency felt that existing developments and plans in Morristown would contribute to an early success of the program. A letter from then-Mayor John "Jay" DeLaney was sent to NJ DOT stating Morristown's commitment to work with the state to pursue the goals embodied by the Transit Village Initiative. In 1999 the planning board and Town Council approved a Transit Village ordinance. Morristown's designation as a Transit Village was timely, as the town was preparing to update its Master Plan in accordance with the municipal land use law.

Morristown Governance

Morristown is a Faulkner Act Municipality with a Mayor-Council government. The current Mayor is Timothy Dougherty, elected in 2010 on the Democratic ticket, who previously served on Town Council and as chairman of the Zoning Board of Adjustment. According to his campaign website, Dougherty ran as a candidate promoting transparency and efficiency in government, traffic safety, Smart Growth, and economic development.(134) He has been a major proponent of TOD in the community. Dougherty was preceded by

Mayors Donald Cresitello and John DeLaney, who supported and oversaw the initial push for TOD in Morristown. The Mayor is also responsible for appointing the seven commissioners of the Morristown Redevelopment Agency, each of whom serves a five year term.(135)

The Town Council is comprised of members from each of four wards plus three at large members, each of whom serves a four year term. The council is currently led by President Michelle Dupree Harris and Vice President Rebecca Feldman, whose platform includes urban planning issues such as downtown revitalization efforts and complete streets.(135)

In addition to the elected government, several administrative units influence urban development and policy in Morristown. The Department of Public Works is home to the Planning Division; the Land Use Division, which administers the activities of the planning board and zoning board of adjustments; and the Engineering Division. The Planning Division employs the Jonathan Rose Companies as town planner.(135,136)

Downtown revitalization efforts are actively promoted by the Morristown Partnership, which has administered Morristown's Special Improvement District since 1995. In its efforts to promote economic growth in the central business district of Morristown, the Partnership has actively promoted TOD and streetscape improvements that promote a walkable downtown that supports local businesses.(131)

Transit Service in Morristown

Morristown is connected to Morris County and the rest of the New York and Northern New Jersey metropolitan region through a variety of transit services. The locus of transit activity is Morristown Station, served by the NJ TRANSIT's Morristown Line. Trains on the Morristown Line operate between Hackettstown and either Hoboken or New York Pennsylvania Station via Newark's Broad Street Station. Weekday service at Morristown Station runs every 15 minutes during peak-hour and hourly off-peak. During fiscal year 2011 commuter rail served a weekday-average of 1,845 patrons.(106) Table 93 shows approximate travel times and costs between Morristown and Newark, Hoboken, and New York City.

Table 93 – Approximate travel times and prices from Morristown Station

	Newark Broad St	Hoboken	New York City
Travel Time (H:MM)	0:45	1:00	1:00 - 1:10
Price (One-Way)	$8.25	$10.25	$13.00
Price (Monthly)	$233.00	$291.00	$361.00

Source: NJ TRANSIT

Since FY99, daily ridership on the Morris and Essex line has grown to more than 54,000 passengers, an increase of nearly 32 percent for the fourteen year period (Table 94). Over this same period, daily boardings at Morristown Station have hovered around 2,000 on an average weekday.

Table 94 – Morris and Essex Line average weekday ridership and Morristown average weekday boardings

Year	Morris and Essex Line	% Change	Morristown Station	% Change
1999	41,000		1,821	
2000	43,900	7%	2,028	11%
2001	47,250	8%	2,102	4%
2002	47,250	0%	1,982	-6%
2003	46,400	-2%	1,911	-4%
2004	47,250	2%	1,949	2%
2005	48,500	3%	2,013	3%
2006	50,350	4%	2,142	6%
2007	53,200	6%	2,222	4%
2008	54,500	2%	2,218	0%
2009	53,500	-2%	2,057	-7%
2010	52,850	-1%	1,891	-8%
2011	52,300	-1%	1,845	-2%
2012	54,100	3%	1,935	5%
% Change, 1999-2012		32%		6%

Source: NJ TRANSIT

In addition to rail transit service, NJ TRANSIT operates local bus service within Morris County along the 800-series routes. NJ TRANSIT had proposed eliminating much of the local bus service in 2010, but after consideration, several local routes were eliminated and the 800-series were introduced.[137] Schedules and routes have since been adjusted. NJ TRANSIT bus routes serving Morristown as of summer 2012 are summarized in Table 95. Typical service along these routes is hourly at peak, and reduced midday. Service ends in the evening.

Table 95 – NJ TRANSIT bus service in Morristown

Route Number	Service Between	Service Availability
871 / 874	Morristown / Boonton / Willowbrook	Daily
872	Morristown / Greystone / Livingston	Weekdays
873	Greystone / Morristown / Livingston	Weekdays & Saturdays
875	Rockaway / Dover / Roxbury	Weekdays
880	Morristown / Dover Rockaway	Weekdays & Saturdays

Sources: NJ TRANSIT, www.morrisdot.org

In addition to NJ TRANSIT buses, several other local and commuter transit services operate in Morristown. The Morristown Department of Public Works sponsors a circulator called Colonial Coach, which runs Mondays, Wednesdays, and Fridays and is free to Morristown residents. Commuter bus services to New York City and several other destinations in northern New Jersey are available through Coach USA/Community Coach and Lakeland Bus. Sixteen buses make the hour and fifteen minute trip each day from the Morristown Green to the Port Authority Bus Terminal in New York City. The price of a one-way trip is $9.40; a ten-trip book costs $84.60.

TOD Development

Between 2000 and 2009, subsequent to Morristown's Transit Village designation, several major TOD projects were completed downtown. The researchers identified ten major TODs in Morristown. Of these projects, six have been completed, one was under construction as of summer 2012, and three are planned redevelopments within one-half mile of Morristown Station. Table 96 and Figure 34 summarize these projects.

Table 96 – TODs in Morristown, New Jersey

	Development	Location	Status	Residential Units	Retail (ft^2)
1	Amli on the Plaza	30 Cattano Ave	Completed 2002	151	7,000
2	Vail Commons	7 Prospect St	Completed 2006	49	1,500
3	Vail Mansion	110 South St	Completed 1919, Renovated 2008	35	15,700
4	Dehart Place Townhomes	Maculloch Ave & Dehart St	Completed 2007	9	N/A
5	Highlands at Morristown Station	10 Lafayette Ave	Completed 2010	217	8,000
6	40 Park / The Metropolitan	40 W. Park Pl / 40 W. Market St	Completed 2010	206	66,000
7	Morristown Square	7 Maple Ave	Under Construction	18	N/A
8	Speedwell Avenue Redevelopment Area	Speedwell Ave between Spring St and Early St	Planned	268 (Phase I/II)	40,000 (Phase I/II)
9	Morris Street Redevelopment	185 Morris St	Planned	30	N/A
10	Morristown Station Redevelopment	Lafayette Ave at Lackawanna Pl	Planned	109 (Maximum)	N/A

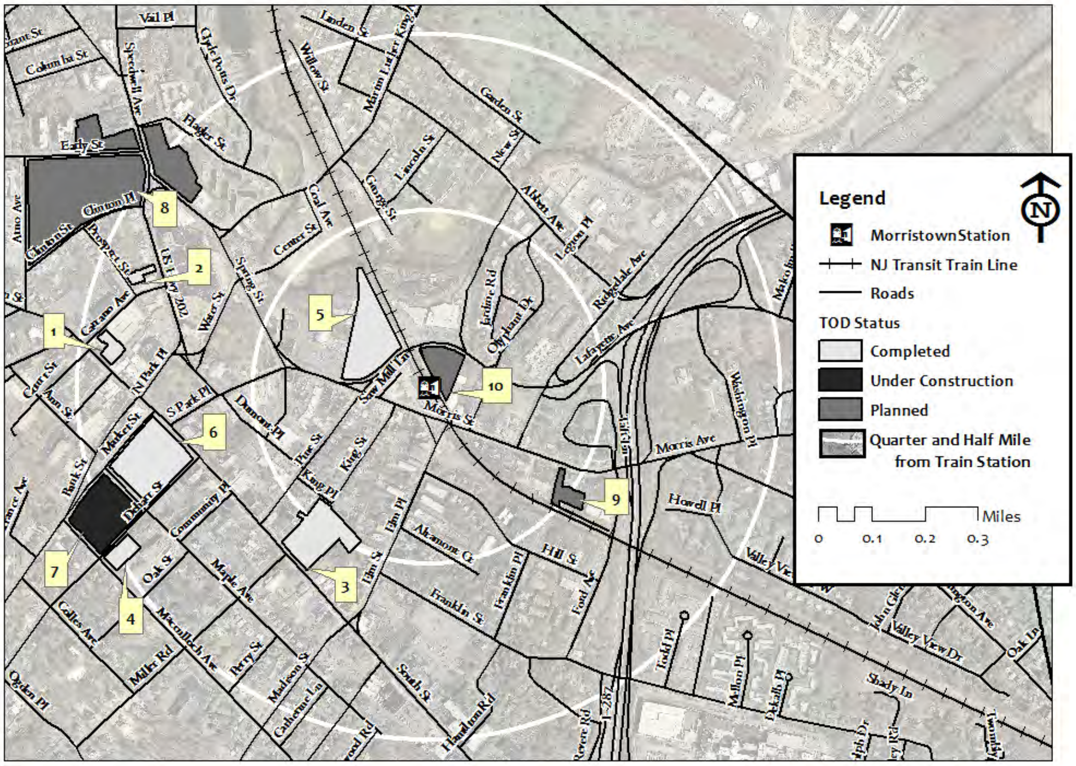

Figure 34. TOD Locations in Morristown

Amli on the Plaza

Amli on the Plaza is perhaps the first TOD to be completed in Morristown. Developed and managed by Amli Residential, a Chicago-based developer, this nine-story apartment complex was constructed in 2002 at Washington Street and Cattano Boulevard, just a half mile from the train station. The project consists of 151 studio, one- and two- bedroom apartments, with a gym, courtyard, and structured parking.[(138)] Retail tenants occupy most of the 7,000 ft^2 of ground retail space that faces Washington Street. As of summer 2012, tenants included a restaurant, a bank and a nail salon. Two 1,500-ft^2 retail units were available for rent.[(139)] Adjacent to this building is The Point at Morristown, completed in 2008. The Point offers 24,000 ft^2 of commercial office space in a 6-story, eco-friendly building, which is nearly 83 percent occupied.[(140)]

Vail Mansion

Shortly after Transit Village designation, Morristown approved the Residences at Vail Mansion, a major redevelopment project. Rosewood, a partnership of Roseland Properties and Woodmont Properties developed the project. The historic mansion, once the home of AT&T executive Theodore Vail, is the project’s centerpiece. Located 0.4 miles from Morristown Station, the project features 35 for-sale-only luxury apartments. The historic mansion houses 2,400 ft^2 of amenity space, including a fitness center, clubroom, and conference room, as well as Class A retail space. As of 2012, one unit remained for sale by the developers.[(141-143)] Also at that time, four retail units comprising the entire 15,700 ft^2 were available for rent in the Vail Mansion.[144] Property managers reported to the planning board in 2010 that it was difficult to find tenants, in part because the mansion is set back substantially from South Street (see Figure 35).[145]

Figure 35. Residences at Vail Mansion site

Source: Bing Maps

The Morristown Parking Authority (MPA) financed and operates 95 new public parking spaces on-site. A third of these parking spaces are located on the U-shaped entrance to the property. The remaining spaces are contained in an onsite parking deck.

Vail Commons

Vail Commons is an infill condominium building developed by Masucci/Reimers Developers. Vail Commons is located about a half mile from the Morristown station, on Cattano Avenue between Prospect Street and Speedwell Avenue. It is well situated, around the corner from the Century 21 department store and a block from the Morristown Green (see Figure 36). Construction on the eight-story midrise began in 2006, and the building opened in 2010, with 49 one- and two-bedroom for-sale units, starting in the low $300,000s. By late 2010, all but three units had sold. Amenities include new appliances, modern kitchens, a gym, and on-site parking.[146]

In order to incorporate a mid-rise structure into Morristown’s historic CBD, the developers attempted to use contextual design elements. The face of the building is largely brickwork, with concrete sections broken by tall, dark green windows that reflect a contemporary take on colonial architecture. As of summer 2012, a restaurant occupied the building's single 1,500 ft^2 ground floor retail space that faces Speedwell Avenue.

Figure 36. Vail Commons site

Source: Bing Maps

The Highlands at Morristown Station

In 2004 the Morristown Planning Board approved The Highlands at Morristown Station, the second major project undertaken by Roseland and Woodmont and the first joint development undertaken by NJ TRANSIT. Located directly adjacent to the Morristown station at 10 Lafayette Avenue, the Highlands is a five-story apartment building with ground floor retail. Prior to redevelopment, the site had been used as surface parking lot for NJ TRANSIT commuters. The transfer of the previously tax-exempt NJ TRANSIT property to the developers is the first example of a joint public-private development in New Jersey. The development includes a walkway that directly connects the building with the eastbound platform of the train station. This makes it the clearest example of a Transit-Oriented development in Morristown (see Figure 37).

Figure 37. The Highlands at Morristown Station site

Source: Bing Maps

The project features 219 one- and two-bedroom luxury rental units. The apartments range from 661 to 1,347 ft^2 and from $1,786 to $3,235 per month as of May 2012.[(147)] In-unit amenities include high ceilings, laundry, and balconies on some units. The building also features a fitness center, a yoga studio, a clubroom, recreation room, and business center with conference room. According to an interview with Debra Tantleff, Vice President of Development for Roseland, cost premiums – municipal height and bulk regulations – made it difficult to create lower priced units in the Highlands. Between 10 and 15 percent of the residents use the train for commuting. The building's primary attraction is luxury, living in a cost- and transportation-efficient location appears to be secondary for many residents.[(147)]

Additionally, the project added 8,000 ft^2 of ground floor retail space to Morristown. While this space has remained vacant for a period of time post construction, more than half the space was leased by October 2012.[(147,148)] According to the developers, one challenge to attracting retail tenants has been parking, Potential tenants offering "quick services" such as a coffee shop or dry cleaner, may struggle without a critical mass of pedestrians. These businesses often seek direct surface or street parking that allows frequent turnover. The Highlands is served by a 724-space parking deck for residents, NJ TRANSIT commuters, and the public.[(149)] Parking of this type may be seen as inconvenient by some retailers.

Figure 38. The Highlands at Morristown Station

Epstein's Redevelopment

The closing of the Epstein department store in 2004 after nine decades of operations created an opportunity to remake the site for new uses. The site was subsequently declared an Area in Need of Rehabilitation. The Epstein's Redevelopment Area encompassed the block south of the Morristown Green bounded by South Street, Dehart Street, Maple Avenue, and Market Street, situated about a half-mile from the Morristown station. The Roseland and Woodmont partnership worked with the Morristown Parking Authority and Michael Levine, the owner of Epstein's, to redevelop the site and create a group of mixed-use facilities featuring rental apartments, condominiums, town homes, retail and office space, as well as a new parking deck.[150] All of the properties on the site have been connected by a piazza-style pedestrian walkway. A site plan from NK Architects, the firm responsible for the plan, is presented in Figure 39.

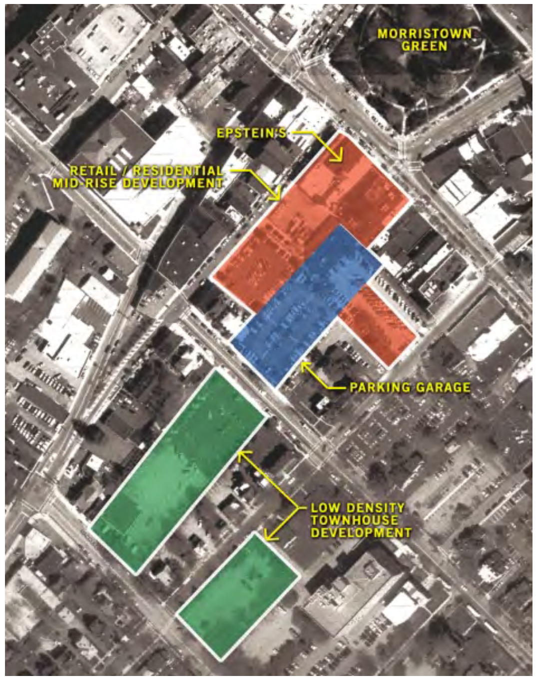

Figure 39. Epstein's redevelopment site plan

Source: NK Architects

The work of this partnership resulted in a $150 million complex anchored by two seven-story structures: 40 Park and The Metropolitan at 40 Park, a sister building. The project was approved in 2005 and constructed between 2008 and 2010.[151,152] The 40 Park building features 76 condominium units while the Metropolitan features 130 rental apartments. These dwelling units range from 756 ft^2 studios, to 1,292 ft^2 two-bedroom units. Building amenities include a clubroom, game room, fitness center, and rooftop terrace.[153] As of 2011, the Metropolitan was fully leased, but condominiums in 40 Park were still available.[154]

Figure 40. Epstein's redevelopment site
(Metropolitan and 40 Park under construction)

Source: Bing Maps

The redevelopment area also includes two townhome projects. The first are the nine DeHart Place luxury townhomes, developed on the Epstein's block by Roseland/ Woodmont, all of which have sold. The second is the Pulte Homes 18-unit development known as "Morristown Square," approved in 2008 and under construction in 2012. These townhomes will replace the surface parking lot just south of the Epstein's block at Dehart Street between Maple Avenue and MacCulloch Avenue.(155) Current plans for these three-story homes feature four separate buildings, with two garages for each unit.(156)

The ground floors of 40 Park and the Metropolitan are devoted to retail uses. The "Shops on the Green" feature 66,000 ft^2 of retail, 55,000 ft^2 of which is located in 40 Park and the balance in the Metropolitan. As of summer 2012, 40 percent of 40 Park's retail space has been leased, with two new leases under negotiation. At the Metropolitan, 20 percent of the retail space has been leased, with new retail tenants moving in fall 2012. The developer reported that the space in the Metropolitan has been more difficult to lease as it faces a side street. More storefronts have been leased facing South Street, which has the most significant levels of pedestrian traffic of the four block faces.(147) Tenants include several restaurants, a Starbucks coffee-shop, a Yoga studio, and an AT&T store purveying mobile communications devices.(157)

Commercial office and parking structures complement the residential and retail components of the Epstein's Redevelopment. The Geraldine R. Dodge Foundation is now housed in a new, LEED certified office building at 14 Maple Avenue. The seven-story DeHart Street parking garage, completed in 2008, provides the Epstein's complex with 791 parking spaces.(158)

In 2007, the planning advocacy organization New Jersey Future bestowed awarded the complex for "Creative Downtown Redevelopment Strategy" as part of its annual Smart Growth Awards Program.(159) In particular, the development was praised for the successful collaboration and coordination between the developers, the Planning Board, Parking Authority, and property owners in pursuit an infill project that was pedestrian-oriented and context-sensitive.

Other Transit-Oriented Type Development

Morristown also features other new and preexisting developments that might be classified as transit oriented.

The Morristown Green lies at the center of downtown Morristown, just over a five-minute walk to the train station. The blocks surrounding the green are extremely walkable, and feature various commercial retail and office facilities. Prominently, Headquarters Plaza, a complex with three commercial office towers and a hotel, lies between Speedwell Avenues and Spring Street on the northwest corner of the Green. The development, constructed in the mid-1980s, features about 600,000 square feet of space, including commercial offices, a Hyatt hotel, and various restaurants. Just across Speedwell is Century 21, a department store that continues to be successful. Restaurants abound along South Street. Various civic and religious institutions, including several historic churches as well as town and county government facilities are also located nearby. The town post office is located on Morris Street, just north of the green. This development pattern, while predating Morristown's participation in the Transit Village Initiative, is fairly characterized as a walkable, transit-oriented downtown. Indeed, it is likely that Morristown's success as a Transit Village has benefited greatly from the preexisting strength of its walkable downtown center. Morristown's designation and its continuing support of maintaining and growing within this land use pattern have allowed the community to prosper.

Station Area Conditions

Completed in 1914, Morristown Station is one of the town's historic landmarks and is listed on the state and national registers of historic places. In 2003 NJ TRANSIT made accessibility improvements to the station, including upgrades to lighting and elevators as well the addition of a partial high-level platform with a canopy. Completed in 2009, the construction of the Highlands at Morristown Stations incorporated direct access to the station platform. Also at that time, NJ TRANSIT undertook a restoration of the station. The agency issued a $2.5 million contract to restore the interior and exterior of the station, replacing windows and light fixtures, as well repairing pedestrian tunnels and platforms.(160)

Pedestrian Conditions

In 2009, a VTC team conducted a walkability analysis within a quarter mile of Morristown Station. The report from this field visit found that, compared with other Transit Villages, Morristown had an above-average score in nearly every walkability category and was assessed especially highly for lighting, sense of security, and amenities, such as street furniture.(161) The report recommended three improvements in particular: enhancing pedestrian amenities, such as wayfinding signage between the train station and downtown; widening the sidewalks on LaFayette Avenue underneath the train tracks; and filling in some sidewalk gaps in the outlying areas of the transit village area.

Pedestrians can enjoy many activities within a very short walk of the station. Walk Score, a website that rates walkability based on location, gives a score of 94 out of 100 ("Walker's Paradise") for the train station, mostly due to the large number of coffee shops, restaurants, bars, and shops within walking distance of the train.[13] (72)

A 2011 field visit confirmed much of what was observed in 2009 and that most of Morristown is highly walkable. However, access to two of the community's most significant facilities, the Morristown Station and the Morristown Green, is made difficult by vehicular traffic on the adjacent roadways that exceeds posted limits. Existing signals in both locations fail to provide pedestrians priority.

[13] Walk Score determined using Saw Mill Ln Morristown NJ 07960 address.

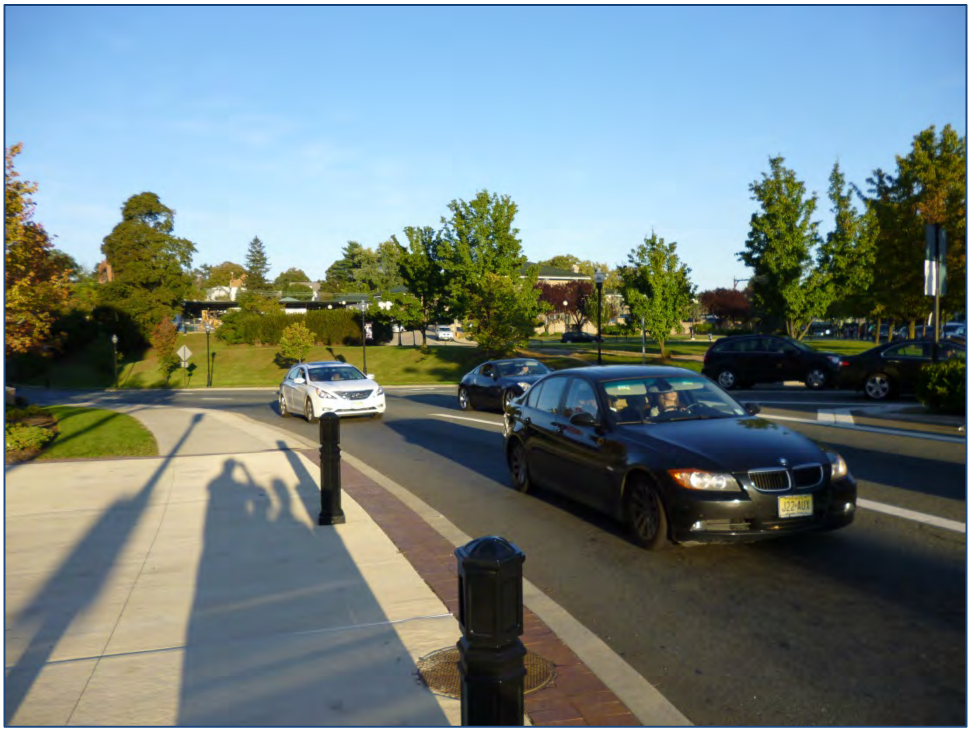

Figure 41. LaFayette Ave near Morristown Station
(The Highlands at Morristown Station is behind photographer)

Parking

Three commuter parking facilities serve the Morristown Station. Lot 1, located at Morris Street and Lafayette Avenue directly in front of the train station, is a small surface lot with 60 standard and three accessible spaces. The facility is operated by Standard Parking, and all spaces are reserved for holders of permits, which can be purchased for $160 per month (residents and nonresidents). This lot also features two Zipcar carsharing vehicles. Lot 2, operated by the Morristown Parking Authority, is located at Lackawanna Place and Lafayette Avenue, and is a larger surface lot with 99 standard and 2 accessible spaces. Monthly permits are available for $50 per month for residents or $85 for nonresidents. This parking lot allows also allows daily parking for $5, and charges are in effect until 7 PM. Lot 1 has an occupancy rate of 20%, and Lot 2 an occupancy rate of 95 percent. The third parking facility is the structured parking at the Highlands development, operated by Standard Parking and features 407 standard and 8 accessible commuter parking spaces for NJ TRANSIT customers. Monthly permits are available for $160 (both residents and nonresidents) and daily parking is available for $6. Charges are in effect at all times.(162) Some short-term parking nearby the train station is available through on-street, metered spaces, as shown in Figure 42.

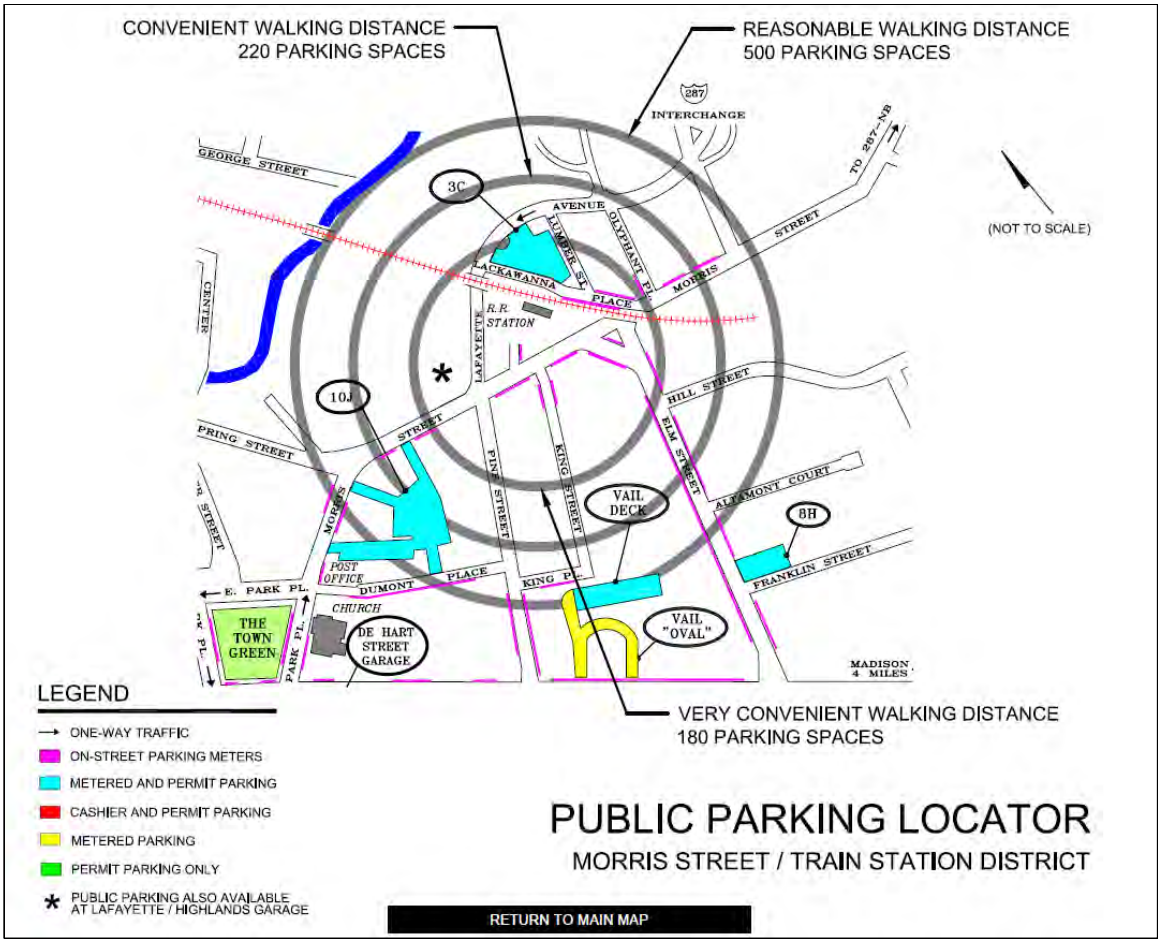

Figure 42. Publicly operated parking in train station district

Source: Morristown Parking Authority

Bicycle Facilities

The surface lots abutting the train station feature a total of 12 bike lockers and 18 bicycle parking spaces in standard racks.[163] Morristown has a strong bicycling community, led by local organizations and businesses such as Bike and Walk Morristown and Marty's Reliable Cycles. Bike facilities, however, are limited to a small number of off-street, recreational trails. The Patriot's Path trail extends into Morristown along Lake Speedwell. Proposed connections would link this with trails surrounding the Frelinghuysen Arboretum and another trail that parallels the NJ TRANSIT right of way between Morristown and Madison.[164] Downtown streets lack bicycle accommodations. In 2011 planners requested but did not receive $75,000 from NJDOT for 18 directional miles of bikeway signs and lane marking, improvements called for in the 2010 update to the Morristown Bicycle Plan.[165] The town continues to pursue the updated plan's recommendations. On July 18, 2012, the Morristown council approved a Complete Streets policy. This policy requires engineers to include adequate accommodations for non-motorized users unless the Council approves an exception.[166]

Built Environment

Land Use

Examination of land use characteristics provided by the 2007 New Jersey Geographic Information Network dataset confirm Morristown's dense commercial core, much of which lies within a half mile of the Morristown Green and in close proximity to the Morristown station. These data predate the completion of many of Morristown's recent TOD projects; for example, the Epstein's construction site appears as "altered land." Around the commercial core is predominantly medium=density residential development, with some high density residential land use around the train station and near I-287 (see Figure 43.

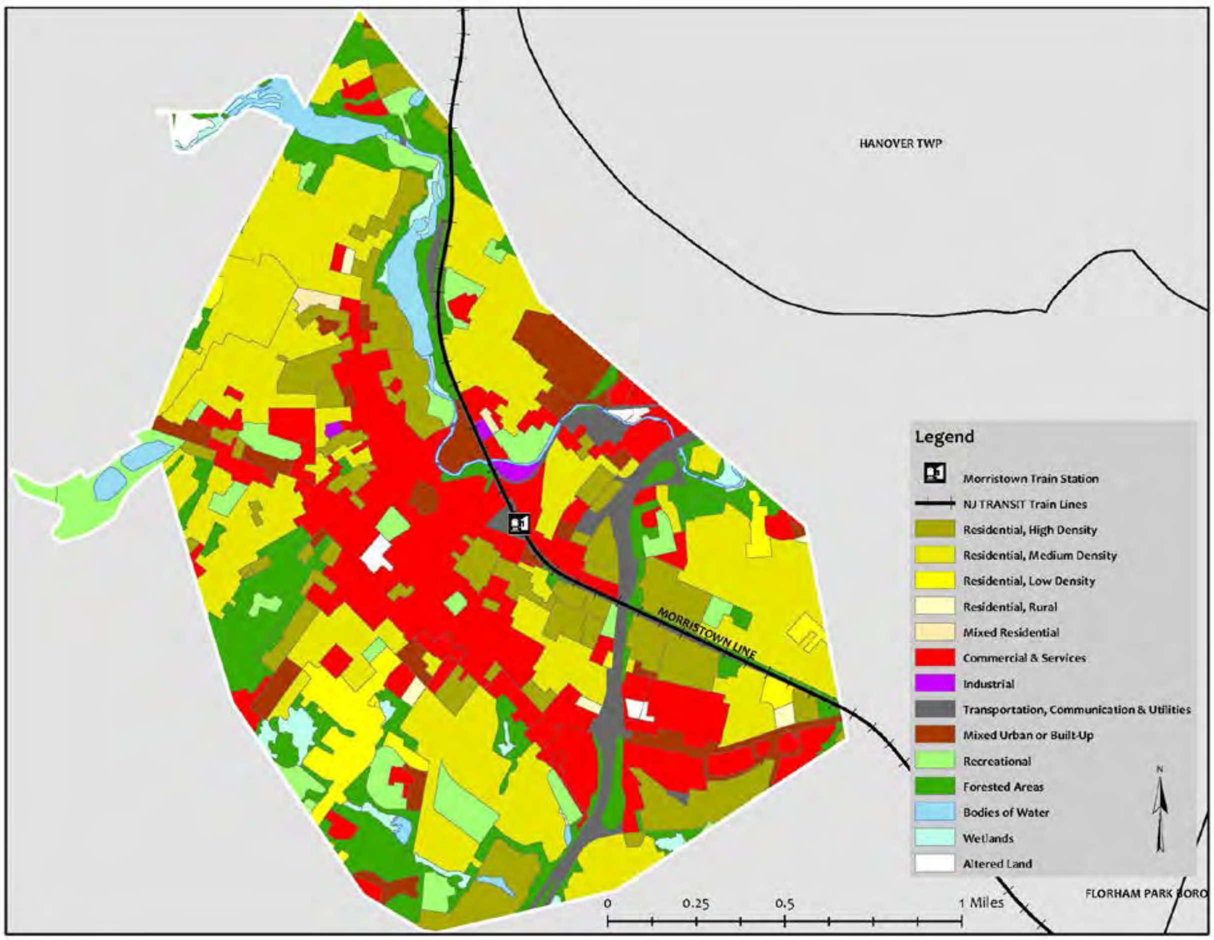

Figure 43. Land use in Morristown

Source: NJ Department of Environmental Protection; NJ Geographic Information System, 2007

Zoning Conditions

In 1999 Morristown updated its zoning, creating a nine-acre Transit Village Core (TVC) zone covering seven parcels in the vicinity of Morristown Station. The establishment of this zone was a necessary step toward achieving Transit Village designation and anticipated the construction of the Highlands at Morristown Station. While this zone currently only encompasses the NJ TRANSIT property and The Highlands at Morristown Station, this zone may be expanded in the future.[(133)]

The purpose of the TVC zone is to facilitate and encourage the construction of high-density, mid-rise buildings with a mix of uses within the TVC zone. Residences, retail stores, banks, open space, restaurants, public buildings, personal and business services and surface parking are permitted uses in the TVC zone. Professional offices, hotel rooms, and structured parking are listed as conditional uses within the zone. Most significantly, buildings within the TVC zone must be mixed use: at least 60% of the net ground floor area of new or renovated buildings must be devoted to retail or other commercial services.[(133)]

The TVC zone also included scheduled parking requirements and allowable reductions, shown in Table 97. The stated zoning rationale for allowing parking reductions is the need to “reflect the importance of a linkage between land use planning and transit planning.” However, the zoning code provides no specific guidance for developers on when parking reductions are appropriate, and any reduction must be approved by the planning board.[(133)]

Table 97 – TVC zone parking regulations

Residential Parking Requirements		Allowable Parking Requirement Reductions	
Number of Bedrooms	Required Parking Spaces per Unit	Land Use	Allowable Parking Reduction
Studio	0.8	Residential	25%
1 Bedroom	1.3	Other Nonresidential	20%
2 Bedroom	1.9	Office	15%
3 Bedroom +	2.1	Public	10%

Sources: Morristown Master Plan

The TVC Zone codified the need for shared parking facilities in the mixed-use zone, capitalizing on the differences in the peak parking times among land uses. The zoning ordinance calls for a modal-split study to be conducted so as to determine the number of spaces necessary under a shared parking scenario. The public agency may only require a developer to construct a number of parking spaces specified by such a study, if the methods are agreed upon by both the developer and planning board. Additionally, the aesthetic impact of parking structures is regulated. Any parking structure must include a façade made of brick or an otherwise approved material, and in order to mitigate the impact of garages on the pedestrian experience, parking structures may not be located within 20 feet of a street, Any street frontage must include an eight-foot high landscaped buffer.[(167)]

Structures in the TVC zone are required to be compatible with the historic character of their surroundings, if within a state or nationally registered historic district; much of downtown Morristown and the Morristown Station are located within the Morristown Historic District These requirements have not thus far dispelled interest on the part of redevelopers, but the Highlands development has at times been criticized for being aesthetically inappropriate in historic Morristown.[167]

Outside of the TVC zone, TODs are situated largely within two Central Business District zones: CBD-1, which allows for three-story buildings, and CBD-2, which allows buildings up to six stories. For these projects, special Areas in Need of Rehabilitation or Redevelopment designated by the 2002 and 2007 updates to the town's Zoning Map have allowed TODs to exceed height and density regulations within the context of denser, downtown development. For instance, apartment buildings in the Epstein's Redevelopment Area rise to seven stories, one floor more than would be allowed by CBD-2 zone that surrounds it. As of 2012, 17 such redevelopment zones have been established downtown, with plans for the first phase of the Speedwell Avenue redevelopment zone approved. Plans for the Spring Street redevelopment zone have a pending approval from the Planning Board.[168]

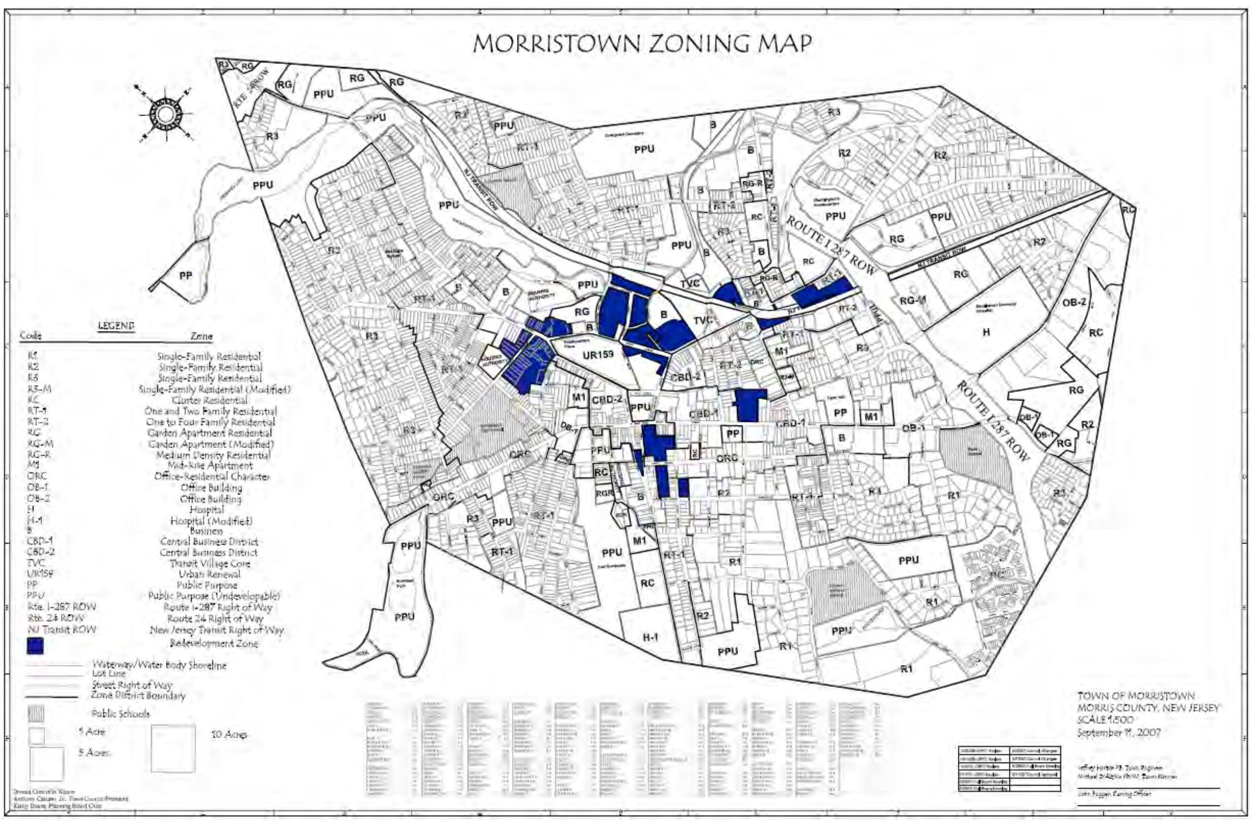

Figure 44. Morristown, 2007 zoning map

Housing Conditions

As of the 2010 Census, Morristown had a total of 8,172 housing units, with an average occupancy of 2.40. Just over nine percent of Morristown's housing units are vacant, and of the occupied housing units, rentals form a 62 percent majority.[(98)]

The 2006-2010 American Community Survey estimated a greater number of housing units (8,703), and provides much useful information regarding the physical characteristics of housing. The typical housing unit in Morristown is older and of a fairly modest size when compared with Morris County and New Jersey overall. Nearly two-thirds of housing units (64.1%) have two or fewer bedrooms. The median number of total rooms is 4.5, an estimate significantly lower than either the county (6.6 rooms) or state (5.7 rooms). A majority of housing in Morristown was built prior to 1960, and nearly a third of homes were built prior to 1939 (32.5%), the earliest date specified by census data. Many structures in the town were built in the 19th century. In contrast, less than one in five homes in New Jersey (18.9%) and in Morris County (13.5%) were built prior to 1939. A majority of homes in Morristown are valued between $300,000 and $500,000 dollars, with a median of $393,500, more expensive than the statewide median of $357,000 but much less expensive than the countywide median of $474,700. The median gross monthly rental cost is $1,224, comparable to a median of $1,221 in Morris County but more expensive than the statewide median of $1,092.[(99)]

The housing stock in Morristown varies in terms of size and style. Within the downtown core, mid- and low-rise apartment buildings, as well as townhomes are common. Beyond downtown, older, single-family detached dwellings are more prevalent. Some of these are built in typical post-war suburban styles, while some of the larger manor homes were built in late Victorian style. However, the overall appearance of Morristown is decidedly colonial. This aesthetic is bolstered by the town's 18th and 19th century churches, the oldest of which is the First Presbyterian Church founded in 1733 and located on East Park Place on the Morristown Green.

Figure 45. First Presbyterian Church, Morristown, NJ

Residents pride themselves on the historic look and feel of their town, which helps to explain some of the negative reactions to the Highlands development. In a focus group conducted by VTC in October 2011 in Morristown, four of the twelve participants said they did not like the Highlands development. One participant memorably expressed his dissatisfaction with the Highlands, primarily because it broke with Morristown's historic context:

> "If I could have stopped that I would have stopped it because it was a monstrosity out of control. High density living situation that I think was destructive to the quality of life in Morristown because it doesn't protect the historical heritage of this town, which is near and dear to many long-term residents."

It is important to note the Highlands was built over an otherwise undeveloped surface lot. Because they replace existing development and integrate better with the historic aesthetic of Morristown, infill projects (such as 40 Park and The Metropolitan) and adaptive reuse projects (such as the Vail Mansion) did not elicit negative reactions and were generally viewed as positive.

Conclusions: Benefits of TOD

Economic

A chief economic benefit of TOD comes from property taxes. Municipalities rely on revenue from property taxes to provide local services and amenities. Because TOD development is denser than traditional, post-war suburban development and because TODs in the state often reclaim underutilized parcels, individual TODs can provide a great deal of local revenue from a comparatively small total land area. As seen in Table 98, completed TODs in Morristown have provided the municipality with nearly $4.5 million dollars in tax revenues in 2011. This total was calculated from locating residential, retail and parking facilities within completed TODs in New Jersey's MODIV tax database, utilizing the most recent tax field.(168) In one case – the commercial office building portion of the Epstein's development – the structure could not be located in the tax database. Although MODIV data does not provide for a simple way to compare TOD with other kinds of development, a case study sponsored by NJ Future suggests that in 2010, mixed-use, mid-rise developments in Morristown generated more than twice the tax revenue per acre than traditional mid-rise multi-family housing, and about 7.8 times the tax revenue per acre of low-rise multi-family housing in surrounding areas.(169) Morristown will also benefit financially from the Speedwell Avenue Redevelopment project, which involves transferring its underutilized Public Works property to private developers, a onetime transaction that will yield the municipality $3.5 million.

Table 98 – Property tax revenues from TOD projects

TOD Project	Most Recent Property Tax Revenues
Highlands at Morristown Station	$826,660
Vail Mansion	$637,565
Dehart Place Townhomes	$198,576
Amli on the Plaza	$552,406
Epstein's Redevelopment	$1,912,125
Vail Commons	$329,881
Total	$4,457,213

Source: Monmouth County, NJ, Open Public Records Search System, http://oprs.co.monmouth.nj.us/oprs/External.aspx?iId=12

Perhaps the biggest financial gain for the town is the Highlands at Morristown Station, as it is situated on property formerly owned by NJ TRANSIT, and was therefore exempted from property taxation. Moreover, NJ TRANSIT has also benefited from the redevelopment financially. According to the development agreement for the Highlands, Roseland Property and Woodmont Property were allowed to redevelop the commuter lot, but were required to construct a parking deck, which includes 415 commuter parking spaces, at a cost of $7 million to the developer and no more than $1.75 million to the transit agency. The result is a net-gain of 115 spaces, which was largely paid for by the developers. Since the capacity increase was deemed necessary, NJ TRANSIT estimates this agreement represents a $3.5 million value. Furthermore, under the agreement NJ TRANSIT owns, operates, and receives all revenue from these spaces. NJ TRANSIT is also entitled to 6% of the future sale or refinancing of the property.[170] The agency estimates the project has generated 41,400 new annual trips and $250,000 in non-farebox revenues.[171]

Another economic benefit of TOD in Morristown is not fiscal, but rather distributional. TOD has helped Morristown to meet its affordable housing goals and fair-share obligation under the New Jersey State Constitution. Fourteen units of affordable housing were created in TODs: four in the Highlands and ten in the Epstein's Redevelopment. The Epstein's project was also approved with a $75,000-per=unit fee to finance affordable housing off-site.[172] The amount of affordable housing in these TODs has been criticized as inadequate, but plans for future redevelopment may include more.

Finally, TOD has created over 100,000 square feet of new commercial retail in Morristown. Although leasing this space has been challenging for some TODs in Morristown, many retailers and restaurants have been attracted to the heavy pedestrian flows that ground-floor, downtown real estate offers. Representatives from Roseland property stated that between 60 and 70 percent of households living in their rental units have annual household incomes in excess of $100,000. The influx of new downtown residents with a high level of disposable income has benefited local businesses, and the increased foot traffic from diners and shoppers keeps downtown Morristown lively.[147]

Environmental

Over the past decade, TOD has had a major impact on Morristown. Evidence from field visits and focus groups suggest that one of the primary draws of Morristown is its extremely walkable downtown. Although Morristown's walkability predates the TOD efforts in town, these efforts have allowed growth to be absorbed into the most walkable part of the community and created a richer retail landscape than has existed in recent decades. Hundreds of dwelling units have been built downtown within a half-mile radius of the train station, nearly all of which have been leased or purchased. This new housing provides room for Morristown's growing population while meeting local and statewide smart growth goals. By concentrating new development downtown, Morristown has expanded residents' opportunity to live within walking distance of the train and downtown shopping, effectively transforming an existing downtown district into a veritable neighborhood. New coffee shops, bars, restaurants, and stores have opened in these newly developed and redeveloped structures, and residents feel a strong sense of community with their neighbors and local businesses, increasing the quality of life in town.

Health

The Centers for Disease Control (CDC) recognize that community design plays an important role in the health of residents. The CDC emphasizes the need to build homes, commercial, and recreational facilities close together to encourage walking and biking between them. It should provide residents the ability to be physically active as a regular part of their daily lives. The community should also offer access to recreational green space and outlets for fruits and vegetables.[173]

While the influence of TOD on actual walking behavior is unclear, participants in the Morristown focus group clearly indicated they view the variety of shopping and community activities within walking distance as an advantage. Indeed, three focus group participants stated that being able to walk to such activities helps them to build relationships with neighbors and shopkeepers, and to feel more in tune with the community. Morristown residents enjoy access to many parks as well as the rich social atmosphere in the town. Various events are held regularly throughout the year on the Morristown Green, including various festivals, parades, concerts, and family movie nights.[174] Numerous religious institutions offer opportunities to engage with the community through volunteer efforts, the most prominent of which is the Mission Street Market, a food bank and goodwill organization. Downtown Morristown is also home of the Mayo Performing Arts Center, a community theater, as well as the Morristown and Morris Township public library, which offers regular events and classes in computer technology and English as a second language.[175,176]

Morristown residents can access healthy foods on a limited basis. The Health Shoppe, a medium sized health food store, had been located a block from the train station but closed in 2012. Kings Food Market, a local high-end grocery chain, continues to operate a store located a half-mile from the train station on South Street. In addition, A&P supermarket is located on Washington Street, 0.8 miles from the train station. The Morristown Partnership also sponsors a farmers market at Spring and Morris Streets, which operates Sundays, mid-June through mid-November. While TOD has not brought new grocers to the area, it has a mutually supportive relationship with the farmers market.

TOD Financing

One notable feature of TOD in Morristown is that it has not involved local or state aid in the form of tax credits or exemptions. Municipalities often choose to initiate options for Tax Increment Financing or Payments in Lieu of Taxes in order to attract developers, but this is not so in Morristown. Nor are developments in Morristown eligible for incentives under the Urban Transit Hub Tax Credit program run by the New Jersey Department of Economic Development. New development downtown has been financed through private capital and equity.[147] This is likely due to a generally healthy local economy during the period in which TOD has been implemented.

Lessons Learned

TOD has been largely successful in Morristown. The town has long been built out, so infill and redevelopment have proven to be successful strategies for accommodating growth. Residential units have been quick to rent and sell, although some of the ground floor retail has proven more difficult to rent. The chief lessons from Morristown are twofold.

The first lesson is about respecting context. Because of the town's historic character, TOD has been very successful and well received where it has respected that context. The Epstein's redevelopment, although taller than the department store it replaced, is a handsome structure with brickwork and other elements that complement the character of downtown. Vail Mansion is a unique example of adaptive reuse of a historic property. The Highlands at Morristown Station was not built with as much attention to aesthetic congruity with its immediate surroundings, and has received negative reviews because of it. Donald Cresitello, Mayor during the Highlands construction, has even said he is displeased with the look of the building.[(160)] This is especially important since it occupies a former surface parking lot, and so added bulk to the landscape.

The second lesson is about forming successful partnerships. Developers have been able to partner with organizations such as the Morristown Department of Public Works and NJ TRANSIT to purchase and redevelop underutilized land owned by public entities. The owner of the former Epstein's store continues to be involved with the redevelopment of that property. The Morris Street Redevelopment is proceeding, with a possible partnership between different landowners. The Speedwell Avenue Redevelopment plans do involve condemning a small number of residential properties, but this is the exception rather than the rule in Morristown. In short, TOD in Morristown has been relatively easy, because various property owners and developers have worked in concert to utilize land in downtown Morristown more efficiently.

Finally, while most of the community is highly walkable, access to two of the community's most significant facilities, the Morristown Station and the Morristown Green, is made difficult by high-speed traffic on the adjacent roadways. Existing signals in both locations fail to provide pedestrians priority.

Next Steps for TOD

Morristown's success with TOD has provided a great deal of momentum, and redevelopment around the train station continues apace. In January 2012, the town council approved a redevelopment agreement for the Speedwell Avenue Corridor, an area at the intersection with Spring Street and Early Street, a half mile from the train station. In the first phase of the project, the developer, Mill Creek Residential Trust, is set to purchase seven residential properties and property owned by the Department of Public Works for $3.5 million. Redevelopment of these parcels should result in 268 rental properties of which 10 percent will be set aside for affordable housing. Phases II and III call for the construction of an additional 394 units and up to 40,000 square feet of retail space.

In addition, two future TOD projects are being actively pursued. One is the Morris Street Redevelopment, which calls for 30 new, stacked townhomes to be built at 185 Morris St, on a disused scrap yard that abuts the NJ TRANSIT right of way. As the parcel has no direct street frontage, the town planner, Jonathan Rose Companies, has suggested establishing an access way with a “woonerf” (or “living street”)-type configuration common in Europe, where pedestrian movements are prioritized through traffic calming measures and automobiles are limited to near-walking speed. Lenoa Development, LLC, the redeveloper for the area, is also considering partnering with the owners of an adjacent property fronting Ford Road; the latter property is home to a vacant building, which would be retrofitted, doubling the number new residential units.

Also under consideration is an additional TOD immediately adjacent to the train station. In early 2012, a Request for Qualifications was circulated, seeking a redeveloper for the surface lot at the train station at Lafayette Street and Lackawanna Place. A mid-rise, mixed-use building with a maximum of 109 units is envisioned for the site. Public amenities, such as a plaza leading to the train station, taxi stand, and pedestrian amenities will be required.

Rahway, NJ

Background

Spanning the north and south banks of the Rahway River, Rahway City is 3.9 mi^2 and has a population of 27,346, which equates to a population density of 7,017 people per mi^2.[177] Residents have access via train to New York City, Newark, Philadelphia, and points in-between on the Northeast Corridor, as well as to points southeast on the shore. With such an ideal location between these places of work and play, Rahway has experienced residential and commercial development over the last decade, and serves as an ideal case study for the positive impacts a train stop can have on a community. As this case study will show 687 new residential units and over 25,000 square feet of commercial space have been built in transit-oriented developments (TOD) in Rahway, helping create a vibrant, pedestrian-friendly downtown anchored by the train station.

Demographics

Rahway is slightly less affluent than New Jersey as a whole, with a median household income of $58,551 compared with $69,811 for the state.[99] Unemployment in Rahway is just over 11 percent, in excess of that found in the state, nearly 10 percent, or nationally, just over 8 percent (all figures are for August 2012).[100,101,177] The educational services and health care industries is the largest employment sector, with 2,655 jobs. Other important sectors include manufacturing, retail trade, and entertainment and recreation.[99]

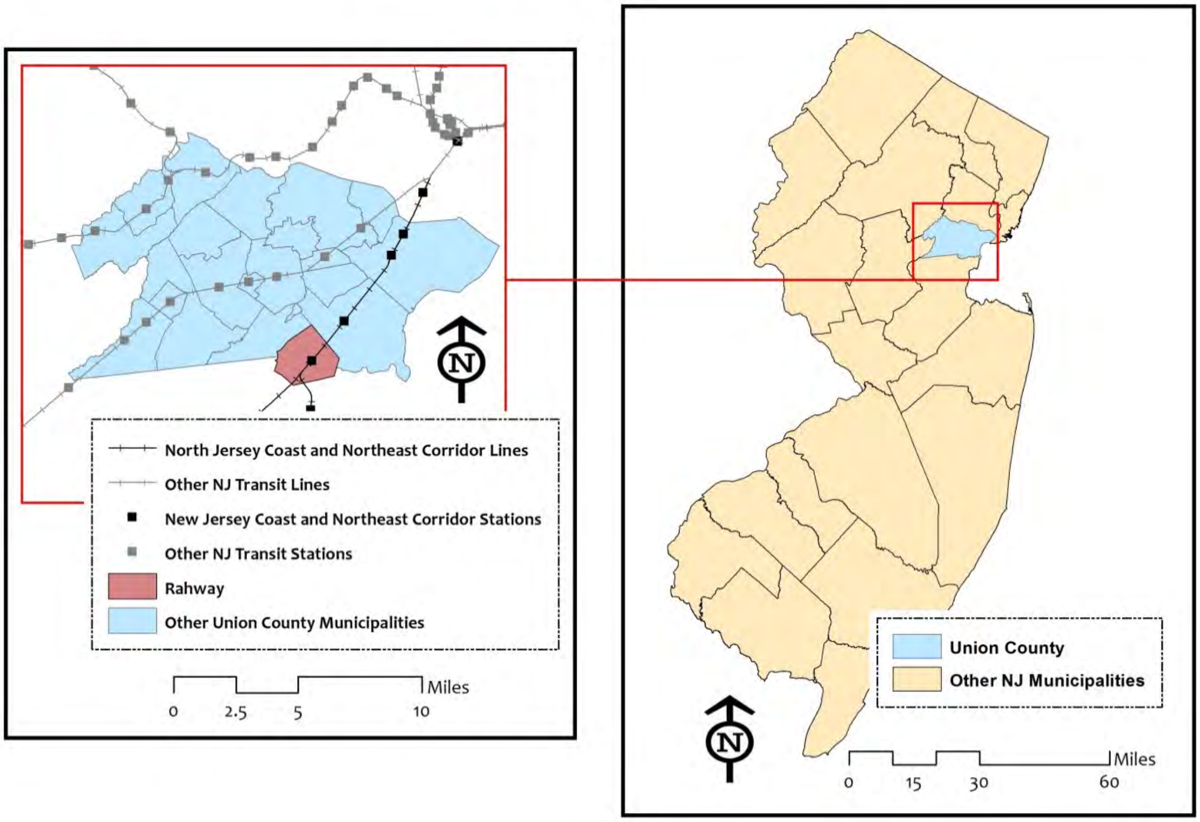

Figure 46. Locations of Rahway and Union County, New Jersey

Sources: New Jersey Office of Information Technology,
Office of Geographic Information Systems

The demographic tables shown below illustrate that Rahway is racially diverse, more so than the state overall (see Table 99). More than half of Rahway's population identifies as White. African Americans make up about 30 percent of the municipality's population. Approximately 24 percent of Rahway's residents consider themselves Hispanic. New Jersey as a whole is less diverse, nearly 69 percent of the population identifies as White and nearly 14 percent as African American. Hispanic population in the state is nearly 18 percent.

Table 99 – Total population of Rahway, Union County, and New Jersey by race and ethnicity

Race	Rahway		Union County		New Jersey	
White	14,301	52.3%	329,052	61.3%	6,029,248	68.6%
Black or African American	8,457	30.9%	118,313	22.1%	1,204,826	13.7%
Asian	1,175	4.3%	24,839	4.6%	725,726	8.3%
Other Races	2,377	8.7%	47,739	8.9%	591,791	6.7%
Two or More Races	1,036	3.8%	16,556	3.1%	240,303	2.7%
Total	27,346	100%	536,499	100%	8,791,894	100%
Hispanic or Latino (of any race)	6,433	23.5%	146,704	27.3%	1,555,144	17.7%

Source: 2010 Census, Profile of General Population and Housing Characteristics: 2010. Table DP-1.

The age distribution of Rahway's residents is similar to that of Union County and the state. The 19-years-old and younger is the largest age cohort in Rahway, at 24 percent (see Table 100). The smallest is 60 to 69 years (9%), and the others are clustered between 13 and 15 percent. In Rahway, school-age children comprise a somewhat smaller proportion than found in the state and slightly larger percentage of people between the ages of 18 and 24, but the other age groups mirror those of New Jersey.[98]

Table 100 – Total population of Rahway, Union County and New Jersey by age

Age Cohort	Rahway		Union County		New Jersey	
19 Years and Under	6,640	24%	144,616	27%	2,291,204	26%
20 to 29 Years	3,518	13%	66,414	12%	1,094,377	12%
30 to 39 Years	4,003	15%	72,935	14%	1,145,041	13%
40 to 49 Years	4,119	15%	83,707	16%	1,354,434	15%
50 to 59 Years	3,939	14%	73,720	14%	1,240,303	14%
60 to 69 Years	2,461	9%	46,661	9%	831,514	9%
70 Years or Over	2,666	10%	48,446	9%	835,021	9%
Total	27,346	100%	536,499	100%	8,791,894	100%

Source: 2010 Census, Profile of General Population and Housing Characteristics: 2010. Table DP-1.

Rahway residents primarily commute by car, nearly 84 percent travel by car, truck, or van to their workplaces (see Table 101). Rahway residents utilize transit for commuting more than in the County or in the state. One in ten Rahway residents commutes by public transportation, about the same as New Jersey residents overall and significantly higher than the five percent of all Americans who commute by transit. This high percentage is no doubt aided by the NJ TRANSIT train station located downtown. Yet car ownership is still quite high, with over 95 percent of all households owning at least one car. These households are quite evenly split between owning one, two, and three cars.[99] This suggests that living in Rahway requires a car to acquire other services. A brief search for amenities reveals, for example, that residents living downtown must drive to the nearest supermarket.

Table 101 – Commute mode split

Commute Mode	Rahway	Union County	New Jersey
Drove alone	74.0%	67.2%	71.6%
Carpooled	8.9%	9.8%	9.0%
Public transportation (excludes taxicab)	10.2%	9.9%	10.6%
Bicycle	0.4%	0.3%	0.3%
Walked	2.7%	3.5%	3.3%
Taxicab, motorcycle, or other means	2.0%	6.4%	1.7%
Worked at home	1.8%	2.8%	3.5%
Total	100%	100%	100%

Source: American Community Survey, 2006-2010 5-Year Estimates, Table B08006

Table 102 – Vehicles available

Number of Household Vehicles	Rahway	Union County	New Jersey
0	4.7%	6.7%	6.7%
1	28.9%	28.1%	22.7%
2	35.9%	40.2%	41.6%
3 or more	30.5%	27.2%	29.0%
Total	100%	100%	100%

Source: American Community Survey, 2006-2010 5-Year Estimates, Table B08014

History of Rahway

Rahway has a long history dating back to the 17th century. It was initially part of the Elizabethtown province – an area of land in New Jersey that included all of present-day Union County, as well as parts of Morris, Essex, and Middlesex counties – that was purchased in 1664 from the Lenni Lenape Indians by an association of New York businessmen. Elizabethtown became the first settlement of the nascent province, of which what would become today's Rahway quickly became a part when colonists began settling along the navigable Rahway River. The rapidly moving river allowed the establishment of mills; soon other developments sprang up as well, including the first church in 1741, a Quaker meetinghouse in 1757, and several taverns.(178)

The Revolutionary War brought two battles to Rahway. They did little, however to dampen post-war success: it prospered, and in 1804 the settlement became Rahway Township. Proximity to the Rahway River triggered an explosion of commercial industries over the next century. During the early 1800s, ships brought many of the products manufactured in Rahway to New York City every week – from hats to boots to carriages. There were not only sailors, however. The town employed dockworkers and bricklayers, tavern-owners and construction workers. And in 1835, one of Rahway's most important developments occurred, one that would have lasting impacts: the construction of the railroad through the town, giving residents direct access to Philadelphia and New York.(178)

In 1858, Rahway was incorporated as a city. New churches were built as immigrants from Britain, Ireland, and Germany set up shop to participate in the economic success. During the 1860s, the city obtained a police department, a fire department, and its first library. By the 1890s, Rahway boasted four public schools, more than a dozen churches, a prosperous commercial district, agreeable neighborhoods occupied by wealthy businessman, many industries with workers' housing nearby, a trolley line, a gas company, and several railroad stations including the former North Rahway Station near Scott Avenue.(178)

The beginning of the 20th century heralded a new manufacturing era. After the Regina Music Box Company located in Rahway in the 1890s, Frederick Jacob Merck started up a small chemical company – now known as Merck & Company, the pharmaceutical giant. The bookmaker Quinn and Boden, set up shop there in 1906, as did Wheatena a year later. In 1916, a new hospital was built, followed by the opulent Rahway Theater later that year.[178]

Rahway met difficult times, however, in the post-World War II era. The city lost most of its manufacturing jobs. As mass transit ridership and investment declined, the North Rahway train station was demolished.[178] Merck moved its headquarters from Rahway to Whitehouse Station in 1992. However, efforts to revitalize Rahway have since been underway. Merck had not abandoned the city entirely. It built new research labs in the old executive offices, employing about 1,000 research scientists and technicians. It also built a 65,000-square foot pilot plant for the development of new research ideas, a biological support laboratory and a day-care center for employees. All this new development significantly increased the tax revenues that Rahway received. Direct support also came when Merck donated $40,000 for a study on improving the downtown area, and over $100,000 to pave some of the roads adjoining its new complexes. According to then-mayor Kennedy, the company's move had little negative impact for the community, as most Merck's executives were not Rahway residents. Nonetheless Merck has been a good neighbor to Rahway: "They had always had a good community conscience."[179]

The crux of Rahway's rebirth has been its train station. The $13 million renovation of the NJ TRANSIT station was completed in 1999. Adjacent to the station stands the station plaza, a $1.5 million project completed in 2001.[180] Located in the heart of the Rahway downtown, the city has pinned its hopes for renewal on redevelopment near the improved station and plaza. New mixed-use retail and residential buildings near the station pay heed to this strategy.

Finally as manufacturing jobs receded, Rahway gained jobs in finance, pharmaceuticals, telecommunications, and, most recently, the arts. Rahway has committed itself to downtown redevelopment not only through zoning and ordinances that encourage TOD, but also through financial support. During his tenure, former Mayor James Kennedy championed for arts-based development. In one instance, the city moved funds generated by the special improvement district (SID) from the Rahway Center Partnership to the Rahway Arts District in 2010. Created in 1993, the Rahway Arts District uses the money raised from property taxes on businesses within the SID to continue investment in arts-based businesses.[181]

Rahway Governance

Most of the recent TOD development in Rahway took place under the tenure of James Kennedy. Mayor from 1990 until he stepped down in 2011, he oversaw the construction of civic buildings such as the new library, train station, and community recreation center. He also pushed for Rahway to become an arts and cultural center, encouraging arts-based development projects and acting as the Rahway Arts District's executive director.[181,182]

Rahway's city government is formed under the Mayor-Council system.(183) Rahway's current Mayor is Democrat Richard Proctor, and it has nine elected council members from six wards. Six members each represent a ward, and three are at-large members who represent the whole city. It is led by Council President Samson Steinman. All of the council members are part-time.(184) Proctor won the mayor's seat in 2012, replacing resigning Democrat James Kennedy. In his first State of the City address in 2011, Proctor promised to continue redevelopment that focuses on the arts, as well as to pursue sustainability initiatives.(185)

Transit Service

Rahway is centrally located in the northern New Jersey train system and uniquely located at the confluence of the Northeast Corridor and North Jersey Coast Line. Passengers boarding at Rahway can travel to New York and Philadelphia by way of the Northeast Corridor, or to Bay Head and other Jersey Shore locations aboard the North Jersey Coast Line. Both routes connect to Newark Liberty International Airport, which allows Rahway residents access to the airport without use of cars.(105) In 2012, a one-way trip to New York Penn Station cost $8.75, to Trenton $9.00, and $9.75 to Bay Head, for both peak and off-peak times. The ride to New York takes about 40 minutes, to Trenton about 50 minutes and to Bay Head about one hour and forty minutes.(105) Table 104 and Table 105 details the frequency of service on these two train lines.

Rebuilt in 1999, the Rahway station and plaza are located at the heart of Rahway on Milton Avenue, between Irving Street and Broad Street.(178) Passengers can purchase tickets at five ticket vending machines; no ticket agent is available. The station is handicap accessible and has bike racks available.

Ridership on the Northeast Corridor as a whole has increased over the last 13 years (see Table 103). Since 1999, average weekday ridership has increased by 35 percent. The biggest jump came between 2005 and 2008, due in part to rising gas prices that left passengers looking for a cheaper way to travel. Growth has slowed, however, in the past three years, with modest drops in ridership, but Northeast Corridor ridership continues to be significantly higher than even ten years ago; since 2006, when it hit nearly 105,000 riders every weekday, it has not dipped below that mark. The North Jersey Coast Line has not met similar success. While average weekday ridership also rose in the middle of the last decade, it has since dropped to 25,000 in 2011, a 16 percent decrease since 1999. It has not registered a gain since 2008. Overall, the line moves less than a quarter of the number of people every day than does the Northeast Corridor Line, indicating that those boarding at Rahway travel mostly toward New York City or Philadelphia.(106)

Average weekday boardings at the Rahway Station have increased by 21 percent since 1999, from 2,539 to 3,060 (see Table 103). The increase was largest between 2005 and 2008, mirroring the increase ridership on both the Northeast Corridor and North Jersey

Coast Lines, although most of it is likely due to increases on the former. In 2008 ridership was at its highest, with 3,244 boardings reports. Since then, ridership has leveled off at just over 3,000 daily boardings. The increase mirrors an increase in employment – with higher employment comes higher train ridership.(106)

Table 103 – Northeast Corridor Line, North Jersey Coast Line, and Rahway Station average weekday ridership

Year	Northeast Corridor	% Change	North Jersey Coast	% Change	Rahway Station	% Change
1999	82,000	--	29,850	--	2,539	--
2000	87,850	7%	31,450	5%	2,718	7%
2001	95,300	8%	32,850	4%	2,941	8%
2002	94,900	-0.4%	31,600	-4%	2,854	-3%
2003	93,000	-2%	28,650	-9%	2,688	-6%
2004	94,700	2%	28,550	-0.3%	2,664	-1%
2005	99,150	5%	28,950	1%	2,710	2%
2006	104,900	6%	30,050	4%	2,871	6%
2007	111,800	7%	31,200	4%	3,014	5%
2008	118,100	6%	31,900	2%	3,244	8%
2009	116,450	-1%	29,950	-6%	3,195	-2%
2010	115,700	-1%	27,850	-7%	3,210	0.5%
2011	110,800	-4%	25,000	-10%	3,060	-5%
% Change, 1999-2011		35%		-16%		21%

Source: NJ TRANSIT

In addition to rail service, NJ TRANSIT operates two bus routes that serve Rahway, routes 115 and 62. Route 62 connects Perth Amboy, and also stops in Edison, Woodbridge, Carteret, Iselin, Rahway, Roselle, Linden, Elizabeth, Newark Airport, and Newark. In Rahway buses stop at the train station, allowing riders to easily transfer to and from the train lines. The cost of a one-way trip to or from Newark costs $2.90. Route 115 connects Rahway and New York, stopping on the way in Roselle, Linden, Elizabeth, and Union City. On weekdays it also serves Avenel. The cost per a one-way ride to or from New York is $7.50.(105)

Table 104 – Train and bus frequency at Rahway Station – weekdays

	Eastbound Vehicles			Westbound Vehicles		
Train Line or Bus Route	AM	PM	Total	AM	PM	Total
Northeast Corridor Line	24	35	59	30	41	71
North Jersey Coast Line	12	15	27	10	17	27
Bus Route 62 @ Train Station (to Newark)	13	28	41	13	24	37
Bus Route 62 @ Inman St. & St. Georges Ave (to Newark)	7	13	20	6	11	17
Bus Route 115	12	7	19	6	14	13

Source: NJ TRANSIT

Table 105 – Train and bus frequency at Rahway Station – weekends and holidays

Train Line or Bus Route		Eastbound Vehicles AM	Eastbound Vehicles PM	Eastbound Vehicles Total	Westbound Vehicles AM	Westbound Vehicles PM	Westbound Vehicles Total
Northeast Corridor Line		20	25	45	18	29	47
North Jersey Coast Line		8	12	20	8	12	20
Bus Route 62 @ Train Station (to/from Newark)	Sat	11	22	33	11	22	33
	Sun	6	17	23	9	18	27
Bus Route 62 @ Inman St. & St. Georges Ave.	Sat	2	12	14	4	11	15
	Sun	3	8	11	4	7	11
Bus Route 115	Sat	5	7	12	4	8	12
	Holidays	7	7	14	4	11	15

Source: NJ TRANSIT

TOD Development

In 2002 Rahway was designated a Transit Village, one of 28 municipalities so named since 1999. A Transit Village is a municipality that has “demonstrated a commitment to revitalizing and redeveloping the area around their transit facilities into compact, mixed-use neighborhoods with a strong residential component.” The Transit Village Task Force and the NJDOT Commissioner designate Transit Villages; the number of designations varies each year. To be designated, a municipality must meet a set of Transit Village criteria. These include identifying existing transit available in the municipality, adopting a TOD redevelopment plan or zoning ordinance, identifying specific TOD projects, identifying pedestrian and bicycle improvements, and identifying efforts that contribute to the municipality’s sense of place, such as cultural and arts events and organizations. Benefits of becoming a Transit Village may include priority funding from some state agencies, technical assistance, and eligibility for grants from NJDOT.[(107)]

Since its designation as a Transit Village, development in Rahway has grown dramatically. Most development, both residential and commercial, has occurred within a half mile of the train station. New development and redevelopment have resulted in a mix of multi-family housing and arts-based projects, both of which the city has accommodated with zoning overlays and financial assistance. As one resident, an employee of the Union County Performing Arts Center, said, “The development – the hotels and retail and the restaurants – are all great assets to the city. They will bring people. And with the two [rail] lines that we have, people are coming to Rahway, and I think that’s what’s necessary.”[(186)] Table 106 shows developments that were built before the designation and after the designation, while Figure 47 shows their locations. The following are descriptions of three of the developments.

Table 106 – TODs and commercial developments proposed, on hold, under construction and completed

	Project	Location	Status	Residential Units	Retail (ft^2)
1	River Place	Lewis St	Completed 2005	136	NA
2	Riverwalk	E Milton Ave	Completed 2005	86	NA
3	Skyview at Carriage City Plaza	E Milton Ave	Completed 2008	222	20,000
4	Park Square I and II	Irving St	Completed 2012	159	7,000
5	Grand Meridia	E Grand Ave	Completed 2008	88	NA
6	Brookside at Rahway	St. Georges Ave	Completed 2012	50	
7	Hamilton Stage for the Performing Arts	Hamilton St	Completed 2012	NA	14,000
8	Jack and Margaret Myers Senior Residence	Esterbrook Ave	Under construction	51	NA
9	Meridia Water's Edge	Main St	Under construction	108	NA
10	Station Place	Campbell St	Planned	115	NA
11	The Brownstones	Elizabeth & West Grand Ave	Planned	TBD	TBD
12	Lafayette Village	Monroe & Main Sts	Planned	115	1,000
13	Affordable Artists' Housing	Hamilton St	Planned	69	NA
14	The Westbury	Main St	Planned	TBD	TBD

Note: See Figure 47 for locations

Source: http://www.rahwayrising.com

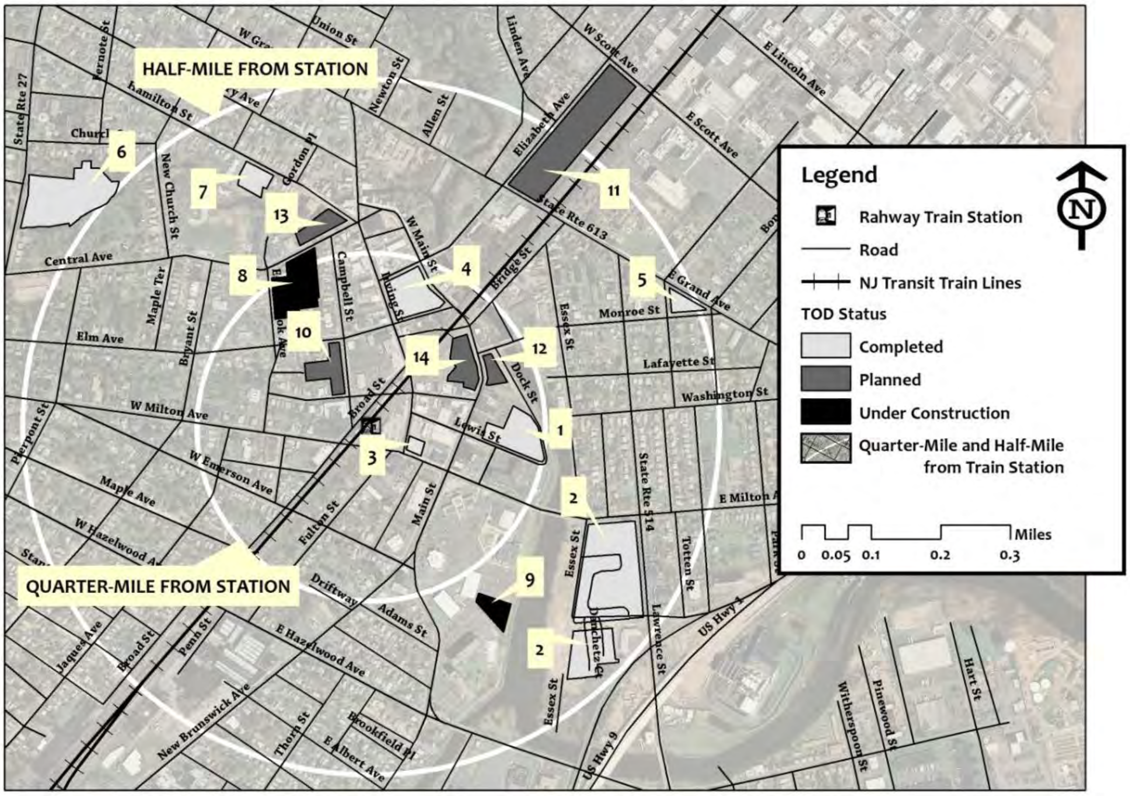

Figure 47. TOD locations in Rahway

Sources: NJ Geographic Information Network; Census TIGER/Line Shapefiles (US Census Bureau); http://www.rahwayrising.com; http://www.state.nj.us/treasury/taxation/lpt/TaxListSearchPublicWebpage.shtml

River Place

Built in 2005 less than a quarter mile from the train station, River Place is a luxury residential development, offering 136 one- and two-bedroom units for lease. It overlooks the Rahway River, the only major housing project to currently do so. Apartment sizes range from 859 to 1,471 ft^2. It has been very successful, with a 99 percent occupancy rate. In 2011, Heartstone Development sold the complex to a private investor. Gebroe-Hammer Associate, which represented both the buyer and the seller in the deal, said that the high per-unit price (about $193,000) was due in part to River Place's proximity to a train station.(185)

Figure 48. Location of River Place

Source: www.bing.com/maps; TIGER/Line

Carriage City Plaza

The development plans for Carriage City Plaza were ambitious: provide residents with spacious luxury condominiums overlooking the train station and plaza, married to an up-and-coming boutique hotel chain and accompanying restaurant, and other ground floor retailers. While some aspects of the project have proven successful, others have not, forcing the owner, Carriage City Properties, to put the development into foreclosure.(187)

The 16-story tower was at the heart of the TOD boom, located across Irving Street from the train station. First opened in 2008, it has struggled to sell the condos and lease 20,000 ft^2 of retail space. Despite initial demand for the housing units, and the successful operation of the Hotel Indigo, interest quickly waned with the struggling economy.(187) More than half of the condominiums – called Skyview – were under contract to be sold.(185)

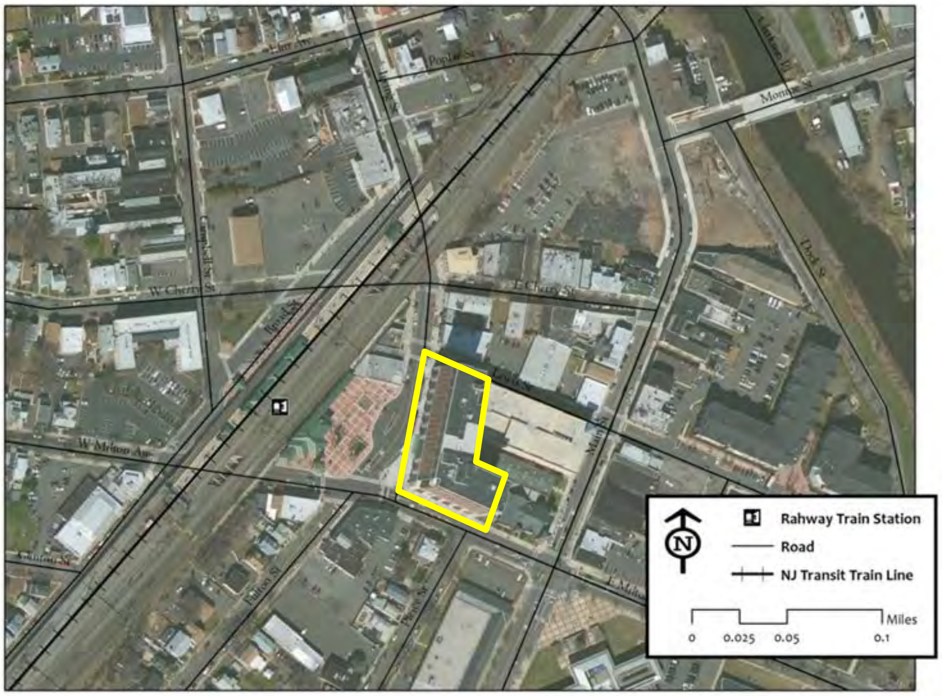

Figure 49. Location of Carriage City Plaza

Source: www.bing.com/maps; TIGER/Line

Soon thereafter, however, the development began experiencing difficulties. In early 2009, Carriage City Properties was declared in default of the redevelopment agreement when it was found to be renting some housing units rather than selling them as specified in the redevelopment agreement. Soon thereafter, the Rahway Redevelopment Agency approved a settlement allowing Carriage City to rent unsold units. Despite this change, the Carriage City Plaza went into foreclosure in November 2010. The remaining units and Hotel Indigo were subsequently purchased by 80 E Milton Ave, LLC. In summer 2012, nearly 90 percent of the one- and two-bedroom units were occupied. The Skyview website touts their proximity to New York City, the Jersey Shore, and other destinations by train, as well as being able to stroll through a "revitalized neighborhood."(185)

The leasing of retail space also proved challenging. As the construction neared completion, potential tenants showed interest in occupying ground floor storefronts. As of summer 2008, expected businesses included a coffee shop, dry cleaner, salon, fitness center, and steakhouse. Mr. G's Coffee and the dry cleaners opened in 2009. However, these establishments did not last and by summer 2012, an Edward Jones investment office remained the only tenant. The owner stated a preference to fill the spaces with "destination-driven tenants."(185)

Figure 50. Hotel Indigo and Sky View
(condos and apartments), Rahway, NJ

Park Square

Park Square, a mixed-use commercial and residential development completed in 2012, lies two blocks north of the Rahway Station at the intersection of Irving St and Main St. The project resulted in two structures, one residential over ground floor retail and one wholly residential. The developer, Landmark Properties, opted to split the block, creating a roadway that separates the two buildings, creating a courtyard and parking/loading zone between the structures. To amass the land required for the project, Landmark Properties acquired a number of underperforming and/or derelict commercial buildings, including a bank, a hardware store, and a gas station.(185) The developer conducted environmental cleanup of the site to allow for residential occupancy.(188)

Figure 51. Location of Park Square

Source: www.bing.com/maps; TIGER/Line

Construction was staged over several years. In 2006, work on Park Square I began which resulted in 63 luxury one- and two-bedroom rental apartments and 7,000 ft^2 ground-floor retail on Irving St. The four-story structure was completed in fall 2009, three years after breaking ground. By October 2009, 33 of the apartments were rented. In 2010, Landmark Properties completed Park Square II, the building facing Main St. This building offers 96 apartments. Overall, residents have access to 205 parking spaces: one level of parking on grade below the building facing Irving St and two levels below the building facing Main St.[(185)]

Online advertising emphasizes the complex's proximity to the rail station and its central location in Rahway, within walking distance to businesses and community amenities.[(189)] An optometrist, Eyes on You, leased the first retail space. Others soon followed suit. In 2010, Chess Mates, a café, and chess club, opened and occupies 1,000 ft^2. The final three retail slots have been filled by Davis Financial, a CPA firm; Diesel Training Center, a strength training facility; and Kennedy Jewelers, owned by former mayor James Kennedy.[(185)]

Figure 52. Park Square, Rahway, NJ

Other Rahway Redevelopment Projects

Riverwalk, a community of 86 townhouses on the eastern side of the Rahway River less than a half-mile from the train station, were sold to residents in the mid-2000s. Facing difficulties brought on by the decline in the housing market, Diversified Communities was unable to sell 19 units, resulting in foreclosure by its creditor, Bank of America, and a Sheriff's Sale of the unsold units. At one point, Diversified had considered building another three dozen townhouses on the neighboring King's Inn site, but the project never materialized.[185]

Also active in the city, Capodagli Property Company is currently involved in a several residential projects. Located less than a half mile from the train station, the Grand Meridia opened in 2010 and was later sold for $19 million. The 88-unit rental building offers one- and two-bedroom apartments as well as 88 ground level parking spaces. In 2012, the company purchased property adjacent the Rahway Library for Meridia Water's Edge and gained Planning Board approval for their plan. The five story structure will house 108 one- and two-bedroom residential units. Most of the 99 parking spaces will be on the ground floor. The minimal number of parking spaces indicates that proximity of the train station (approximately a quarter mile away) and the prime downtown location allows some tenants to forgo car ownership. Construction is expected to be finished in 2013.[185]

Capodagli also proposed Lafayette Village in February 2012 to replace the stalled Savoy, located about a quarter mile from the train station on the corner of Monroe and Main Streets. The 115-unit rental complex would be four-stories with about 115 parking spaces. Like Water's Edge, Lafayette Village will offer one- and two-bedroom residential units. The plans also call for 1,000 ft^2 of ground-floor retail for two tenants: pet grooming and pet boarding, both in intended for use by the residents as well as the public. Construction is scheduled to begin in 2013 and to take about two years. Finally, Capodagli recently proposed a multi-family housing development, The Brownstones, to be built upon the former Wheatena site. Preliminary plans call for two- to three-story walk-up units. Acquisition of the property and eight additional parcels would need to be completed before work could begin.[(185)]

On Main St, between Poplar and West Cherry Sts, construction at the Westbury may resume. It stalled a few years ago due to poor economic conditions, but recent improvement is encouraging the owner of the lot, Slokker Real Estate Group, to restart work. New conceptual plans were presented to the Redevelopment Agency in December 2012 and call for two four-story buildings housing a total of 184 residential units and 4,500 ft^2 of ground-floor retail space. Current plans call for less retail space and parking than originally proposed. The property is currently being used as surface parking with about 100 spaces, leased by the Parking Authority until development begins again.[(185)]

Station Place is slated to begin construction in summer 2013. Heartstone Development has approval for 116 apartment units in four floors above ground floor parking. The units – totaling 121,900 ft^2 – will be one- and two-bedroom apartments; 123 parking spaces will be provided.[(190)]

Located about a half-mile from the rail station on St. George Ave, Brookside at Rahway encountered a major setback in 2011 when the structure burned down as work neared completion.[(185)] Rebuilt and opened in 2012, the three-story building offers 50 one-bedroom and two-bedroom apartments and on-site parking.[(191)]

Domus Corporation, the development arm of the Archdiocese of Newark, is building senior housing on the site of the former St. Mary's Convent by. Located on Esterbrook Avenue, the Jack and Margaret Myers Senior Residence will be four stories and contain 51 residential units in 444,456 ft^2. It will be home to very low-income seniors, financed in part by the U.S. Department of Housing and Urban Development as well as the Union County Department of Parks and Community Renewal. It is a half-mile from the train station and is slated to be finished in 2013.[(185)]

More specialized housing has been proposed near local theaters: affordable housing for artists. In May 2012, the Rahway Redevelopment Agency conditionally designated the Actors Fund Housing Development Corporation (AFHDC) as redeveloper. The AFHDC proposes 60 residential units and 60 parking spaces. The new building will replace the Elizabethtown Gas building and require environmental cleanup of the site.(185)

Arts-based housing supports Rahway's burgeoning arts community. Over the past decade, a number of arts businesses have grown and improvement to the arts community have taken place in the station area including Union County Performing Arts Center (UCPAC), renovated in 2008. In the spring of 2011, Rahway borrowed $11.765 million in general improvement bonds, of which $7.89 million was for redevelopment. Much of the redevelopment monies are dedicated to art district projects, including the renovation of the Bell Telephone building and the demolition of the Hamilton Laundry building. In 2012 the Hamilton Stage for the Performing Arts opened – a 199-seat black box theater – in the former Bell building. Owned by the Redevelopment Agency, the Hamilton Stage has been leased to the UCPAC for 30 years. Next door to the Hamilton Stage, the former Hamilton Laundry site is the planned as an amphitheater, though work has been put on hold due to financial constraints.(185)

Retail conditions

Not unlike other downtown locations, commercial retail in Rahway has seen a high turnover rate since the start of the recession. Carriage City Plaza has had a number of commercial residents move in, but few have lasted, and a few years after construction finished, the ground floor retail space remained empty except for the Hotel Indigo and its restaurant, and an investment office.(185)

Other downtown vacancies during the past few years include Thomas' Surf-in-Turf that lasted for two years; the Marcel Truppa Gallery on Irving Street; about 1,500 ft^2 once occupied by Royal Treasure Antiques; a parcel occupied by a beauty supply before it burned; and Decker Tavern that closed after 66 years in business. Eateries and restaurants in particular have experienced a lot of closings, the most conspicuous being the renowned David Drake, which was replaced in 2010 by the Rail House 1449.(185)

Some projects, however, have had greater success in attracting and maintaining retail business. The Park Square project successfully leased all of its ground floor retail. Thus, while downtown retail continues to be weak throughout the New Jersey market continued expansion of Rahway's population and increased visitors should help to sustain retail's growth. Growth in Rahway's arts community may also lend support for retail.

Station Area Conditions

In 1999 Rahway saw the completion of its new $16 million rail train station, which was complemented by an adjacent public plaza in 2001.(178) The $600,000 plaza provides many passenger amenities, featuring benches, landscaping, and flagpoles. The plaza and station offer an attractive center to the community, utilizing red brick and vegetation

– young trees planted throughout. The plaza and most of the station amenities are located on the eastbound (inbound) side, while the westbound side offers fewer services and limited parking. These amenities as well as the civic events that occur on the plaza – from a seasonal farmer's market to a baby parade – help establish the station as the center of the town, inviting passengers and non-passengers alike to spend time there beyond simply to ride the train. In Rahway, improvements to the station and TOD have contributed to a higher quality of life as the city utilizes opportunities to build pleasant public spaces and streets.

Figure 53. Rahway Station

The revitalized station and plaza has also helped set the stage for private investment in the community. According to former Mayor Kennedy, the plaza "has brought in a variety of private developers who are interested in the new growth of downtown."[192]

A number of surface lots as well as a garage and on-street parking are located nearby, all of which is priced depending on length of stay. On the eastbound side, Carriage City Plaza, a hotel, retail and condominium complex, is immediately across the street. There are also a number of residences, a church, the post office, and retail establishments. The train station is located on the edge of the central business district.

Pedestrian Conditions

In 2009, a research team at Rutgers University conducted a walkability audit of Rahway and found that the city was above average in most categories, particularly for streetscapes and pedestrian amenities. The streets of East and West Cherry just north of the station were noted for their pedestrian infrastructure, as was Broad St directly north of the station. The Irving St and Poplar St intersection was found to have an attractive, well-lit pedestrian path. However, good pedestrian facilities tend to be isolated, typically near the train station. At that time, some stretches had large cracks or were unevenly paved, which could be dangerous to vulnerable populations, such as children and people with disabilities. Recommended improvements included minimizing driveway curb cuts near the train station, repairing some sections of sidewalks, and adding more pedestrian amenities, such as lighting and seating.(193)

Parking

Parking is plentiful and appropriately priced in Rahway. The Rahway Parking Authority – an arm of the municipal government – operates on-street and off-street parking downtown. The city's one parking garage is conveniently located on the same block as Carriage City Plaza, across from the train station. Parking costs vary according to the length of stay. Maximum daily cost is $12 for 13 to 24 hours. Monthly parking fees are $90. The municipality owns six surface lots, each of which has different stay limitations; some hourly, others limit parking to holders of monthly permits. Metered locations, both on- and off-street, cost $0.25 per half hour and $6 per day.(194)

Bicycle Facilities

Rahway offers some facilities for bicyclists. At the station, cyclists can make use of either bike racks or bike lockers. Additionally cyclists can travel from the city's north to south end by way of a bike trail located in Rahway River Park. The trail runs along the Rahway River for about a mile from Elizabeth Ave between W Main St and W Grand Ave and the playing fields at the end of the park, where it encircles the fields for another mile.(195)

Rahway has pursued efforts to provide additional bicycle amenities. In 2005 the city commissioned CME Associates to develop a Bike Path Plan for Rahway. The plan focused on connecting targeted sites with a network of bike paths, including city hall, parks, the rail station, public schools, and the Merck properties. The plan presented three concepts: 1) use of the existing roadway infrastructure to create a bike path network; 2) use of existing sidewalk infrastructure to create a shared pedestrian-and-bike network on each of the designated streets; and 3) widening sidewalks to make a shared path on one side of the street. The first option would require reducing on-street parking downtown, and/or widening roadways to accommodate bike lanes. The second and third concepts would have a smaller impact upon on-street parking by widening sidewalks to six feet; this would use less road space than the first option.(196) As of 2012 none of these plans has been implemented.

Built Environment

Land Use

An evaluation of land use patterns illustrates Rahway's development pattern and shows a strong commercial core near the train station around which high- and medium-density housing clusters, see Figure 53. Since 2007, the date of these data, six multi-family housing developments have been completed within walking distance of the train station, in addition to a number of retail establishments, further increasing density near the station. Of note are two sites classified as "Altered Land." These two locations are sites of Carriage City Plaza and Park Square under construction at the time.(197)

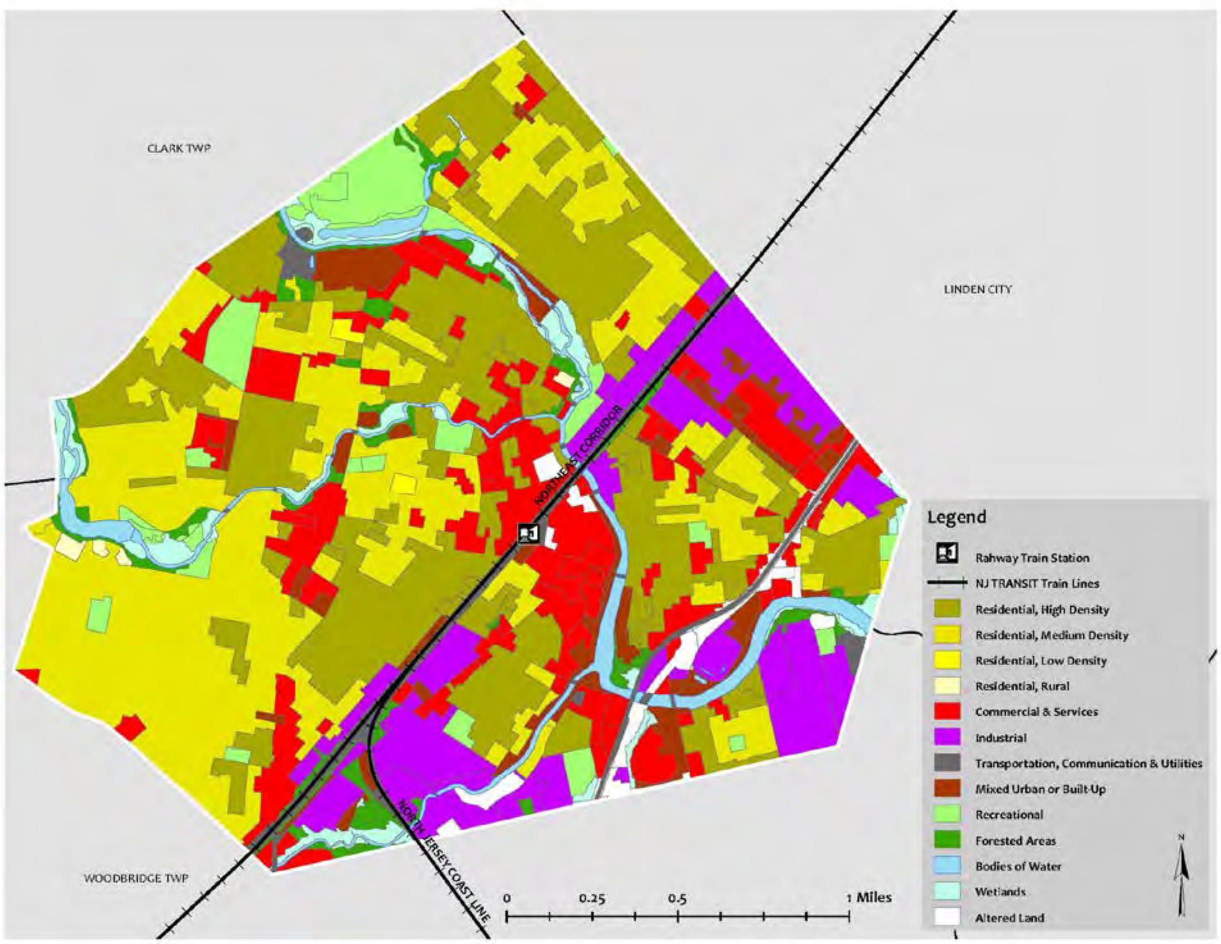

Figure 53. Land Use in Rahway

Source: NJ Department of Environmental Protection;
NJ Geographic Information System, 2007

Zoning Conditions

Most Rahway TOD projects are located in residential areas within adopted redevelopment zones in the central business district, the neighboring service business district, or bordering these two districts. Rahway also adopted a number of redevelopment overlays for many of the TODs. Most of these have been residential overlays, either low-rise multi-family or high-rise multi-family.(198) By adopting these overlays, Rahway has committed to remaining flexible in its development plans and changing its zoning according to the city's needs.

Since 1999 the city also has had in place a Downtown Business Improvement Zone. The purpose of the zone is to "promote economic growth and employment within the business district and in particular the Special Improvement District [SID]." This allows the city to apply for Department of Community Affairs funding to make public improvements in the SID. Established in 1993, the SID aims to serve as the commercial, cultural, and civic center of Rahway; revitalization efforts would be focused there, and indeed they have been. In a nod to the importance that arts-based development plays in Rahway's revitalization, the Rahway Arts District took over the SID's management in 2010. Notably, the SID is almost entirely contained within a quarter mile of the train station.(199) Even before it was designated a Transit Village, Rahway recognized that development had occurred near the station in the past and should continue to do so into the future.

As part of the stipulation of becoming a Transit Village, NJDOT requires that municipalities develop a sense of place and community. In 2012 the City Council adopted a sidewalk café ordinance that contributes to this. Richard Watkins, Director of the Department of Building, Planning and Economic Development, hopes that other businesses will follow Hotel Indigo's example in expressing interest in sidewalk cafés. Previously businesses that wanted outdoor restaurant seating had to do so under special arrangements with the city. Standardizing and encouraging café seating could help enliven the streets during the day and evening. Also, in 2012 the City Council passed an ordinance allowing temporary or "pop-up" uses, such as galleries or cafés, in vacant storefronts until a long-term tenant is found to fill the space. These have been successful elsewhere, such as in Chicago and Austin, Texas. These kinds of uses can help bring businesses and customer foot traffic to the downtown and eliminate unattractive vacant storefronts.(184,185)

Housing Conditions

The 2010 census counted 11,300 housing units in Rahway, with 10,533 occupied (93%). Of those, 4,271 are rented.(98) The 2006-2010 American Community Survey found that there are 5,523 single-family detached houses, and 4,769 buildings with two or more units in the structure. The median value of all the owner-occupied units is $331,500.(99) The housing immediately surrounding the train station is predominately high-density, and becomes low-density further away.

The census tract in which the station is located has a lower housing occupancy than the city as a whole, 81.1 percent.[98] Just under a third of residential units in this tract are single-family houses, 20 percent contain two units, and 15 percent have 20 or more units. Housing is generally old, about 40 percent built before 1939. Only 15 percent of housing units were built since 2000. Of the 1,210 units, tenure is fairly evenly split between renters (45%) and owners (55%). Median rent was $1,104.Median value of owner-occupied units was $321,400, slightly below the median value found in Rahway overall.[99]

Aesthetics

Rahway has pursued a number of efforts to enhance the city's physical attractiveness. The construction of the new train station and plaza has contributed greatly to the city's appearance through improvements in landscaping that incorporated trees and benches. Similarly, site improvements associated with new housing and arts-based development has resulted in sidewalk widening, storefront enhancement, and new street trees. The Sustainable Master Plan element advocates for the enhancement of the downtown, such as erecting statues of famous Rahway residents and redesigning the unattractive bridge.[200] Additionally, Rahway has a designated historic overlay zone, which contains most of downtown and TODs. The purpose is to preserve historic streetscapes, buildings, and districts to help maintain the historic and cultural character of Rahway. The town has established a list of the historic structures that are subject to the overlay regulations.[199]

Livability Assessment

Rahway has a number of opportunities for civic involvement. The Rahway Arts District is not only a community organization but also responsible for the management of special improvement district.[181] It promotes life in Rahway through its website, advertising city-sponsored events (free salsa dancing classes, a farmers market held every Thursday in the summer), children's camps and events at local theaters, as well as city attractions such as dining, recreation and shopping.[201]

The city is also home to a burgeoning arts scene. Arts Guild New Jersey is located downtown; it presents fine art exhibitions and holds arts classes and lectures for all ages.[202] The Union County Performing Arts Center, a 1,300-seat theater that has called Rahway home for over 80 years, provides live performances throughout the year.[203] Meanwhile the Hamilton Stage for the Performing Arts is slated to open soon, a 199-seat theater that will be home to a number of theater companies and hold events and educational programs.[204] Other arts spaces include The Academy of Music, Chess Mates and the Nai-Ni Chen Dance Company. These organizations offer classes, private lesson, workshops and camps for kids, adults and seniors.[201]

Other Rahway civic organizations focus on environmental and historic preservation issues. The Rahway River Association (RRA) works to preserve and protect the

Rahway River. The RRA has partnered with the city to create a greenway alongside the river and its volunteers have worked to restore natural environments along the river.(205) Established in 2009 by a city resident, the Rahway Community Garden offers plots to residents and community groups at its St. Georges St location.(206) The Merchants and Drovers Association maintains and offers public programs at Rahway historic sites. The circa 1795 Merchants and Drovers Tavern has been restored to its 1820s condition and is open to visitors.(207)

Residents also can enjoy numerous community institutions offering activities to a wide range of ages including the Rahway YMCA, senior center, recreation center, and library. All are located within a half-mile of the train station. Built in 2000, the recreation center and library are located adjacent city hall.

Bisecting the city, the Rahway River provides residents ample green space. The Rahway River Parkway runs along the river, with sports fields, a running track, a bicycle path, and a number of recreational amenities. North and northwest of downtown, Madison Avenue Park and Milton Lake Park provided places for recreation in residential neighborhoods, the latter of which has access to canoeing and fishing.(195)

Further enhancements and extensions have recently been proposed. In 2006, the RBA Group drafted the Rahway River Greenway Concept Plan for the city and the Rahway River Association, which Rahway then amended to their Master Plan. The plan maps out the future of the Rahway River's mile-and-a-half between Elizabeth Ave and Wall St. Some of the proposals include building continuous bicycle and pedestrian facilities both by the river and connecting to downtown Rahway, providing public access and facilities to the river for activities such as boating, constructing public gathering spaces near the river, and restore the natural river environment.(208) However, these efforts have been stalled. Neither this plan nor the Rahway River Greenway Plan, which covers the entire Rahway River basin, have been implemented, due mainly to a lack of funds. However, in June 2009 Rahway adopted a Green Building and Sustainability Master Plan Element that focused on sustainable downtown redevelopment; a citywide river/greenway system; and community outreach and environmental education.(200)

Rahway holds popular citywide events each spring. Established in 2002, the Taste of Spring features gourmet caterers, eateries and food vendors in the Rahway area, as well as tastings from wineries and breweries. It also hosts a bakery competition, live music, and an art show sale.(209) The Rahway Center Partnership holds Hot Rods and Harleys every May showcasing classic cars, hot rods and motorcycles. It also holds a yearly St. Patrick Pub Crawl.(210)

These organizations, located downtown and easily accessible by public transit, help draw new residents. The variety of activities and organizations for all ages makes it an attractive place to live for all demographics. They support the success of TODs as residents look for activities that enrich their lives.

Despite these many assets, Rahway does lack basic amenities including a major grocery store in the downtown. Convenience stores and small markets abound, but residents must travel two mi north to Linden, or 1.4 mi south to Avenel to shop at Pathmark, the nearest full-service grocery store, Shoprite stores in Clark and Woodbridge are 2.5 mi or more from Rahway Station. The TOD area also only offers one drugstore, Skaff's Corner Pharmacy.

Residents have access to many other local businesses: a laundromat, pet supply stores, jewelers, beauty salons, a bookstore, and three banks, among others. There is also no shortage of restaurants.[(201)] Many of these services are located downtown, near the train station, enabling residents who live near the station to shop within walking distance of their home.

Conclusions: Benefits of TOD

Economic

Transit-focused redevelopment has allowed Rahway to grow. New businesses have opened, most notably those associated with the arts. Building on the long-established Union County Performing Arts Center, Hamilton Stage for the Performing opened in 2012, joining gallery spaces, performance and recording venues, and classes support aspiring artists. First floor retail in several residential projects has provided desirable space for business, ranging from jewelers to accountants to coffee shops. They contribute to the local economy and provide goods, services, and employment to TOD residents and visitors.

In total Rahway has gained 687 new multi-family housing units and 41,000 ft^2 of retail space within a half-mile of the station. A number of PILOTs (Payments In Lieu Of Taxes) have been used, giving the municipality higher revenue than it would get from the standard property tax rate. All told, in 2011 the city collected more than $2.5 million from PILOTs and in property taxes from its TODs.

Former mayor, James Kennedy, provides fitting insight on how Rahway has benefited financially from development around the train station. In particular, high rental rates and increased property values have provided the city with a significant source of income, over and above that which could have been gained from previous, underperforming uses. While commercial development delivers windfall revenues, residential development provides a long-term, steady income stream because they are continuously paid every year. Further, because TOD is high-density, the city receives both higher property tax revenues and lower service delivery costs.[(211)]

The central, transit-friendly, location of these residences and businesses allows residents and visitors to navigate the community by foot. Shop owners benefit from the foot traffic that the location and high transit usage generates. “I’m catering to people who may be in a higher income bracket, because they live in this community but they work in the city,” says Edel Quinn, who recently opened a bookstore a block from the train station. “What I’m trying to do is to catch them, get them to stop. [They] leave anywhere from 6 to 7:30 or 8 in the morning, so I sit out here sometimes early in the morning, and they come back anywhere from 5 to 6 or 7 in the evening, so I’m trying to catch those commuters as they get on the train and get off.”[212]

Environmental

The TODs constructed in Rahway have occurred predominantly on brownfields near the train station, replacing existing buildings or vacant properties. The city updated its zoning to allow mixed-use, multi-family developments in land zoned commercial through redevelopment zoning overlays. By building on brownfields near the train station, Rahway has preserved its green space and improved the environmental quality of its developed lands. Additionally, preventing development along the Rahway River and keeping it as a park is particularly important for maintaining the river’s health.

Health

Rahway boasts a number of design characteristics known to encourage physical activity. The new TODs, located as they near downtown, allow their residents to walk to stores, restaurants, and some recreational areas. Some of them provide just one parking space per unit, expecting residents to only need one car and to use the train and to walk to many destinations. Rahway’s flexible use of zoning enabling mixed-use and residential developments in the commercial zones surrounding the train station – also encourages people to walk and bike to destinations downtown. By doing so, active transportation becomes part of residents’ daily lives, for living, for working, for playing. Finally, the Rahway community garden connects interested residents with fresh fruits and vegetables, along with exercise.

Challenges

Rahway has faced some opposition to its TOD strategy insofar as it has been tied to arts-based development. The city has acquired property and borrowed money to support the burgeoning arts scene. In 2010 the Redevelopment Agency purchased a house on Hamilton Street – adjacent to the proposed amphitheater project – to make room for arts district projects. The following year the city borrowed about $8 million in bonds for redevelopment and arts-based projects. The money covered concept plans, surveying, permitting and floor plans, among others.[185]While these costs are significant, Rahway’s officials view them as necessary to attract new residents and improve the city’s quality of life.

Lessons Learned

The influx of residents and businesses to the new TODs has helped revitalize this former industrial city. Rahway has used redevelopment of its vacant and underutilized properties downtown as a successful growth strategy. Support from city hall has helped move projects forward. The current and former mayors, city council, and the Rahway Redevelopment Agency all contributed to the effort that has resulted in many TOD projects to take root.

One way in which the city been supportive of redevelopment has been through updated zoning that allows for mixed-use buildings by right. Additionally, Rahway made the arts a major focus of its redevelopment effort, supporting it through financing and zoning. This strategy has been beneficial to the community, drawing in new businesses and providing additional amenities for Rahway residents and visitors. By promoting a vision of their city over a sustained period of time, Rahway officials provided additional incentive for residents to choose to live in the community. Residential developers recognize this and have used the arts as an important selling point when they advertise their TOD units. Redevelopment and support of the arts has worked hand-in-hand. Samson Steinman, the Executive Director of the Union County Performing Arts Center, affirmed this position. “We need to get a critical mass of people down here, and that’s through the redevelopment. And, you have to give them some reason to move here, and that’s the arts, the entertainment, the amenities.”(213)

Despite the difficulties occasioned by the national recession, Rahway has continued to move forward with its transit focus redevelopment efforts. While progress on some construction projects has lagged, the city has seen the completion of several mix-use projects and the reuse of several sites throughout the Transit Village area. As construction begins to pick up with improvements in the economy, the city’s investment in their arts district and support for TODs will likely continue to pay off as more and more people see the benefits of living in a Transit Village like Rahway.

Next Steps for TOD

In 2012 new Mayor Rick Proctor took office, continuing the effort to revitalize Rahway’s downtown begun by former Mayor James Kennedy. “Revitalization has not only provided funding for new development but has attracted new business and provided investment as well as units for sale and rent to supplement and provide vitality to the city’s downtown area,” he wrote in a letter on the website *Rahway Rising*. “I continue to support the progress that has been made regarding the Arts District.”(185)

A number of TODs are under construction, while others have been proposed. Over the next two years, Meridia Water’s Edge, Jack and Margaret Myers Senior Residence, and Station Place will open for occupancy. Others are under consideration, such as The Westbury and Lafayette Village. Despite the poor economy, Rahway’s designation as a

Transit Village and dedication to making development around the train station practical and attractive will pay off as the city continues to grow.

Conclusions

Each community came to TOD for its own unique reason. Cranford chose this form of redevelopment to improve derelict properties and to create housing for residents who wish remain in the community once they no longer required single-family homes to meet their family needs. Having seen a number of redevelopment projects succeed near the Morristown Green, the town's core area, Morristown sought to extend this redevelopment effort to the not-too-distant station area where transit agency owned surface parking was repurposed as mixed-used housing, retail, and structured parking. Rahway has taken on perhaps the most ambitious TOD program of the three communities profiled – the renovation of its station, the redevelopment of considerable underperforming property within the station area, and the development of an arts-based economic development program.

TOD redevelopment in Cranford resulted in Cranford Crossing and soon to be completed Riverfront at Cranford Station – each adding housing and retail to the community's downtown station area. These projects replaced outdated properties, allowing the environmental cleanup each site and their reuse in ways that satisfy community demands. The development of these project required considerable planning, rezoning, and other work on the part of the community and investors. These efforts resulted in additions to Cranford landscape that have allowed long-term residents to remain in the community when a single-family home has been become unnecessary or too demanding. It has also opened up the community to other, largely younger, residents who seek different forms of housing and a car-free or car-light existence. Additionally these projects have added to the retail mix in Cranford, allowing the community to sustain its downtown. Soon to be completed pedestrian improvements will further enhance the area, and allow safer waking conditions.

Morristown has seen a number of recent redevelopment projects, the majority of which, though within walking distance of the Morristown Station, are proximate to the Morristown Green. Redevelopment of surface parking adjacent to the station that resulted in the Highlands at Morristown Station has expanded improvements in the community's downtown housing stock and retail locations and has contributed to its financial well-being. As evidenced by the Morristown focus group, development of the station area has been generally well received by residents. Further improvements are needed to adequately address the needs of pedestrians.

Rahway has taken on the most ambitious TOD program of the three communities profiled. The city is home to multiple projects within walking distance of the station. As evidenced by the focus group, residents are pleased with the redevelopment activity taking place in the community as new projects often replace derelict properties. However residents would like to see more successful retail to take hold in Rahway's station area. Faced with a moribund downtown, Rahway pursued improvements to its station and surrounding properties that allowed the community to (1) rebuild its downtown, (2) increase income mix among residents by attracting more financially well-off residents interested in new housing and an easy rail commute to Newark and New York, and (3) draw visitors to its arts-focused businesses and attractions. While not all redevelopment projects met with immediate success, the municipality and its residents – both old and new – have gained from these new additions to the Rahway landscape. Revenues from redeveloped properties have placed the community in a more advantageous position as intensifying land uses at the city's core has provided increased tax revenues disproportionate to municipal costs.

While each of these three communities came to TOD for its unique reasons, all have gained from the endeavor. Each has been able to add new population in landscapes that were essentially built-out. Each has expanded the type of housing stock available to residents, allowing some residents in each community to live car-free or car-light. Each has been able to convert underperforming properties into those that provide improved revenues to the community. All three have expanded the amount of retail space available within the community – though not all have been success in having that space fully utilized.

APPENDIX B: STRUCTURED INTERVIEW QUESTIONNAIRE

Introduction

The Alan M. Voorhees Transportation Center at Rutgers, The State University of New Jersey is conducting a study funded by the NJ Department of Transportation. The purpose of this study is to assess the impacts of transit-oriented development (TOD) and to develop a methodology for measuring these impacts. Our conversation today will focus primarily on learning about how you think TOD has affected individuals, communities, and regions in the state. Our investigation is wide-ranging and we would like to discuss a whole host of impacts including its effects on transportation, economic development, health, environment, and community (i.e., livability). We would also like to talk about any other effects that transit-oriented development has had.

(Read IRB consent)

General

Introductions: Agency name; Interviewee Name, and Title

Please briefly describe your experience with TOD planning and/or projects

Transportation Impacts

In your experience, how does the travel behavior of those living in or near TOD differ from those not living near TOD?

How are the residents of the TOD(s) been utilizing nearby transit?

Has there been a rise in transit usage at this location?

Has this had a financial impact on transit provided at this location?

To what extent have you seen differences in auto ownership among TOD residents versus other living nearby or living more distantly?

How has the TOD affected local auto usage among residents?

… among those working at the TOD or nearby?

… visitors to the location?

How much parking was required in the TOD(s)?

How does this differ from other projects that are located more distantly from the transit facility or from other projects that you have been involved with?

How do you think we should go about evaluating and measuring the transportation effects of TOD on its residents and others living near TOD?

Economic Development/Impact

Was the TOD part of a larger economic development strategy?

To what extent has TOD planning (or project) impacted the economic viability of the community?

Has the TOD been able to attract additional jobs to the location?

Has the TOD been financially advantageous to the community?

… to the developer?

… to the transit provider?

How do you think we should go about evaluating and measuring the economic impact effects of TOD on its residents and others living near TOD?

Health Impact

Do residents typically walk to the transit?

… to other nearby locations?

How have the needs of bicycles been addressed in the TOD?

… in the surrounding area?

Has the TOD or related development addressed/improved accessibility to grocery stores?

If not, was this a concern in the planning of the TOD?

If so, does the grocery store(s) address the needs of all residents, regardless of income?

What has been impact of the TOD on pedestrian/bicyclist safety?

Has there been a change in the number of auto crashes (between autos or between autos and pedestrians and/or bicyclists)?

How do you think we should go about evaluating and measuring the health effects of TOD on its residents and others living near TOD?

Environmental Impact

What has been the impact of the TOD on local air quality?

How has the noise produced by cars changed with the completion of the TOD?

Has the noise of transit been an issue in the development of the TOD?

If so, how has it been addressed?

How do you think we should go about evaluating and measuring the environmental effects of TOD on its residents and others living near TOD?

Community Effects

Has the TOD planning or project added affordable housing to the community? How?

Are the residents of the TOD satisfied with the neighborhood in which they live?

How well integrated into the neighborhood are the residents of the new TOD development?

How do the residents of the surrounding area utilize the TOD?

Have you found that residents of the TOD are involved in community activities and/or civic engagement beyond those that may occur in the TOD (i.e., clubs, local government, and social activities)?

How do you think we should go about evaluating and measuring the community effects of TOD on its residents and others living near TOD?

Other Effects

Our intent is to measure the effects of TOD as holistically as possible. What other areas of investigation do you think we should be looking at?

Closing Remarks

Are there any issues we did not yet discuss on this topic that you would like to bring up or think would be valuable for us to consider as we move forward in our research? Please elaborate.

Thank you for your participation in this interview.

APPENDIX C: FOCUS GROUP GUIDE, REVISED 3-7-12

Assistant Moderator distributes and supervises completion of Consent Forms, Participant Questionnaires, and Tent Name-Cards

I. Welcome and Introduction

- Moderator introduces self and identifies Rutgers University and VTC/BSCR/EJB as the research facilitators.
- Explain what focus groups are for and how they work.
- Only one person speaks at a time. Please start your comments by saying your name first.
- We are interested in everyone's opinion. There are no right or wrong answers.
- Time limit: we'll be done and you'll be on your way home by 8:30 pm.
- You'll receive the incentive when we're finished, just as you leave.

Our purpose tonight is to study transit-oriented developments, or TODs. Transit-oriented developments involve higher-density mixed-use building within walking distance of transit stations.

So that definition has two parts – first, that the area is ***walking distance of transit [public transportation] stations***, and, second, this type of development tends to be higher-density and mixed use. By "higher-density," we mean that there are a lot of people living in the area, so there will be different kinds of housing – multi-family housing, apartment buildings, apartments over commercial buildings and such as well as single-family housing. By "mixed use," we mean there are people living near stores, and so these kinds of areas are usually very walkable – people can walk from their homes to nearby shops and stores, to visit their neighbors and friends who live nearby, to get to the train station, or even just walk to work.

Our work is trying to assess this type of development – is this a good thing? And if so, how and why? And so, we're here in Rahway tonight to learn from you how the adoption of a TOD has been for your city.

Before we begin, though, I need to make two points:

First, your participation is in this focus group is completely voluntary. You may choose not to answer any questions with which you are not comfortable, and any time during our conversation you may stop participating.

Second, your participation in the discussion is anonymous. We do have a consent form for you to read and sign, and we do need you to sign a receipt when you receive your cash incentive, but the discussion portion is anonymous, which means that we will not record your name, address, phone number, date of birth, etc. and your comments will not be directly associated with your participation. The research team, research sponsor and the Institutional Review Board at Rutgers University are the only parties that will be allowed to see the data. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated.

Assistant Moderator collects completed, signed Consent Forms and Participant Questionnaires.

II. Introductions

The first thing I like to do is to get to know each other a little bit, so let's go around the room and share with each other some basic information. So, please share with us:

- Your first name or a nickname?
- The town or city where you live?
- How many years have you lived there?
- What types of public transportation do you regularly use?

I'll go first…. [respondents follow]. O.k., thanks! Now that we all know each other a little better, and we all have some background on TODs, let's begin our discussion.

III. Substantive Discussion

Are you familiar with any TODs?

What towns do you know have TODs in them?

Do you live in or near a TOD? [or, assuming widespread awareness of Rahway as a TOD location, ask: *Please describe to me the Rahway TOD*.]

If not mentioned, prompt for:

(1) Park Square [159 1&2 bedroom rentals];

(2) Carriage City Plaza / Carriage/Skyview [16 story tower/hotel/residential/retail];
(3) River Place at Rahway [136 luxury apartments]
(4) Rahway Parking Deck [524 spaces]
(5) River Walk [86 townhouse]
(6) Grand Meridia / Renaissance at Rahway [88 rentals]

Now, I'd like to explore how living in or near a TOD affects you, personally. The key question is does it make your quality of life better, or worse, and if so, how?

To explore that, I'd like to first ask you a set of questions about how living in or near a TOD affects you individually, in your daily life, your work, your shopping, your recreation and things like that. So, let's start with some general questions:

What do you like about living in or near a TOD? What don't you like about it?

What would you change about living in or near a TOD? Are there some things you'd want to eliminate? Or maybe that you want to encourage or increase?

A. Transportation Impacts

Okay, now let's get a little more specific. Let's talk about transportation:

Who walks to the train? Why?

How does living in or near a TOD affect your transportation? For example, do you walk more? And, please, think about all the kinds of walking you do – we walk to the train for our commute, or maybe we walk to work in town; we walk to stores and shops; we walk to visit neighbors, we walk to go to the library? Did anyone walk to the focus group tonight? We even walk the dog!

How about access to transportation – for commuting, for non-work chores and errands, and for recreation? Does living in or near a TOD make getting to and from transportation easier for you? More convenient?

B. Economic Development

Okay, great. Now let's explore how living in or near a TOD affects the local economy and local economic development.

How about jobs? Does a TOD bring jobs to Rahway?

Did it attract new businesses? What kinds of businesses?

Did it make it easier for you to commute to your job, or to change jobs?

How about demand for housing? Do a lot of people want to move here?

What about the difference between rental property and private owner-occupied property? Do you notice any differences? Do they matter? How?

How about demand, if you know, for commercial stores and service providers and such.

C. Health Impacts

Thanks – now, how about health? [NO INITIAL PROMPT HERE – IF NECESSARY PROBE WALKING MORE]

D. Environmental Impacts

Now let's talk a little about how being a TOD has affected Rahway's environment – how things are downtown.

Is there more automobile or truck congestion?

What about safety? [PROMPT IF NOT RAISED: Is it easier to cross the street?]

What above overall safety, crime and the like?

And how about how the downtown looks, you know the appearance of the downtown?

Has the presence of a TOD helped to improve the look and feel of Rahway? How?

E. Community Effects / Social Capital

Finally, let me ask you about the effect living in or near a TOD has had on you in terms of your relation to your town.

Do you know more people there? Are you friendly with folks in town, and do you visit with them?

When you visit, do you walk?

Has living in or near a TOD changed how and how much you interact with your neighbors?

F. Ranking and Catch-all

Okay, now of all the things we just discussed which are the most important? In other words, in your opinion – for both positive and negative – What's the most important / significant / meaningful impact **on you** as a result of living in or near a TOD?

Now, please let me ask the same question – for both positive and negative – but now, What's the most important / significant / meaningful impact **to Rahway** as a result of having a TOD in town?

Okay, thanks. Now before we move on to our last topic, help me out here: Please tell me what I don't know – in other words, tell me what questions you would ask if you were me (that we haven't already covered).

H. Wrap Up

Almost done! Now, to wrap up, I'd like to ask you a very basic question. Thinking about what it is to "be" a driver or "be" a pedestrian: Are you a "driver" or a "pedestrian"?

Okay, recognizing that how people travel is important for all the reasons we discussed, transportation access and availability, economics, health, environment – with all that in mind:

Is the TOD a good thing for Rahway?

Do you think Rahway should build more – have more development of housing and shops -- in and around the train station?

IV. Conclusion

Thank you for your participation in this group discussion. We're handing out large index cards and on them please write three bullet points that tell us what you believe the most important things we discussed this evening, or even to bring to our attention something that we might have or should have discussed, but didn't.

Distribute incentives, get signed receipts.

APPENDIX D: SURVEY INSTRUMENT

RUTGERS

Edward J. Bloustein School
of Planning and Public Policy

New Jersey Transportation and Housing Study

Alan M. Voorhees Transportation Center
Edward, J. Bloustein School for Planning and Public Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue
New Brunswick, New Jersey 08901

Conducted by

The Bloustein Center for Survey Research
33 Livingston Avenue
New Brunswick, New Jersey 08901

NJ TRANSIT
The Way To Go.

Informed Consent

The Alan M. Voorhees Transportation Center (VTC) at Rutgers, The State University of New Jersey is conducting a study of how transit affects the choice of where people live. We are conducting this survey to gather information on the attitudes and preferences of people who live within about 2 to 3 miles of a transit station. Roughly 8,000 households will be asked to take part in this study.

This survey can be taken on-line and will take less than 15 minutes to complete. You will be asked about your household and your opinion of conditions near transit stations. Answering any or all of these questions is voluntary. You may refuse to answer any of the questions and you may stop the survey at any time. If you would prefer to receive a copy of the survey that you can mail back to us, please return the enclosed postcard.

This research is confidential. The research records will include some information about you and this information will be stored in such a manner that some linkage between your identity and the response in the research exists. Some of the information collected about you includes your name and address. Please note that we will keep this information confidential by limiting individuals' access to the research data and keeping it in a secure location such as a locked file cabinet or access controlled computer server except when in use. Data are stored on access controlled computer servers.

The research team and the Institutional Review Board at Rutgers University are the only parties that will be allowed to see the data, except as may be required by law. If a report of this study is published, or the results are presented at a professional conference, only group results will be stated. All study data will be kept for three years.

If you have any questions about how the study works, you can contact Stephanie DiPetrillo, Senior Research Specialist, Alan M. Voorhees Transportation Center, Edward J. Bloustein School of Planning and Public Policy, Rutgers University, 33 Livingston Avenue, New Brunswick, NJ 08901 at 848-932-2872 or by email at sdipetrillo@ejb.rutgers.edu.

If you have any questions about your rights as a research subject, you may contact the IRB Administrator at Rutgers University at:

Rutgers, The State University of New Jersey
Institutional Review Board for the Protection of Human Subjects
Office of Research and Sponsored Programs
3 Rutgers Plaza
New Brunswick, NJ 08901-8559
Tel: 848-932-0150
Email: humansubjects@orsp.rutgers.edu

Yes, I consent to take this survey. If so, please initial here, and proceed to the next page: _______

No, I do not consent to take this survey. If so, please return blank survey in the prepaid envelope provided.

PLEASE TELL US ABOUT WHERE YOU LIVE

1. In what year did you move to your current home?

Year: __ __ __ __

2. Where did you live before moving to your current home?

a. Town: ______________________________

b. County: ______________________________

c. State: ______________________________

d. Country: ______________________________

3. Which best describes the building you live in? Include all apartments, flats, etc., even if vacant. *[Check One]*

- O A one-family house detached from any other house
- O A one-family house attached to one or more houses
- O A building with 2 or 4 apartments
- O A building with 5 to 19 apartments
- O A building with 20 or more apartments
- O Other (please specify) : ______________________

4. About when was this building first built? *[Check One]*

- O 2000 or later → Specify year __ __ __ __
- O 1990 to 1999
- O 1980 to 1989
- O 1970 to 1979
- O 1960 to 1969
- O 1950 to 1959
- O 1940 to 1949
- O 1939 or earlier

5. How many bedrooms are in your home? *Count as bedrooms those rooms you would list if this home were for sale or rent. If this is an efficiency/studio apartment, enter "0".*

___ ___ Number of rooms

6. Have you volunteered your time for a neighborhood project or organization? *[Check one]*

- O Yes
- O No

7. **People's reasons for selecting a new neighborhood to live in may be different from their reasons for choosing a particular house or apartment.** *Please rate each of these factors that may have attracted you to this NEIGHBORHOOD.*
[Check one for each]

	Very Important	Somewhat Important	Neither Important or Unimportant	Somewhat Unimportant	Not Important
a. Close to friends or relatives	O	O	O	O	O
b. Close to job	O	O	O	O	O
c. Close to train station or bus stop	O	O	O	O	O
d. Access to major roads or highways	O	O	O	O	O
e. Little or no traffic	O	O	O	O	O
f. Easy to park car	O	O	O	O	O
g. Good variety of shops and services	O	O	O	O	O
h. Low crime rate	O	O	O	O	O
i. Good schools	O	O	O	O	O
j. Can easily walk in my neighborhood	O	O	O	O	O
k. Close to parks or other open space	O	O	O	O	O
l. Other: ________________	O	O	O	O	O

8. Please tell us how much you agree or disagree with the following statements.
[Check one for each]

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
a. My neighborhood is a good place to live.	O	O	O	O	O
b. Living in my neighborhood gives me a sense of community.	O	O	O	O	O
c. I know my neighbors.	O	O	O	O	O
d. At night I feel safe walking by myself in my neighborhood.	O	O	O	O	O
e. Traffic makes it unsafe for me to walk in my neighborhood.	O	O	O	O	O
f. My neighborhood is a good place to raise children.	O	O	O	O	O
g. Most people in my neighborhood can be trusted.	O	O	O	O	O
h. My neighborhood is noisy.	O	O	O	O	O

PLEASE TELL US ABOUT WORK OR SCHOOL

9. Did you work for pay last week, either full time or part time? *[Check all that apply]*

- ☐ Work full time
- ☐ Work part time
- ☐ School full time
- ☐ School part time
- ☐ Did not work or attend school ⟶ **Please skip to Question 19**

10a. At what location did you work [or go to school] LAST WEEK?

If you worked [or went to school] at more than one location, print where you worked [or went to school] most last week.

Number & Street: ____________________

City: ____________________

Zip Code: __ __ __ __ __

○ Do not know exact address

10b. If the exact address is not known, give a description of the location such as the building name or the nearest street or intersection.

Building Name: ________________________

St/Ave/Rd: ______________ and ________________ St/Ave/Rd

City: ____________________________

Zip: __ __ __ __ __

11. What time did you usually leave home to go to work [or school] LAST WEEK?

______:______ ___a.m. ___ p.m.

Hour Minute

12a. How many minutes did it usually take you to get from home to work [or school] LAST WEEK?

__ __ __ minutes

12b. In an average week, how often do you make stops longer than five minutes during your trip from home to work?

- ○ Everyday
- ○ Few times a week
- ○ Once a week
- ○ Never

13. How did you usually get to work or school LAST WEEK? If you usually used more than one method of transportation during the trip, mark the box of the one used for most of the distance. *[Check one only]*

- O Car, truck, or van
- O Motorcycle

- O Bus
- O Light rail or street car
- O Subway or elevated rail
- O Train
- O Ferry

- O Taxicab
- O Bicycle
- O Walked
- O Worked at home
- O Other [specify]: ___________
- O Did not work last week

14. How many people, including yourself, rode in the car, truck, or van LAST WEEK?

______ person(s)

15. If you drove to work or school LAST WEEK, how much did you pay in tolls each day?

$ ________

16a. If you drove to work or school LAST WEEK, did you pay for parking? *[Check One]*

- O No
- O Yes

16b. How much did you pay for parking?
[Answer one only]

$________ Per day
$________ Per week
$________ Per month
$________ Per year

17a How do you pay for public transportation?

- O Weekly Pass
- O Monthly Pass
- O Individual Tickets

17b. How much did you pay?

$___ ___ ___

18. Sometimes you may not be able to commute by transit. Please indicate what are your most common reasons for not traveling by transit?

	Yes	No
a. Transit does not serve my destination	O	O
b. Transit takes too long	O	O
c. Transit does not run at a convenient time	O	O
d. Transit service is unreliable	O	O
e. Fear of crime, going to and from the station or stop	O	O
f. Not enough parking at station/stop	O	O
g. Cost is too high	O	O
h. Need to carry things	O	O
i. Other: ______________________	O	O

19. How often do you do the following within walking distance of your local train station?
[Check one for each]

	Every Work-day	Few Times a Week	Once a Week	Once a Month	Few Times a Year	Never
a. Shop at retail stores	O	O	O	O	O	O
b. Eat at restaurants or go to coffee shops	O	O	O	O	O	O
c. Engage in personal business (e.g., banking, doctor, dry cleaner, etc.)	O	O	O	O	O	O

PLEASE TELL US ABOUT HOW YOU TRAVEL

20. How often do you travel by each of the following means of transportation? *[Check one for each]*

	Every Workday	Few Times a Week	Once a Week	Once a Month	Few Times a Year	Never
a. Car, truck, or van	O	O	O	O	O	O
b. Bus	O	O	O	O	O	O
c. Light rail or street car	O	O	O	O	O	O
d. Subway or elevated rail	O	O	O	O	O	O
e. Train	O	O	O	O	O	O
f. Ferry	O	O	O	O	O	O
g. Motorcycle	O	O	O	O	O	O
h. Bicycle	O	O	O	O	O	O
i. Walked	O	O	O	O	O	O

21. When you use the bus or train, how do you usually get to the station or bus stop? *[Check one only]*

- O Never use the bus or train
- O Bicycle
- O Drive car, truck or van
- O Carpool
- O Dropped off
- O Walk

21b. When you walk to the bus stop or train station, how many minutes do you walk?

__ __ __ minutes

22. Sometimes you may not be able to walk to the transit station or stop.

Please mark why from the following list.

	Yes	No
a. Takes too long	O	O
b. Too much car traffic	O	O
c. Too difficult to cross nearby streets	O	O
d. Crime going to or from station or stop	O	O
e. Don't want to walk in the dark at night	O	O
f. Too tired to walk	O	O
g. Don't want to walk in rain or snow	O	O
h. Not physically capable of walking	O	O
i. Need to carry things	O	O
j. Other: ________________	O	O

23a. If you drive to and park near or at the station, do you pay for parking? *[Check One]*

O No
O Yes

23b. If yes, how much do you pay for parking at this station? *[Answer one only]*

$________ Per day
$________ Per week
$________ Per month
$________ Per year

24. Please tell us about the last time you left from your home, work, or transit station, when or how did you travel to go to a restaurant or coffee shop?

From Home	From Work	From Station
When? ***[Check one]***	When? ***[Check one]***	When? ***[Check one]***
O Never	O Never	O Never
O Today	O Today	O Today
O Yesterday	O Yesterday	O Yesterday
O _____ days ago [Fill in]	O _____ days ago [Fill in]	O _____ days ago [Fill in]
How? ***[Check one only]***	How? ***[Check one only]***	How? ***[Check one only]***
O By car, truck or van	O By car, truck or van	O By car, truck or van
O By train or light rail	O By train or light rail	O By train or light rail
O By bus	O By bus	O By bus
O Walked	O Walked	O Walked
O Other: ___________ *[Please specify]*	O Other: ___________ *[Please specify]*	O Other: ___________ *[Please specify]*

25. Please tell us about the last time you left from your home, work, or transit station, when and how did you travel to buy food or groceries?

From Home	From Work	From Station
When? ***[Check one]***	When? ***[Check one]***	When? ***[Check one]***
O Never	O Never	O Never
O Today	O Today	O Today
O Yesterday	O Yesterday	O Yesterday
O _____ days ago [Fill in]	O _____ days ago [Fill in]	O _____ days ago [Fill in]
How? ***[Check one only]***	How? ***[Check one only]***	How? ***[Check one only]***
O By car, truck or van	O By car, truck or van	O By car, truck or van
O By train or light rail	O By train or light rail	O By train or light rail
O By bus	O By bus	O By bus
O Walked	O Walked	O Walked
O Other: ___________ *[Please specify]*	O Other: ___________ *[Please specify]*	O Other: ___________ *[Please specify]*

26. Where do you park your vehicle at home? *[Check One]*

- o Don't own a vehicle
- o Home garage or carport
- o Driveway
- o On-street
- o Surface parking lot
- o Enclosed parking structure

27. How long does it take to park and walk to your home? *[Check One]*

- o Less than a minute
- o 1 to 5 minutes
- o 5 to 10 minutes
- o More than 10 minutes

PLEASE TELL US ABOUT YOUR HEALTH/EXERCISE HABITS

28a. In the last year, has your doctor advised you to increase your physical activity? *[Check One]*

- o No
- o Yes

28b. How have you increased your physical activity? *[Check one for each]*

	Yes	No
a. Walking more	o	o
b. Taking an exercise class	o	o
c. Purchased and using home exercise equipment	o	o
d. Taking the stairs	o	o
e. Joined a sports team	o	o
f. Joined a walking group	o	o
g. Going to a gym	o	o
h. Increased outdoor activity (golf, canoeing, hiking, etc.)	o	o
i. Other: ______________________	o	o

29. Have you EVER been told by a doctor or other health professional that you had...?
[Check one for each]

	Yes	No
a. A heart condition	o	o
b. Diabetes	o	o
c. Asthma or other respiratory illness	o	o
d. High blood pressure	o	o
e. Obesity	o	o
f. Other chronic condition, specify: _______________	o	o

30. On average, about how often do you walk outdoors for 5 minutes or more? *[Check one]*

- o More than once a day
- o Once a day
- o Several times a week
- o Several times a month
- o A few times a year or less

31. Within the last 30 days, have you walked for any of the following reasons? *[Check one for each]*

	Yes	No
a. To work or school	o	o
b. For exercise	o	o
c. To walk or exercise dog	o	o
d. To public transit station or stop	o	o
e. To a community/ recreation center	o	o
f. To neighborhood shops and restaurants	o	o
g. To the post office/ public library/ municipal office	o	o
h. To a park	o	o
i. To a medical facility	o	o
j. To your children's school	o	o
k. To a place of worship	o	o
l. Other, specify: ____________________	o	o

32. How many times a week do you usually do 20 minutes or more of vigorous-intensity physical activity that makes you sweat or puff and pant? *(e.g., heavy lifting, digging, jogging, aerobics, or fast bicycling) [Check one]*

- o 3 or more times a week
- o 1 to 2 times a week
- o Never

33. How many times a week do you usually do 30 minutes or more of moderate-intensity physical activity or walking that increases your heart rate or makes you breathe harder than normal? *(e.g., carrying light loads, bicycling at a regular pace, or doubles tennis) [Check one]*

- o 5 or more times a week
- o 3-4 times a week
- o 1-2 times a week
- o Never

PLEASE TELL US ABOUT YOUR HOUSEHOLD

34. Including yourself, how many adults and children live in your household?

___ ___ Number of adults
___ ___ Number of children under 18

35. How would you describe your household? *[Check one]*

- o Single
- o Couple(unmarried or married)
- o Parent(s) and children
- o Extended family (e.g., grandparents, cousins, etc.)
- o Unrelated adults
- o Other, specify: ____________________

36. How many motorized vehicles are available for use by members of your household?
Please be sure to include motorcycles, mopeds and RVs.

___ ___ Number of motorized vehicles

37. Do you have a bicycle available for your use on a regular basis? *[Check one]*

- o Yes
- o No

38. Please indicate how many people in your household, including yourself, are in each of the following age categories. *[Fill in number]*

___ Under 5 years
___ 5 to 13 years
___ 14 to 17 years
___ 18 to 24 years
___ 25 to 34 years
___ 35 to 49 years
___ 50 to 64 years
___ 65 to 74 years
___ 75 or older

39. How many dogs do you have in your household?

___ ___ Number of dogs

40a. Do you own or rent your home? *[Check one only]*

- o Live with friend/family/parent
- o Own
- o Rent

40b. How much is your monthly rent?

$ ___ ___ ___ ___

39. What race or ethnicity best describes you? *[Check one only]*

- o White Hispanic
- o Black Hispanic
- o White not Hispanic
- o Black not Hispanic
- o Asian
- o Multiracial
- o Other _______________

52. So we can be sure we are getting a cross-section of all people, please estimate your household's total annual income for 2011. *By "total," we mean adding together the annual income of everyone in your household. Which of the following categories does it fall in? [Check one]*

- o Less than $10,000
- o $10,000 to less than $15,000
- o $15,000 to less than $25,000
- o $25,000 to less than $35,000
- o $35,000 to less than $50,000
- o $50,000 to less than $75,000
- o $75,000 to less than $100,000
- o $100,000 to less than $150,000
- o $150,000 to less than $200,000
- o $200,000 to less than $250,000
- o $250,000 or more
- o Don't know

Thank you for completing the survey.

Please return survey in the prepaid envelope provided.

ID NUMBER

APPENDIX E: MODULES IN THE NJRTM-E MODEL

This appendix provides additional detail on the NJRTM-E travel demand model that is used in our modeling analysis.

Transit links in NJRTM-E

This model was developed by NJTPA specifically to model transit networks and adopted existing transit networks from the NJ Transit Regional Transit Model, which are shown in Figure 55. The primary purpose of the transit network is to develop estimates of the time and cost variables for peak and off-peak periods as required for the mode choice model and to load trips within the transit assignment process.[90]

Figure 55. Transit network layer (including bus) in NJRTM-E

The various modes included in the NJRTM-E transit network are listed in Table 107. The first 10 modes represent the actual transit services provided in the region. Modes 11-15 are the non-transit modes, which provide access and transfer linkages for the transit users. Two different access related modes, auto-access and walk-access, are used in NJRTM-E.

Table 107 – NJRTM-E transit network modes

Mode Number	Mode Designation	Type of Service
1	Transit	Commuter rail (NJ Transit rail)
2	Transit	PATH
3	Transit	NYC Subway
4	Transit	Newark subway
5	Transit	NJ Transit bus routes
6	Transit	Port Authority bus routes
7	Transit	Park-and-Ride bus routes
8	Transit	Ferry
9	Transit	Light Rail
10	Transit	Long haul ferry
11	Non-Transit	Auto Access to Zone to Gathering Node (PNR Lot)
12	Non-Transit	Walk Transfer
13	Non-Transit	Not Used
14	Non-Transit	Walk-Access – Zone to Station
15	Non-Transit	Auto Gathering Access - Gathering Node (PNR Lot) to Station

Source: URS Corporation [91]

The NJRTM-E transit model involves ten different transit modes as shown in Table 108. The transit network includes 20,823 links and 12,053 nodes in all. These links includes highway, train, subway, light rail and ferry.

Table 108 – Mileage and number of links for each mode in the NJRTM-E network

Mode	Length	Number of links
Commuter rail (NJ Transit rail)	564 miles	171 links
PATH	19 miles	15 links
NYC Subway	307 miles	509 links
Newark subway	3.9 miles	11 links
NJ Transit bus routes	2,295 miles	5,871 links
Port Authority bus routes	2,016 miles	4,098 links
Park-and-Ride bus routes	13.3 miles	318 links
Ferry	12.4 miles	188 links
Light Rail	7.9 miles	15 links
Long haul ferry	50 miles	3 links

Source: URS Corporation [90]

Trip Generation Model in NJRTM-E

The trip generation component includes several procedures used to prepare the necessary zonal variables and apply the trip estimation techniques, each of which is briefly defined below:[90]

Household Submodels. In this step, households are stratified into 90 groups (6 by household size * 5 by income group * 3 by life cycle) and then 60 groups (4 by number of workers * 5 by income group * 3 by life cycle).

Trip Production Estimation. This step applies the trip production rates derived from a household survey to each household group. The resulting trip productions are then aggregated to 15 groups (5 by income group and 3 by life cycle).

HBU Trip Generation Submodel. This routine applies a customized technique to estimate home-based trip generation at colleges and universities. Special procedures are applied to estimate this purpose due to the limitations in the enrollment database used to control the estimation of trips for the HBU trip purpose.

NHB Trip End Estimation. Trip ends are estimated for non-home-based trip purposes and normalized to the regional total derived from a cross-classification process
.

Non-motorized Submodel. Total person trips are partitioned into Non-motorized trips and motorized trip productions by trip purpose.

Trip Attraction Estimation. Motorized trip attractions are estimated for home-based purposes and stratified by income group.

Regional Adjustment. The resulting productions and attractions are adjusted at the county level for the modeled region. These adjustments are applied primarily to counties in the buffer region near the edge of the modeled area to account for trips destined to areas outside of the modeled area.

Figure 56 shows an overview of the trip generation process in NJRTM-E.

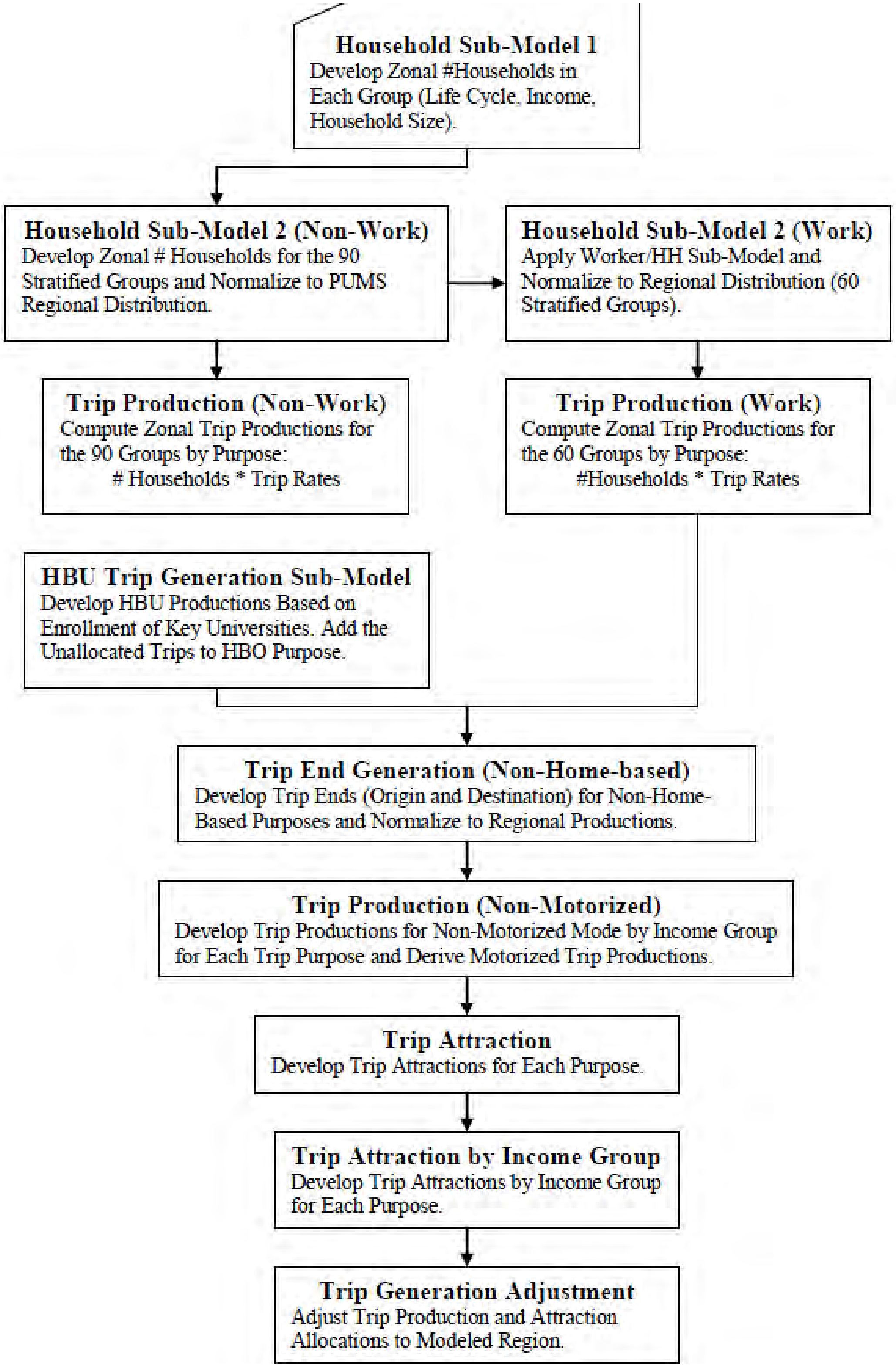

Figure 56. Trip generation structure in NJRTM-E

Source: URS Corporation [90]

Trip Generation Model in NJRTM-E – Motorized Home-based Work trips

As a part of the household submodel for work trips, the production cross-classification process uses the number of workers as a predictive variable. In order to estimate households by number of workers, a submodel was used to disaggregate households into several worker categories. These estimates are derived using the zonal joint distribution of households by household size, income group, and life cycle as previously calculated.[90]

A discrete choice worker per household submodel was developed to obtain the joint distribution of households by number of workers, income and life cycle. The worker per household submodel was estimated based on the NJTPA regional travel – household interview survey (RT-HIS) data, which has nearly 11,000 respondents. The primary modeling technique was a multinomial logit structure with the alternative "households with 3+ workers" as the reference alternative (with a zero utility). Thus all variables and corresponding coefficients can be interpreted as relative contributions to having less than three workers in the households. The multinomial logit model for workers per household model is defined in the following formula: [90] (Note: This is not a choice model and it only estimates the proportion (probability) of households with 0, 1, 2, 3+ workers per households.)

$$P_i = G * \frac{\exp(V_j)}{\sum_{j=0}^{3} \exp(V_j)}, for\ i = 0,1,2,3 \tag{2}$$

Where:

i,j = 0,1,2,3 Choose alternatives (number of workers in the household)

Pi Probability of alternative i

Vi Utility function for alternative i

The utility function of the worker per household submodel has the following general form:

$$V_i = \alpha_i X * \sum_{k=1}^{3} \beta_i^k Y^k + \sum_{l=1}^{4} \gamma_i^l Z^l \tag{3}$$

Where:

k = 1,2,3 Life cycle group

l = 1,2,3,4 Income group from 1 to 4 with income group 5 serving as the reference group

α_i Alternative-specific coefficients for household size

X Alternative-specific coefficients for household size

β_i^k Alternative-specific constants for life cycle category k

Y^k Binary variable for life cycle category k

γ_i^l Alternative-specific constant for income group l

Z^l Binary variable for Income group l

The estimated coefficients and t-statistics are listed in Table 109. Note that the 3+ Worker Household is the reference alternative.

Table 109 – Workers per household sub-model coefficients and constants

Workers /HH	HH Size	Retiree	With Children	No Children	Income Groups			
					Grp1	Grp2	Grp3	Grp4
0	-1.844 (-12.7)	6.973 (-13.4)	4.996 (15.6)	-1.329 (13.6)	5.271 (6.3)	2.38 (0)	0.2993 (6.3)	-1.413 (0)
1	-0.8222 (-7.7)	3.911 (-8.6)	4.673 (9.9)	0.4245 (11.5)	3.228 (5.8)	1.796 (0.6)	0.6452 (5.8)	-0.5227 (0.6)
2	-0.6018 (-5.9)	2.619 (-3.3)	4.34 (5.9)	1.419 (9.1)	1.188 (5.1)	0.6782 (-0.5)	0.4720 (5.1)	-0.2749 (-0.5)

Note: “Rho-Squared” w.r.t. Zero = 4048
“Rho-Squared” w.r.t. Constants =.3870
Source: (92)

Using the above model the joint distribution of number of households in each household size/income group/life cycle/number of workers per household category can be estimated in each zone. Using the total number of households in each zone the number of households stratified by number of workers, income and life cycle are obtained at the zonal level.

The trip production rates are cross-tabulated for each of the household groups, both by household size, income group and life cycle for the non work-related purposes, while the work-related purposes are stratified by number of workers, income group, and life cycle. The resulting trip generation rates, together with the households by category generated by household submodels, are used to generate zonal level trip productions for each household group by trip purpose.

The NJRTM-E trip generation process stratifies the generic HBW trip purpose into two separate purposes, "direct" (HBWD) and "strategic" (HBWS). The HBWS trips include those trips that involve intermediate stops. The trip rates (including HBWD and HBWS) for each household size, income group and lifecycle are estimated from the PUMS survey data. (The HBWS is approximately 26% of the total HBW purpose trips).

Adjustment factors by area type and trip purpose (shown in Table 110) are used to calibrate the initial trip production estimates to match the target trips. Note that these factors are used for the whole network.

Table 110 – Production adjustment factors by area type and trip purpose

AREA TYPE	HBWD	HBWS	HBSH	HBO	HBU	WBO	NHB
Cbd/Urban High	1.20	0.95	1.40	1.10	1.60	0.75	1.12
Urban	0.90	0.86	0.74	0.83	0.95	0.83	0.85
Suburban High	1.10	1.03	1.17	1.08	1.00	1.07	1.00
Suburban	1.07	1.20	1.13	1.17	1.50	1.17	1.13
Rural	0.85	1.08	0.98	1.00	0.90	1.04	1.08

Source: URS Corporation [90]

Trip Attraction Models in NJRTM-E

There are a series of linear regression models for trip attraction for each trip purpose with the following variables:

Total households
Total employment
Employment by type
Area type
Employment density
Household size
Household density

The appropriate dataset of independent variables varies by trip purpose. For work-related purposes, employment-related data play an important role in the estimation and household-related demographics are irrelevant. For non-work-related purposes, both household-related data and employment-related data could be used as predictive variables. Density-related terms, which incorporate employment density, household density and area type, could influence the magnitude of trips; therefore, these terms were included in the estimation data set.

For HBWD + HBWS trip the following set of variables are significant:

- Total employment

- Employment density

Further details on the model coefficients and significant set of variables for other trip purposes are shown in Table 111.

Table 111 – Coefficients for attraction models by trip purpose

CODE	HBWD	HBWS	HBSH	HBO	WBO	NHNW	VARIABLES
1							POP
2	0.2271	1.3085	0.6308				HH
3	1.0355	0.3507					Total EMP
4	-0.0516	0.8186					EMPBASIC
5							EMPRETAIL
6							EMPSERVICE
7	1.4541						RETAIL
8							NON_RETAIL
9							AGRICULTURE&MINING
10	18.28						CONSTRUCTION
11							MANUFACTURING
12							TRANSPORTATION
13	-8.2863						WHOLESALE
14	3.152	0.8728	2.1261				RETAIL
15	-7.8257	-1.4006					F.I.R.E
16	3.6232	2.2983	0.8552				SERVICE
17	-11.3489	-5.6111					GOVERNMENT
18							MILITARY/OTHER
19							AREA TYPE
20	-0.0076						VICINITY DENSITY
21							HHSIZE
22							HH WITH RETIREE
23							HH WITH CHILDREN
24							HH WITH NO CHILDREN
25							Density
26							%HH RETIRED
27							% RETAIL
28	0	0	0	0	0	0	CONSTANT

Source: URS Corporation [90]

Trip Distribution Model in NJRTM-E

To estimate trip distributions, the gravity model is used as follows:

$$Trip_{i\to j} = \frac{P_i * A_j * f\left(\operatorname{lm} p_{i\to j}\right) * k_{i\to j}}{\sum_{r=1}^{zones} A_r * f\left(\operatorname{lm} p_{i\to j}\right) * k_{i\to j}} \qquad (4)$$

Where:

P_i	The number of trips produced from zone i
A_j	The number of trips attracted to zone j
$\operatorname{lm} p_{i \to j}$	The travel impedance from zone i to zone j
$f(\operatorname{lm} p_{i \to j})$	The friction factor, which is a factor of travel impedance
$k_{i \to j}$	Specific zone to zone adjustment factor

The impedances are calculated using the skim matrices that are updated for each iteration of the process.

Mode Choice Model in NJRTM-E

The mode of travel chosen by users is an important aspect of the NJRTM-E model. The description of the mode choice model in NJRTM-E is given below.

Probability of choosing a mode *a*: [90]

$$P_a = \frac{e^{U_a}}{\sum_{i=1}^{m} e^{U_i}} \tag{5}$$

P_a	is the probability of a traveler choosing mode a;
U_a	is the utility (or attractiveness) of mode a; and
$\sum U_i$	is the sum of the utilities for all m modes.

Utility of a mode *a*:

$$U_a = c_1 * Distance_a + c_2 * \ Fare_a + c_3 * InVehicleTime_a + \cdots + C_a \tag{6}$$

The models are structured as a series of choices, or “nests”, such as “transit vs. auto” or “walk access vs. drive access to transit.” The nested logit structure implies that the share of trips choosing a particular mode b is dependent upon the logarithm of the sum (“logsum”) of the exponentiated modal utilities of those submodes nesting below mode b. This is computed as: [90]

$$U_b = c_{nest} * \ln\left(\sum_{i=1}^{m} e^{U_i}\right) + C_b \qquad (7)$$

where:

U_b is the utility for the nest b,

C_{nest} is a coefficient called the nesting coefficient, or theta; and

C_b is a nest level constant for nest b- obtained through calibration.

The nesting structure for the model is presented in Figure 57. The nesting coefficients (thetas) were estimated from research completed by Resource Systems Group (RSG) and were set at 0.5 for the transit, walk-access, and drive-access nests. [92]

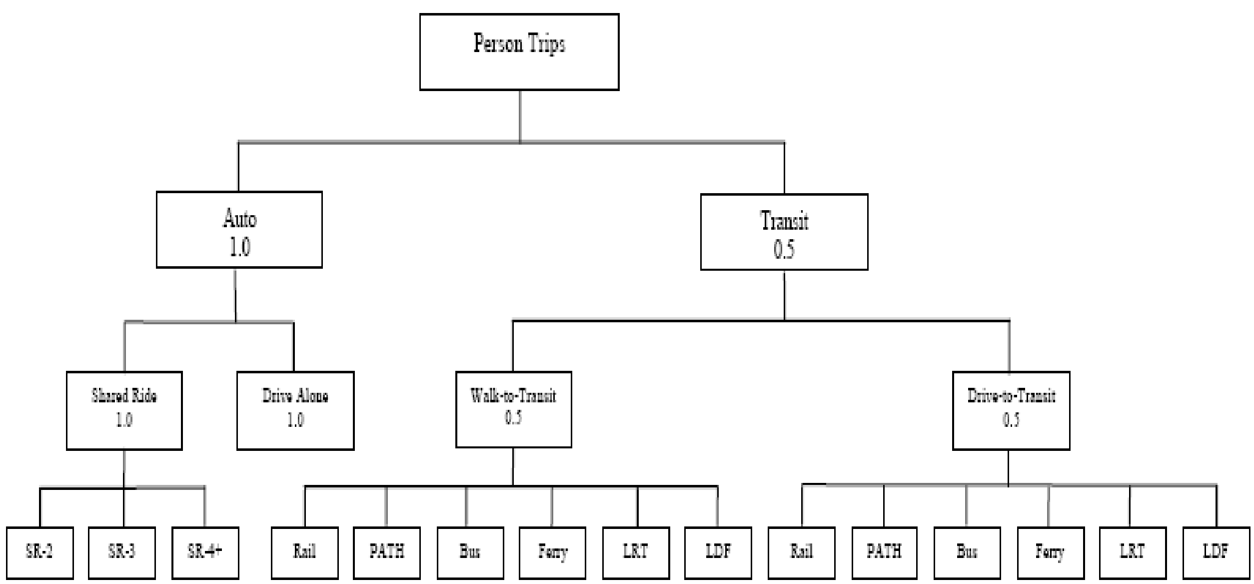

Figure 57. Nested structure of modes

Source: URS Corporation [90]

Coefficients for the HBW mode choice model were originally estimated for the previous version of NJTDFM (for base year 1990) using ALOGIT and the HBW trans-Hudson survey trip data. The coefficients are shown in Table 112.

As part of the NJTDFM update to base year 2000, all components of Out-of-vehicle time (walk time and waiting time) were weighted 1.5 times transit in-vehicle time and 2.0 times commuter rail in-vehicle time. Drive-to-Transit time was weighted as 1.5 times transit in-vehicle time and 2.0 times commuter rail in-vehicle time.

Table 112 – HBW mode choice model coefficients

Parameter	Coefficient
AUTO IVTT (minutes)	-0.04195
RAIL/LONG FERRY IVTT (minutes)	-0.03222
NON-RAIL/LONG FERRY TRANSIT IVTT (minutes)	-0.04306
WALK (minutes)	-0.06444
WAIT (minutes)	-0.06444
XFERS 1)5.3min 2)6.9 3)7.6 4)8.2 5+)8.6	-0.04306
DRIVE ACCESS TIME (minutes)	-0.06444
DRIVE COST (1990 cents)	-0.00157
TRANSIT FARE (1990 cents)	-0.00162
RAIL/LONG FERRY DIST (in LN(miles*100))	0.8027
BUS DIST (in LN(miles*100))	0.2836
OTHER TRANSIT DIST (in LN(miles*100))	-0.3245
RAIL TO PATH/FERRY XFER	-0.1
BUS TO RAIL/PATH/LRT XFER	-0.4
USE OF NYC SUBWAY	-0.4

IVTT – In-vehicle travel time
XFERS – Transfer time

Source: URS Corporation [90]

Drive Cost=$0.15/mile + toll + (½ parking cost / the vehicle occupancy) (10)

In addition, the original mode choice estimation included transportation costs (fares, tolls, parking and automobile operation costs) in 1990. In order to maintain consistency with the original model estimation, it was necessary to represent future transportation costs within the updated NJTDFM mode choice models. Current year 2000 costs are coded (in cents) into the highway and transit networks. Within the mode choice model, the coded fares are adjusted for inflation from 2000 (coded) to 1990. This is done by using the annual New York-Northern New Jersey-Long Island Consumer Price Index (CPI) data from the U.S. Department of Labor for 2000 (182.5) and 1990 (138.5). Thus, the coded Year 2000 transportation costs are multiplied by 0.759 to properly account for the costs as they were in 1990. The deflated costs from Step 2 (Year 1990 dollars) are then entered into the utility function.[90]

The HBW income constants (C_a in the expression for utility U_a) were originally estimated for the previous version of the NJTDFM for base year 1990. The corresponding income levels for year 2000 were computed by inflating the 1990 household income data to year 2000 by using the annual New York-Northern New Jersey-Long Island CPI. The final Home-Based Work income constants are summarized below in Table 113.[90]

Table 113 – NJRTM-E home-based work income constants

Income Group	Household Income	Household Income	Transit - Rail/ Long Island Ferry		Transit - Non Rail/ Long Island Ferry	
	1990	2000*	Constant	T-statistic	Constant	T-statistic
1	Under $15,000	Under $19,799	-1.124	-2.95	0	NA
2	$15,000-$24,999	$19,800-$32,899	-0.1254	-0.73	-0.7819	-3.65
3	$25,000-$34,999	$32,900-$46,099	0	NA	-0.8076	-3.92
4	$35,000-$49,999	$46,100-$65,899	-0.4534	-3.56	-1.2650	-6.29
5	$50,000-$74,999	$65,900-$98,799	-0.4734	-4.1	-1.2400	-6.28
6	$75,000-$99,999	$98,800-$131,799	-0.4225	-3.5	-1.4520	-7.24
7	$100,000-$149,999	$131,800-$197,700	-0.5383	-4.33	-1.5430	-7.57
8	Over $150,000	Over $197,700	-0.5534	-4.21	-2.0670	-9.85

* Year 2000 Household Income developed by inflating the Year 1990 House Incomes using Consumer Price Index data from U.S. Department of Labor. All coefficients are expressed at the bottom nest level

Source: URS Corporation [90]

To allow the model to closely replicate observed ridership patterns, the region is subdivided into 11 different market segments. Each market segment has its own set of mode-specific constants (these constants for each segment and mode can be found in Appendix N [90]). The market segments are described in Table 114.

Table 114 – Market segment definitions

Market Segment	Description
1. NY	From everywhere (except Staten Island) to Manhattan
2. NK	From everywhere (except Staten Island and Manhattan) to Newark Super CBD
3. JH	From everywhere (except Staten Island and Manhattan) to Jersey City/Hoboken Core
4. OC	From everywhere (except Staten Island and Manhattan) to other CBDs1*
5. OE	From everywhere (except Staten Island and Manhattan) to East of Hudson (except Manhattan)
6. NN	From Non-Dense** to Non-Dense (except non-dense zone in NK, JH, OC)
7. YN	From Manhattan to everywhere (except Manhattan)
8. SI	To or from Staten Island
9. VN	From Dense to Non-Dense (except non-dense zone in NK, JH, OC, OE)
10. NV	From Non Dense to Dense (except dense zones in NK, JH, OC, OE)
11. VV	From Dense to Dense (except dense zones in NK, JH, OC, OE)

* Other CBDs include Morristown, New Brunswick, Elizabeth, and Trenton

** Dense is defined as zones with a population density greater than 25,000 persons per square mile

Source: URS Corporation [90]

NJ Transit's NJTDFM Model

The regional planning model used by NJ TRANSIT is the New Jersey Transit Demand Forecasting Model (NJTDFM). This model is used by planners at NJ TRANSIT to predict users' transit demands along the transit network of NJ TRANSIT. The predictions are based on mode choice of users based on various inputs such as fares and highway travel time.

The model is very similar to NJRTM-E and is based on a four-step procedure. The NJTDFM model was provided by NJ TRANSIT staff for this project. There are various differences between the NJRTM-E and NJTDFM models, and these are noted in this section. This model was not used in any analysis as the NJRTM-E model was determined to be more appropriate for the needs of this project.

Comparison of Models

The four-step planning process and highway assignment in NJRTM-E is based on multiple iterations.[90] The NJTDFM is based on highway assignment with only a single iteration. Having only one iteration may be sufficient for the operational needs of NJ TRANSIT's train, subway, and light rail service modes, but multiple iterations are necessary to obtain a reasonable convergence of the shortest path-based traffic assignment. Moreover, if the highway link volumes are inaccurate they may impact the modeling accuracy of bus service.

The mode choice component of NJRTM-E and NJTDFM are very similar if not the same. By comparing the model development document of NJRTM-E and the NJTDFM's ridership forecasting methodology, it can be seen that the mode choice model structure and coefficients are the same.

The number of zones in NJRTM-E and NJTDFM do not match. NJTDFM has about 500 extra zones. These additional zones include parts of Pennsylvania and Staten Island, NY.

The NJTDFM ridership forecasting model is determined by transit path skims' estimation, mode choice and assignment. It does not take into account the trip generation and trip distribution steps of the four-step process. NJTDFM accepts the trip tables, which are the output of the trip distribution process as an input. The NJTDFM model provided by NJ TRANSIT does not include the steps before mode choice in the four-step process.

The trip tables also differ in structure between NJRTM-E and NJTDFM. The NJRTM-E trip tables are separated based on trip purposes, namely:

Home-based

- work Direct (HBWD)
- work Strategic (HBWS: include work trips that have intermediate stops)
- shop (HBSh)
- university (HBU)

- Other (HBO)

Work-based Other (WBO)

- Non-home-based non-work (NHNW)
- Airport trips

The NJTDFM trip tables are:

Home-based

- work (HBW)
- Other (HBO)
- shop (HBS)

Non-home-based non-work (NHB)
Airport trips

Additionally, the number of trips is also different between NJRTM-E and NJTDFM by an average of about 5%. The individual differences can be seen in Table 115.

Table 115 – Trip table comparison between NJTDFM and NJRTM-E

Period	TRIP TYPE	NJTDFM	NJRTM-E	Difference	% Difference
PEAK	HBW*	5810727	6103278	292551	5.0%
	HBS	1465722	1544914	79192	5.4%
	HBO	6275452	6679385	403933	6.4%
	NHB**	2796952	2869994	73042	2.6%
	AIR1	5664	6655	991	17.5%
	AIR2	7180	4759	-2421	-33.7%
	AIR3	13104	8997	-4107	-31.3%
	AIR4	11538	5595	-5943	-51.5%
	TOTAL_PK	16386339	17223577	837238	5.1%
OFF-PEAK	HBW*	2231073	2403454	172381	7.7%
	HBS	1596239	1673656	77417	4.8%
	HBO	4862333	5038835	176502	3.6%
	NHB**	3945712	4078393	132681	3.4%
	AIR1	6223	10896	4673	75.1%
	AIR2	9146	7862	-1284	-14.0%
	AIR3	10185	14731	4546	44.6%
	AIR4	12297	9696	-2601	-21.2%
	TOTAL_OP	12673208	13237523	564315	4.5%
TOTAL	ALL	29059547	30461100	1401553	4.8%

* Home Based Work Direct and Home Based Work Special are combined as Home Based Work for NRTME
** Work-Based Other and Non-Home-Non-Work Trips are combined as Non-Home Based for NRTME

Both models include information on the number of users in various income groups, the proportion of users walking to transit at production end, and the proportion of users walking from transit at attraction end. These proportions are significantly different between the two models.

Due to the reasons mentioned above, the NJRTM-E model appeared more appropriate as compared to NJTDFM for the purpose of this study.

REFERENCES

1. D. Belzer, and G. Autler. *Transit Oriented Development: Moving from Rhetoric to Reality.* The Brookings Institution Center on Urban and Metropolitan Policy and The Great American Station Foundation, 2002.

2. R. Cervero. *Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects, TCRP Report 102.* Transportation Research Board, 2004.

3. J. E. Evans and R. Pratt. TCRP Report 95: Traveler Response to Transportation System Changes. *Transportation Research Board of the National Academies, Washington, DC*, 2007.

4. R. Ewing, and R. Cervero. "Travel and the Built Environment: A Meta-Analysis." *Journal of the American Planning Association*, Vol. 76 No. 3, 2010, pp 265-294.

5. G. B. Arrington, R. Cervero, National Research Council (U.S.). Transportation Research Board., United States. Federal Transit Administration., Transit Development Corporation., and Transit Cooperative Research Program. *Effects of TOD on Housing, Parking, and Travel.* Transportation Research Board, Washington, D.C., 2008.

6. X. Cao, P. L. Mokhtarian, and S. L. Handy. "Examining the Impacts of Residential Self-Selection on Travel Behaviour: A Focus on Empirical Findings." *Transport Reviews*, Vol. 29 No. 3, 2009, pp 359-395.

7. D. G. Chatman. "Residential Choice, the Built Environment, and Nonwork Travel: Evidence using New Data and Methods." *Environment and Planning A*, Vol. 41 No. 5, 2009, pp 1072-1089.

8. Cambridge Systematics Inc. "The Role of State DOTs in Support of Transit-Oriented Development (TOD)." , 2006.

9. R. Cervero, and G. B. Arrington. "Vehicle Trip Reduction Impacts of Transit-Oriented Housing." *Journal of Public Transportation*, Vol. 11 No. 3, 2008, pp 1-18.

10. K. Bartholomew, and R. Ewing. "Hedonic Price Effects of Pedestrian- and Transit-Oriented Development." *Journal of Planning Literature*, Vol. 26 No. 1, 2011, pp 18-34.

11. K. Bartholomew and R. Ewing. Hedonic Price Effects of Pedestrian and Transit-Oriented Development. *Working Paper*, 2010.

12. M. G. Boarnet, D. Houston, G. Ferguson, and S. Spears. Land use and Vehicle Miles of Travel in the Climate Change Debate: Getting Smarter than Your Average Bear. , 2010.

13. D. Chatman, and S. E. DiPetrillo. *Eliminating Barriers to Transit-Oriented Development.* New Jersey Dept. of Transportation, Trenton, NJ, 2010.

14. U.S. Environmental Protection Agency (EPA). "Location Efficiency and Housing Type - Boiling it Down to BTUs." , 2011.

15. T. Haas. *New Urbanism and Beyond : Designing Cities for the Future.* Rizzoli, New York, 2008.

16. W. P. Anderson, and T. R. Lakshmanan. *Assessing the Economic Benefits of Transit Projects.* Working Paper # CTS2000A, Boston University Center for Transportation Studies, 2000.

17. D. R. Bowes, and K. R. Ihlanfeldt. "Identifying the Impacts of Rail Transit Stations on Residential Property Values." *Journal of Urban Economics*, Vol. 50 No. 1, 2001, pp 1-25.

18. S. D. Bhatta, and M. P. Drennan. "The Economic Benefits of Public Investment in Transportation: A Review of Recent Literature." *Journal of Planning Education and Research*, Vol. 22 No. 3, 2003, pp 288-296.

19. S. Gibbons, and S. Machin. "Valuing Rail Access using Transport Innovations." *Journal of Urban Economics*, Vol. 57 No. 1, 2005, pp 148-169.

20. J. Berechman. *The Evaluation of Transportation Investment Projects.* Routledge, New York, 2009.

21. Yanmaz-Tuzel, O., K. Ozbay, S. Mudigonda, and B. Bartin. Quantification of Possible Impacts of Capacity Expansion Projects on Transportation Costs Via Trip-Based Full Marginal Cost Estimation Methodology. In *Transportation Research Board 87th Annual Meeting*, 2008.

22. K. Ozbay, B. Bartin, O. Yanmaz-Tuzel, and J. Berechman. "Alternative Methods for Estimating Full Marginal Costs of Highway Transportation." *Transportation Research Part A: Policy and Practice*, Vol. 41 No. 8, 2007, pp 768-786.

23. M. Aftabuzzaman, G. Currie, and M. Sarvi. "Evaluating the Congestion Relief Impacts of Public Transport in Monetary Terms." *Journal of Public Transportation*, Vol. 13 No. 1, 2010, pp 1-24.

24. D. J. Graham. "Agglomeration, Productivity and Transport Investment." *Journal of Transport Economics and Policy (JTEP)*, Vol. 41 No. 3, 2007, pp 317-343.

25. D. G. Chatman, and R. B. Noland. "Do Public Transport Investments Increase Agglomeration Economies? A Review of Literature and Agenda for Research." *Transport Reviews*, Vol. 31 No. 6, 2011, pp 725-742.

26. Y. Song, and G. J. Knaap. "New Urbanism and Housing Values: A Disaggregate Assessment." *Journal of Urban Economics*, Vol. 54 No. 2, 2003, pp 218-238.

27. D. B. Hess, and T. M. Almeida. "Impact of Proximity to Light Rail Rapid Transit on Station-Area Property Values in Buffalo, New York." *Urban Studies*, Vol. 44 No. 5, 2007, pp 1041.

28. S. Mathur, C. Ferrell, United States. Dept. of Transportation. Research and Innovative Technology Administration, California. Dept. of Transportation, Mineta Transportation Institute, and University Transportation Centers Program (US). *Effect of Suburban Transit Oriented Developments on Residential Property Values.* Mineta Transportation Institute, College of Business, San Jose State University, 2009.

29. M. Duncan. "The Impact of Transit-Oriented Development on Housing Prices in San Diego, CA." *Urban Studies*, Vol. 48 No. 1, 2011, pp 101-127.

30. M. Zhang. "Can Transit-Oriented Development Reduce Peak-Hour Congestion?" *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2174 No. 1, 2010, pp 148-155.

31. M. Zhang, and C. Yi. *Can Transit Oriented Developments Reduce Austin's Traffic Congestion?* SWUTC/06/167869-1, Southwest Region University Transportation Center, 2006.

32. L. E. Daniels. "Track Maintenance Costs on Rail Transit Properties." *Transit Cooperative Research Program* No. Web Only Document 43, 2008.

33. R. Cervero. "Alternative Approaches to Modeling the Travel-Demand Impacts of Smart Growth." *Journal of the American Planning Association.*, Vol. 72 No. 3, 2006, pp 285-295.

34. R. Cervero. *Methodology and Results for Forecasting Year 2025 Ridership among Three Land-Use Scenarios: Charlotte-Mecklenburg Transit-Land use Plan.* LDR International, Inc., Colombia, Maryland, 1998.

35. R. Cervero. *St. Louis MetroLink South Ridership Forecasts: Second Revised Estimates for Modified Alignments using Local and National “Direct” Ridership Forecasting Models.* HNTB, Inc., Kansas City, MO, 2004.

36. R. Cervero. "Transit-Oriented Development's Ridership Bonus: A Product of Self-Selection and Public Policies." *Environment and Planning A*, Vol. 39 No. 9, 2007, pp 2068-2085.

37. *Benefit-Cost and Job Creation/Economic Stimulus Analyses: Bloomfield Center Gateway and Access Improvements.* U.S. Department of Transportation, TIGER II Discretionary Grants Program, RITS Laboratory, 2010.

38. K. Ozbay, B. Bartin, S. Mudigonda, and S. Iyer. "Assist-Me: A Post-Processing Tool for Transportation Planning Model Output." *Transportation Research Record: Journal of the Transportation Research Board*, Vol. Accepted, 2013.

39. G. Duranton, and D. Puga. "Micro-Foundations of Urban Agglomeration Economies." *Handbook of Regional and Urban Economics*, Vol. 4, 2004, pp 2063-2117.

40. D. G. Chatman, R. B. Noland, N. K. Tulach, B. P. Grady, K. Ozbay, L. Rognlien, A. Desautels, L. Alexander, D. J. Graham, P. Bilton, D. Deka, N. Voorhoeve, N. Klein, and J. Berechman. *Methodology for Determining the Economic Development Impacts of Transit Projects.* Transit Cooperative Research Program, Web-Only Document 56, Transportation Research Board, Washington, D.C., 2012.

41. National Research Council (U.S.). Committee on Physical Activity, Health, Transportation,and Land Use., National Research Council (U.S.). Transportation Research Board., and Institute of Medicine (U.S.). *Does the Built Environment Influence Physical Activity? : Examining the Evidence.* Transportation Research Board, Washington, D.C., 2005.

42. A. L. Dannenberg, R. J. Jackson, H. Frumkin, R. A. Schieber, M. Pratt, C. Kochtitzky, and H. H. Tilson. "The Impact of Community Design and Land-use Choices on Public Health: A Scientific Research Agenda." , 2003.

43. C. Lee, and A. Moudon. "Physical Activity and Environment Research in the Health Field: Implications for Urban and Transportation Planning Practice and Research." *Journal of Planning Literature*, Vol. 19 No. 2, 2004, pp 147-181.

44. L. M. Besser, and A. L. Dannenberg. "Walking to Public Transit: Steps to Help Meet Physical Activity Recommendations." *American Journal of Preventive Medicine*, Vol. 29 No. 4, 2005, pp 273-280.

45. U. Lachapelle, L. Frank, B. E. Saelens, J. F. Sallis, and T. L. Conway. "Commuting by Public Transit and Physical Activity: Where You Live, Where You Work, and how You Get there." *Journal of Physical Activity & Health*, Vol. 8 Suppl 1, 2011, pp S72-82.

46. U. Lachapelle, and L. D. Frank. "Transit and Health: Mode of Transport, Employer-Sponsored Public Transit Pass Programs, and Physical Activity." *Journal of Public Health Policy*, Vol. 30, 2009, pp S73-S94.

47. M. Greenberg, J. L. Renne, R. Lane, and J. Zupan. "Physical Activity and use of Suburban Train Stations an Exploratory Analysis." *Journal of Public Transportation.*, Vol. 8 No. 3, 2005, pp 89-116.

48. R. E. Wener, and G. W. Evans. "A Morning Stroll." *Environment and Behavior*, Vol. 39 No. 1, 2007, pp 62-74.

49. B. B. Brown, and C. M. Werner. "A New Rail Stop: Tracking Moderate Physical Activity Bouts and Ridership." *American Journal of Preventive Medicine*, Vol. 33 No. 4, 2007, pp 306-309.

50. B. B. Brown, and C. M. Werner. "Before and After a New Light Rail Stop: Resident Attitudes, Travel Behavior, and Obesity." *Journal of the American Planning Association*, Vol. 75 No. 1, 2009, pp 5-12.

51. C. M. Werner, B. B. Brown, and J. Gallimore. "Light Rail use is More Likely on "Walkable" Blocks: Further Support for using Micro-Level Environmental Audit Measures." *Journal of Environmental Psychology*, Vol. 30 No. 2, 2010, pp 206-214.

52. C. M. Werner, and B. B. Brown. "Using Accelerometer Feedback to Identify Walking Destinations, Activity Overestimates, and Stealth Exercise in Obese and Nonobese Individuals." , 2008.

53. R. D. Edwards. "Public Transit, Obesity, and Medical Costs: Assessing the Magnitudes." *Preventive Medicine*, Vol. 46 No. 1, 2008, pp 14-21.

54. J. M. MacDonald, R. J. Stokes, D. A. Cohen, A. Kofner, and G. K. Ridgeway. "The Effect of Light Rail Transit on Body Mass Index and Physical Activity." *American Journal of Preventive Medicine*, Vol. 39 No. 2, 2010, pp 105-112.

55. R. J. Stokes, J. MacDonald, and G. Ridgeway. "Estimating the Effects of Light Rail Transit on Health Care Costs." *Health & Place*, Vol. 14 No. 1, 2008, pp 45-58.

56. R. Ewing, and E. Dumbaugh. "The Built Environment and Traffic Safety." *Journal of Planning Literature*, Vol. 23 No. 4, 2009, pp 347-367.

57. R. B. Noland, and M. A. Quddus. "A Spatially Disaggregate Analysis of Road Casualties in England." *Accident Analysis & Prevention*, Vol. 36 No. 6, 2004, pp 973-984.

58. R. B. Noland, N. Klein, and N. K. Tulach. "Do Lower Income Areas have More Pedestrian Casualties?" *Accident Analysis & Prevention*, Vol. in press, 2013.

59. M. M. Ishaque, and R. B. Noland. "Simulated Pedestrian Travel and Exposure to Vehicle Emissions." *Transportation Research Part D: Transport and Environment*, Vol. 13 No. 1, 2008, pp 27-46.

60. Kim JJ, Smorodinsky S, Lipsett M, Singer BC, Hodgson AT, and Ostro B. "Traffic-Related Air Pollution Near Busy Roads: The East Bay Children's Respiratory Health

Study." *American Journal of Respiratory and Critical Care Medicine*, Vol. 170 No. 5, 2004, pp 520-6.

61. R. Sturm, and D. A. Cohen. "Suburban Sprawl and Physical and Mental Health." *Public Health*, Vol. 118 No. 7, 2004, pp 488-496.

62. K. E. Portney, and J. M. Berry. "Participation and the Pursuit of Sustainability in US Cities." *Urban Affairs Review*, Vol. 46 No. 1, 2010, pp 119.

63. L. Freeman. "The Effects of Sprawl on Neighborhood Social Ties." *Journal of the American Planning Association*, Vol. 67 No. 1, 2001, pp 69.

64. K. M. Leyden. "Social Capital and the Built Environment: The Importance of Walkable Neighborhoods." *American Journal of Public Health*, Vol. 93 No. 9, 2003, pp 1546.

65. World Health Organization. Quantifying Burden of Disease from Environmental Noise: Second Technical Meeting Report. , 2005.

66. D. Ouis. "Annoyance from Road Traffic Noise: A Review." *Journal of Environmental Psychology*, Vol. 21 No. 1, 2001, pp 101-120.

67. E. Y. W. Seto, A. Holt, T. Rivard, and R. Bhatia. "Spatial Distribution of Traffic Induced Noise Exposures in a US City: An Analytic Tool for Assessing the Health Impacts of Urban Planning Decisions." *International Journal of Health Geographics*, Vol. 6 No. 1, 2007, pp 24.

68. D. A. Dillman. *Mail and Internet Surveys: The Tailored Design Method.* Wiley New York, 2000.

69. X. Cao, P. L. Mokhtarian, and S. L. Handy. "The Relationship between the Built Environment and Nonwork Travel: A Case Study of Northern California." *Transportation Research Part A*, Vol. 43 No. 5, 2009, pp 548-559.

70. B. Sehatzadeh, R. B. Noland, and M. D. Weiner. "Walking Frequency, Cars, Dogs, and the Built Environment." *Transportation Research Part A: Policy and Practice*, Vol. 45 No. 8, 2011, pp 741-754.

71. U. Lachapelle, and R. B. Noland. "Does the Commute Mode Affect the Frequency of Walking Behavior? the Public Transit Link." *Transport Policy*, Vol. 21, 2012, pp 26-36.

72. Walk Score. Walk Score Methodology. http://www.walkscore.com/methodology.shtml, Accessed 05/08, 2013.

73. D. Kravetz, and R. B. Noland. "Spatial Analysis of Income Disparities in Pedestrian Safety in Northern New Jersey." *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2320 No. 1, 2012, pp 10-17.

74. Zillow. What is a Zestimate? http://www.zillow.com/wikipages/What-is-a-Zestimate/, Accessed 12/19, 2012.

75. Zillow. New Jersey Data Coverage and Zestimate Accuracy. http://www.zillow.com/howto/DataCoverageZestimateAccuracyNJ.htm, Accessed 12/19, 2012.

76. State of New Jersey Dept. of the Treasury. General Tax Rates by County and Municipality. http://www.state.nj.us/treasury/taxation/lpt/taxrate.shtml, Accessed 12/19, 2012.

77. NYC Department of City Planning, Transportation Division. Manhattan Core Public Parking Study. , 2011.

78. Parsons Brinckerhoff Quade and Douglas Inc. *Cleveland Regional Travel Demand Forecasting Model Documentation Report.* Greater Cleveland Regional Transit Authority and the Northeast Ohio Areawide Coordinating Agency, 1998.

79. I. Barton-Ashman Associates. *Estimation, Calibration, and Validation of the Houston Mode Choice Model. Technical Report.* Metropolitan Transit Authority of Harris County, Houston, TX, 1993.

80. Parsons Brinckerhoff Quade and Douglas Inc. *Calibration of the Mode Choice Models for the Minneapolis-St. Paul Region.* Metropolitan Council, St. Paul, MN, 1993.

81. Parsons Brinckerhoff Quade and Douglas Inc. *Travel Demand Model Methodology Report.* North Illinois Regional Commuter Railroad Corporation (METRA), Chicago, IL, 1999.

82. K. H. Kim. *Technical Specifications for the March 1998 Travel Demand Model.* Metro Transportation Department, Portland, OR, 1998.

83. U.S. Environmental Protection Agency (EPA). COMMUTER Model Coefficients. , 2000.

84. M. Wardman. "A Review of British Evidence on Time and Service Quality Valuations." *Transportation Research Part E: Logistics and Transportation Review*, Vol. 37 No. 2, 2001, pp 107-128.

85. R. Liu, R. M. Pendyala, and S. Polzin. "Assessment of Intermodal Transfer Penalties using Stated Preference Data." *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1607 No. 1, 1997, pp 74-80.

86. Central Transportation Planning Staff (CTPS). *Transfer Penalties in Urban Mode Choice Modeling.* FTS, U.S. Department of Transportation, 1997.

87. K. Ozbay, B. Bartin, and J. Berechman. "Estimation and Evaluation of Full Marginal Costs of Highway Transportation in New Jersey." *Journal of Transportation and Statistics*, Vol. 4 No. 1, 2001, pp 81-103.

88. K. Ozbay, O. Yanmaz-Tuzel, S. Mudigonda, and B. Bartin. "Evaluating Highway Capacity Investments using a Geographic Information Systems-Based Tool: Trip-Based Full Marginal Cost Approach." *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2024 No. 1, 2008, pp 44-53.

89. K. Ozbay, O. Yanmaz-Tuzel, S. Mudigonda, B. Bartin, and J. Berechman. *Cost of Transporting People in New Jersey Phase 2 .* FHWA/NJ-2007-003, , 2007.

90. URS Corporation, Citilabs, AECOM, I. PB Americas, Urbitran Associates, Gallop Corporation, and Paragon. *North Jersey Regional Transportation Model Enhanced - Model Development Report.* North Jersey Transportation Planning Authority, 2008.

91. URS Corporation. *North Jersey Regional Transportation Model Enhanced - Users Guide Part 1.* North Jersey Transportation Planning Authority, 2008.

92. URS Corporation. *North Jersey Regional Transportation Model Enhanced - Users Guide Part 2.* North Jersey Transportation Planning Authority, 2008.

93. K. A. Small, and E. T. Verhoef. *The Economics of Urban Transportation.* Routledge, 2007.

94. U.S. Bureau of Labor Statistics. Table 1. Summary: Mean Hourly Earnings(1) and Weekly Hours for Selected Worker and Establishment Characteristics, New York-Newark-Bridgeport, NY-NJ-CT-PA CSA, may 2009. , 2009.

95. Yanmaz-Tuzel, O., K. Ozbay, and J. Holguin-Veras. Value of Travel Time Estimation for PANYNJ and NJ Turnpike Facilities Via Hierarchical Bayesian Mixed Logit Approach. In *88th Annual Meeting of the Transportation Research Board*, Washington, D.C., 2010.

96. D. J. Forkenbrock, and J. March. "Issues in the Financing of Truck-Only Lanes." *Public Roads*, Vol. 69 No. 2, 2005.

97. Holguin-Veras, J., and M. Bromm. Trucking Costs: Comparison between Econometric Estimation and Cost Accounting. In *87th Annual Meeting of the Transportation Research Board*, Washington, D.C., 2008.

98. U.S. Census Bureau. Profile of General Population and Housing Characteristics: 2010 Demographic Profile Data. http://factfinder2.census.gov/, Accessed July 12, 2012.

99. U.S. Census Bureau. 2006-2010 American Community Survey 5-Year Estimates. www.factfinder2.census.gov, Accessed September 11, 2012.

100. Murray, B. T. New Jersey Employers Add Workers in August. http://lwd.dol.state.nj.us/labor/lwdhome/press/2012/20120816_unemployment_release.html, Accessed September 20, 2012.

101. United States Department of Labor. United States Department of Labor. http://www.dol.gov, Accessed September 20, 2012.

102. The Township of Cranford. http://www.cranford.com, Accessed September 11, 2012.

103. Cranford Downtown Management Corporation. Downtown Cranford. http://www.cranford.com/downtown/, Accessed September 11, 2012.

104. District Management Corporation. 2011 Annual Report, Cranford Downtown. http://cranford.com/uploads/downtown/DMCAnnualReport2011.pdf, Accessed September 22, 2012.

105. NJ TRANSIT. http://www.njtransit.com/, Accessed July 20, 2012.

106. NJ TRANSIT. Average Weekday Ridership Data. , 2012.

107. NJ Department of Transportation. Transit Village Initiative. http://www.state.nj.us/transportation/community/village/, Accessed July 20, 2012.

108. Alan M. Voorhees Transportation Center. Cranford's Downtown Attracting Residents and Shoppers. http://policy.rutgers.edu/vtc/tod/newsletter/vol2-num2/tran_village_update_2.html#Cranford, Accessed September 13, 2012.

109. NJ Future. 2005 Smart Growth Award Winner: Cranford Crossing. http://www.njfuture.org/smart-growth-101/stories/2005-award/cranford-crossing/, Accessed September 11, 2012.

110. S. Magnola. Cranford Starts New Year Facing Multiple Lawsuits. *The Cranford Chronicle*, 2009.

111. S. Magnola. Township Considers Allowing Office Space at Crossing; Settles Lawsuit with Morgan. *The Cranford Chronicle*, 2009.

112. C. Hehl. Riverfront Moves Forward in Cranford. *Local Source: Union County Edition*, 2011.

113. Garden Commercial Properties. Riverfont at Cranford Station: Cranford, NJ. http://www.gardencommercial.com/pdf/riverfront.pdf, Accessed September 11, 2012.

114. Alan M. Voorhees Transportation Center. Municipal Spotlight: TOD in Cranford Township. http://policy.rutgers.edu/vtc/tod/newsletter/vol1-num2/article_cranford.html, Accessed September 13, 2012.

115. Alan M. Voorhees Transportation Center. Cranford Township Walkability Audit 2010 – Work Product. , 2010.

116. M. Walbaum. State Grants Cranford Coin for Construction. *Cranford Patch*, 2011.

117. T&M Associates. Township of Cranford Master Plan. http://mygreencranford.org/uploads/masterplan102909.pdf, Accessed September 11, 2012.

118. Cranford Bike Shop. http://www.cranfordbike.com/?page_id=67, Accessed September 11, 2012.

119. R. Hutchins. Flood-Related Problems are Increasing in Cranford, Fairfield. *The Star-Ledger*, 2011.

120. Cranford Dramatic Club. http://www.cdctheatre.org/, Accessed September 12, 2012.

121. Cranford Historic Society. http://www.cranfordhistoricalsociety.com/index.html, Accessed September 12, 2012.

122. Cranford Jaycees. http://www.cranfordjaycees.com/events, Accessed September 12, 2012.

123. Cranford Newcomers' Club
. http://www.cranfordnewcomers.org/index.php, Accessed September 12, 2012.

124. Cranford Canoe Club. http://cranfordcanoeclub.com/calendar.html, Accessed September 12, 2012.

125. New Jersey Department of Agriculture. Jersey Fresh. http://www.state.nj.us/cgi-bin/agriculture/jerseyfresh/, Accessed September 12, 2012.

126. G. Eisenberg. Township Authorizes Settlement of $650,000 for Parking Garage. *The Cranford Chronicle*, 2011.

127. New Jersey State Planning Commission. The New Jersey State Development and Redevelopment Plan. http://www.nj.gov/state/planning/plan.html, Accessed July 20, 2012.

128. New Jersey Department of Community Affairs. Building Permits: Yearly Summary Data. http://www.state.nj.us/dca/divisions/codes/reporter/building_permits.html, Accessed July 13, 2012.

129. The Morris Canal: A Brief History. http://www.morriscanal.org/history.htm, Accessed July 12, 2012.

130. M. Lurie, and M. Mappen. *The Encyclopedia of New Jersey.* Rutgers University Press, New Brunswick, 2004.

131. Morristown Partnership. Morristown Partnership. http://www.morristown-nj.org/, Accessed July 9, 2012.

132. NJ TRANSIT. NJ TRANSIT Celebrates 10-Year Anniversary of Midtown Direct. http://www.njtransit.com/tm/tm_servlet.srv?hdnPageAction=PressReleaseTo&PRESS_RELEASE_ID=2228, Accessed July 12, 2012.

133. Morristown Planning Board. Morristown Master Plan Re-Examination 2008. http://www.townofmorristown.org/vertical/sites/%7B0813EA2E-B627-4F82-BBB0-DDEE646947B5%7D/uploads/%7B9AD4A3C4-39AC-4AD4-8EAD-51A3D8ECB562%7D.PDF, Accessed July 12, 2012.

134. Tim Dougherty, Mayor of Morristown. http://www.timdoughertyformayor.com/issues.html, Accessed July 19, 2012.

135. The Town of Morristown. http://www.townofmorristown.org/, Accessed July 9, 2012.

136. Jonathan Rose Companies. Morristown, New Jersey. http://www.rosecompanies.com/all-projects/morristown, Accessed July 9, 2012.

137. NJ TRANSIT. NJ TRANSIT Restructures Morris County Bus Service. http://www.njtransit.com/tm/tm_servlet.srv?hdnPageAction=PressReleaseTo&PRESS_RELEASE_ID=2629, Accessed July 12, 2012.

138. AMLI on the Plaza. http://www.apartments.com/New-Jersey/Morristown/AMLI-on-the-Plaza/1524, Accessed July 19, 2012.

139. Amli on the Plaza. http://www.loopnet.com/Listing/16366299/Washington-Street-Morristown-NJ/, Accessed July 19, 2012.

140. The Point at Morristown. http://www.loopnet.com/xNet/MainSite/Listing/Profile/Profile.aspx?LID=17593892, Accessed July 19, 2012.

141. The Residences at Vail Mansion. vailmansion.com/, Accessed July 19, 2012.

142. Roseland Property. Vail Mansion, Morristown, NJ. http://www.roselandproperty.com/CORP_SITE/comm_sale_vail.html, Accessed July 19, 2012.

143. Woodmont Properties. The Residences at Vail Mansion, Morristown, New Jersey. http://www.woodmontproperties.com/vail-mansion-redevelopment.html, Accessed July 19, 2012.

144. Vail Mansion. http://www.loopnet.com/xNet/MainSite/Listing/Profile/Profile.aspx?LID=17393989&SRID=2699609000&StepID=101, Accessed July 19, 2012.

145. Morristown Redevelopment Agency. Agenda, June 7, 2011. http://www.townofmorristown.org/vertical/sites/%7B0813EA2E-B627-4F82-BBB0-DDEE646947B5%7D/uploads/RATM_6-7-11_Agenda_REVISED(1).PDF, Accessed July 19, 2012.

146. Coldwell Banker. Only Three Condos Remain at Vail Commons in Morristown, NJ. http://www.prlog.org/11039767-only-three-condos-remain-at-vail-commons-in-morristown-nj.html, Accessed July 19, 2012.

147. D. Tantleff. Personal Interview. , 2012, October 4.

148. L. C. Hochman. Godfather Brick Oven Coming to Highlands at Morristown Train Station. *The Star-Ledger*, 2012.

149. Roseland Property. The Highlands at Morristown Station, Morristown, NJ. http://www.roselandproperty.com/CORP_SITE/comm_rent_morristownst.html, Accessed October 4, 2012.

150. J. Lockwood. Upscale Residential Buildings Unveiled at Morristown Site of Former Epstein's Department Store. *The Star-Ledger*, 2010.

151. Emporis. The Metropolitan at 40 Park. http://www.emporis.com/building/the-metropolitan-at-40-park-morristown-nj-usa, Accessed July 19, 2012.

152. Emporis. 40 Park Place. http://www.emporis.com/building/40-park-place-morristown-nj-usa, Accessed July 19, 2012.

153. Roseland Property. The Metropolitan at 40 Park, Morristown, NJ. http://www.roselandproperty.com/CORP_SITE/coming_rent_metro.html, Accessed July 19, 2012.

154. D. Burns. Morristown and Roseland Property Company Steal the show at Annual NJBA Sales and Marketing Awards. *Morristown Patch*, 2011.

155. J. Dunphy. Early Work Begins at 'Morristown Square'. *Morristown Patch*, 2012.

156. PultyGroup, I. Morristown Square. http://www.pulte.com/communities/nj/morristown/morristown-square/, Accessed July 19, 2012.

157. Roseland Property. Shops on the Green, Morristown, NJ. http://www.roselandproperty.com/CORP_SITE/retail_40park.html, Accessed July 19, 2012.

158. Emporis. DeHart Street Parking Garage. http://www.emporis.com/building/dehart-street-parking-garage-morristown-nj-usa, Accessed July 26, 2012.

159. NJ Future. Epstein's Rehabilitation Plan and Implementation, Morristown. http://www.njfuture.org/smart-growth-101/stories/2007-award/morristown/, Accessed July 26, 2012.

160. T. Drobness. Morristown Station to Get Upgrade for Morris, Essex NJ Transit Lines. *The Star-Ledger*, 2009.

161. Alan M. Voorhees Transportation Center. Morristown Town Walkability Audit 2010 – Work Product. , 2010.

162. NJ TRANSIT. Parking Guide, 2010 Edition.

163. TransOptions. http://www.transoptions.org/, Accessed July 26, 2012.

164. Morris County Division of Transportation. Morris County Bicycle & Pedestrian User Guide. , n.d.

165. K. Coughlin. State Gives Flat Tire to Morristown Bike Plan. *MorristownGreen.Com*, 2011.

166. N. Morristown Town of. Morristown, NJ Complete Street Policy. , 2012.

167. Morristown, N., Town of. Land use Regulations. http://clerkshq.com/default.ashx?clientsite=morristown-nj, Accessed 2012, July 26.

168. Monmouth County, NJ, Open Public Records Search System. Assessment Records Search. http://oprs.co.monmouth.nj.us/oprs/External.aspx?iId=12, Accessed July 26, 2012.

169. E. Katen-Narvell. *Financial Benefits of Density in Two New Jersey Downtowns.* NJ Future, 2011.

170. NJ TRANSIT. Board Approves Agreement for Morristown Transit-Oriented Development Project. http://www.njtransit.com/tm/tm_servlet.srv?hdnPageAction=PressReleaseTo&PRESS_RELEASE_ID=2187, Accessed August 2, 2012.

171. NJ TRANSIT. NJ TRANSIT & Value Capture: Experience, Analysis & Strategies for the Future. , 2011.

172. Jonathan Rose Companies. *Interim Housing Element and Fair Share Plan.* , 2011.

173. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. Healthy Community Design. http://www.cdc.gov/healthyplaces/docs/Healthy%20Community%20Design.pdf, Accessed July 26, 2012.

174. The Morristown Green. Events at the Morristown Green. http://themorristowngreen.org/events.html, Accessed August 2, 2012.

175. The Morristown & Morris Township Library. http://www.jfpl.org/, Accessed August 2, 2012.

176. Mayo Performing Arts Center. http://www.mayoarts.org/, Accessed August 2, 2012.

177. Rahway, N. Rahway Facts & Figures. http://www.cityofrahway.com/facts_figures_2003.htm, Accessed July 27, 2012.

178. McTeague, L. B. Rahway History. http://www.cityofrahway.com/history1.htm, Accessed July 12, 2012.

179. I. Peterson. A Company Move that Hasn't Irked the Neighbors. *The New York Times*, 1992.

180. Alan M. Voorhees Transportation Center. Municipal Spotlight: The Resurgence of Rahway. http://njtod.org/municipal-spotlight-the-resurgence-of-rahway/, Accessed June 7, 2013.

181. E. Caroom. Rahway Shifts Funding to Mayor's Arts. *The Star-Ledger*, 2010.

182. E. Caroom. Rahway Mayor Will Not Seek Reelection. *The Star-Ledger*, 2010.

183. New Jersey State League of Municipalities. The Faulkner Act: New Jersey's Optional Municipal Charter Law. http://www.dudley-2010.com/Faulkner%20Act%2046pages.pdf, Accessed August 2, 2012.

184. Rahway, N. Municipal Council. http://www.cityofrahway.com/municipal_council.htm, Accessed August 2, 2012.

185. Hrywna, M. Rahway Rising. www.rahwayrising.com, Accessed July 23, 2012.

186. Personal Interview. , 2012, August 3.

187. E. Caroom. Tower at Heart of Rahway's Rebirth Headed for Foreclosure," *the Star-Ledger*, 1 December 2010. *The Star-Ledger*, 2010.

188. NJ Future. 2008 Smart Growth Award Winner: Park Square, Rahway. http://www.njfuture.org/smart-growth-101/stories/2008-award/rahway-2/., Accessed September 12, 2012.

189. Park Square. http://parksquareonline.com/, Accessed July 13, 2012.

190. C. Bonny. Email Correspondence. , 2012.

191. Brookside at Rahway. www.brooksideatrahway.com, Accessed July 23, 2012.

192. Rahway, N. RCP, City to be Recognized for Train Station Plaza. http://www.cityofrahway.com/pr/pr_train_station_recognized.htm, Accessed July 20, 2012.

193. Alan M. Voorhees Transportation Center. Rahway City Walkability Audit 2010 – Work Product. , 2010.

194. Rahway Parking Authority. www.rahwayparking.org, Accessed July 23, 2012.

195. Rahway River Park. , 2006.

196. CME Associates. Master Plan for the City of Rahway. , 2004.

197. NJ Department of Environmental Protection. *NJ Geographic Information System.* , 2007.

198. Official Zoning Map of the City of Rahway, NJ.

199. Rahway, N. Zoning Regulations. http://www.ecode360.com/9586854, Accessed July 17, 2012.

200. Greener by Design. *City of Rahway Green Building and Sustainability Master Plan Element.* , 2008.

201. Rahway Arts & Culture. www.artsrahway.com, Accessed July 26, 2012.

202. Artists Guild of New Jersey. www.agnj.org, Accessed July 26, 2012.

203. Union County Performing Arts Center. http://ucpac.org/index.cfm, Accessed July 26, 2012.

204. Hamilton Stage for the Perfrming Arts Center. http://hamiltonstage.com/, Accessed July 26, 2012.

205. Rahway River Association. www.rahwayriver.org, Accessed July 26, 2012.

206. E. Caroom. Community Garden Gains Ground in Rahway. *Star-Ledger, the (Newark, NJ)*, 2010.

207. Merchants and Drovers Tavern Museum. www.merchantsanddrovers.org, Accessed July 26, 2012.

208. Abeles Phillips Preiss & Shapiro. Master Plan for the City of Rahway. , 2006.

209. The Rahway Taste of Spring. rahwaytaste.com, Accessed July 26, 2012.

210. Rahway Center Partnership. rcpnj.blogspot.com, Accessed July 26, 2012.

211. J. Kennedy. Personal Interview. , 2012.

212. E. Quinn. Personal Interview. , 2012.

213. S. Steinman. Personal Interview. , 2012.

214. N. Levine, D. Lord, and B. Park. Crimestat Version 3.3 Update Notes: Part 2: Regression Modeling. , 2010.

215. N. Levine. CrimeStat: A Spatial Statistics Program for the Analysis of Crime Incident Locations. , 2010.

ABOUT THE AUTHORS

ROBERT B. NOLAND, PH.D.

Robert B. Noland is a professor at the Edward J. Bloustein School of Planning and Public Policy and serves as the director of the Alan M. Voorhees Transportation Center. He received his Ph.D. in Energy Management and Environmental Policy from the University of Pennsylvania. Prior to joining Rutgers University, he was Reader in Transport and Environmental Policy at Imperial College London and a policy analyst at the U.S. Environmental Protection Agency. He also conducted postdoctoral research in the Economics Department at the University of California, Irvine. The focus of Dr. Noland's research is the impacts of transport planning and policy on both economic and environmental outcomes. Work on economic effects has included examining behavioral reactions to changes in reliability, associations with the built environment and trip-chaining behavior. Environmental work includes impacts on safety, climate, health, and other factors associated with overall quality of life. Active research areas include developing methods to evaluate the life cycle greenhouse gas emissions associated with building transport projects; evaluating the economic impacts of transit-oriented development; analysis of walking behavior and links to other travel behavior and the built environment; analysis of traffic and pedestrian safety using spatial analysis techniques; and, assessment of the economic effects of transport investments, in particular those associated with agglomeration externalities. Dr. Noland's research has been cited internationally in debates over transport infrastructure planning and environmental assessment of new infrastructure. He is currently associate editor of *Transportation Research-D (Transport and Environment)* and the *International Journal of Sustainable Transportation* and chair of the Transportation Research Board Special Task Force on Climate Change and Energy.

KAAN OZBAY, PH.D.

Kaan M.A. Ozbay has joined Department of Civil and Urban engineering and Center for Urban Science and Progress (CUSP) at NYU on August 2013. Professor Ozbay was a tenured full Professor at the Rutgers University Department of Civil and Environmental Engineering until July 2013. He joined Rutgers University as an Assistant Professor in July, 1996. In 2008, he was a visiting scholar at the Operations Research and Financial Engineering (ORFE) Department of Princeton University. Dr. Ozbay's research interests in transportation cover a wide range of topics including the development of simulation models of large scale complex transportation systems, advanced technology and sensing applications for Intelligent Transportation Systems, modeling and evaluation of traffic incident and emergency management systems, feedback based on online, real-time traffic control techniques, traffic safety, application of operations research techniques in network optimization and humanitarian inventory control, and transportation economics.

Dr. Ozbay is the recipient of the prestigious National Science Foundation (NSF) CAREER award. He has published approximately 300 refereed papers in scholarly journals and conference proceedings and serves as the associate editor of *Networks and Spatial Economics* and *Transportmetrica B: Transportation Dynamics*. He is also a member of the editorial board of the *ITS* journal. In 2013, Dr. Ozbay served as the elected member of the Board of Directors of the Intelligent Transportation Society of New Jersey. He is also a current member of the Board of Directors of the University Transportation Research Center (UTRC) at the City University of New York – USDOT's Region 2 University Transportation Center. Since 1994, Dr. Ozbay, has been the Principal Investigator and Co-Principal Investigator of 80 projects funded at a level of more than $12,000,000 by National Science Foundation, NJDOT, NYMTC, NY State DOT, New Jersey Highway Authority, USDOT, FHWA, VDOT, CUNY University Transportation Research Center (UTRC), Department of Homeland Security, and USDOT ITS Research Center of Excellence. He was the founding director of the Rutgers Intelligent Transportation Systems (RITS) laboratory that led ITS research and education activities at Rutgers University until 2013.

STEPHANIE DIPETRILLO

Stephanie DiPetrillo is Senior Research Specialist at the Alan M. Voorhees Transportation Center, Rutgers University. She has more than 10 years of experience in transportation and urban planning research, as well as in historic preservation, architecture, and urban design. Her current work combines quantitative and qualitative techniques and principally examines connections between transportation and land use, chiefly transit, community transportation, and transit-oriented development (TOD). Past works include: *Eliminating Barriers to TOD, Economic Development Benefits of New Transit Service: RiverLINE*, and *The Impact of Demographic Changes in Transit Patterns in New Jersey*, all funded by the NJ DOT Research Bureau; and *An Evaluation of Property Values in New Jersey Transit Villages* funded by the New Jersey Association of Realtors Governmental Research Foundation.

She recently completed two projects that examined community transportation and its ability to serve people with disabilities in traveling to work. The first, *A Strategy for Getting People with Disabilities to Work: Supporting NJ County Transportation*, looked closely at the financial underpinnings of New Jersey's county transportation providers, as well as national best practices for efficient and effective provision of community transportation. The second, *Connecting to Jobs by Connecting to Transit*, sought to develop, pilot, and refine a transportation orientation program for employment counselors working with people with disabilities. She is the editor of the online publication, *NJTOD.org*, home to a transit-friendly development newsletter, sponsored by NJ TRANSIT, and is an advisor to The TOD Line, an online newsletter of TOD in New York and Connecticut. She has taught at Hofstra University, Rutgers University, and the New Jersey Institute of Technology (NJIT). Ms. DiPetrillo holds a BA in Economics, a Master of City and Regional Planning (MCRP) from Rutgers, and a Master of Architecture from NJIT.

SHRI IYER

Shri Iyer was a Researcher in the Rutgers Intelligent Transportation Systems (RITS) Laboratory at Rutgers University from 2010-2013. At RITS Lab, his research interested included transportation modeling, economics of transportation investments, analysis of policy initiatives, and mode shift to public transit. He has experience on several federal- and state-funded research projects related to this study including *Costs of Highway and Transit trips in the NY/NJ Region*, *Elimination of Weight Restrictions on Rail Lines*, *Feasibility of*

Freight Villages in the NYMTC Region, *Impacts of the NJ Rail Grants Program*, *Handheld Devices on Rail for Fare Collection and Communication*, *Transit Origin-Destination Estimation Using Advanced Technologies*, and *Using GPS Data from Taxis to Understand Public Transit Demand and Choice*. Shri is currently employed as a Principal Transportation Planner at MTA New York City Transit.

MNTRC
MINETA NATIONAL TRANSIT RESEARCH CONSORTIUM

SAN JOSÉ STATE
UNIVERSITY

Funded by U.S. Department of
Transportation