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Economic Impacts of Bus Rapid Transit in Southeast Michigan

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MNTRC Report 12-34

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ECONOMIC IMPACTS OF BUS RAPID TRANSIT IN SOUTHEAST MICHIGAN

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16. Abstract

In recent years, Bus Rapid Transit (BRT) has generated great interest across the United States. There are more than 20 BRT systems in existence, and more are in the planning stage (including in Detroit). Within the next few years, BRT will be planned and implemented phase by phase in various parts of Southeast Michigan. The purpose of this study is to develop a framework to identify probable economic impacts of BRT in Southeast Michigan.

Taxable real estate values, injury and fatal crash data, and selected demographics of BRT users, including employment sector, age group, median income, and daily vehicle miles traveled were reviewed to identify Southeast Michigan's current and future trends.

The project team also performed shift-share analysis using Cleveland and Kansas City data to determine the BRT-advantaged age group. The authors recommended a number of action items to attract choice riders and gratify riders who must rely on BRT, such as tax incentives, branding, guaranteed levels of service, etc. Based on the literature review and analysis of existing BRT-related data by the project team, BRT-advantaged job sectors and age groups within the Southeast Michigan region were identified. BRT will be implemented in phases. This will affect the amount, type, and timing of investments in BRT. Considering this uncertainty, the potential economic impacts as a function of type and amount of investment were discussed. It is to be noted that in order to achieve the projected results, the BRT system must be planned, designed, and implemented based on the unique attributes of the Southeast Michigan region rather than by copying a system that has achieved success in another region.

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DISCLAIMER

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EXECUTIVE SUMMARY

In recent years, Bus Rapid Transit (BRT) has generated great interest across the United States and around the world. There are more than 20 BRT systems in existence, and more are in the planning stage, including in the Detroit metro region (Figure 1). Within the next few years, BRT will be planned and implemented phase by phase in the Southeast Michigan counties of Wayne, Oakland, Macomb and Washtenaw. This study aims to synthesize available evidence related to performance, cost, and impact of BRT and other transit systems and to develop a framework to identify potential economic benefits (quantitative and qualitative) of BRT in its broader use in Southeast Michigan. The main focus of the literature review was to identify:

- Physical features of a number of BRT systems in the US.
- Job sectors that experience growth near BRT and other forms of transit ("BRT-advantaged" job sectors).
- Economic development impact within the BRT sheds in various cities currently using BRT.
- The effect of BRT station proximity on property values.

To identify current and future trends for the region, the authors analyzed the past 5 to 10 years of taxable real estate values, injury and fatal crash data, and specific demographics, including employment sector, age group, median income, and daily vehicle miles traveled.

They also performed shift-share analysis using Cleveland and Kansas City (heavy and light BRT system) data to determine the BRT-advantaged age groups and recommended a number of action items to attract "choice" riders (riders who choose transit over other available modes) to the planned BRT system and gratify those who must rely on transit. These recommendations include tax incentives, guaranteed levels of service, branding, and others.

Findings of this study are:

- The population density, travel-time-to-work, and average household size of the Southeast Michigan region are very comparable to other BRT cities.
- Based on the experiences of other cities, "heavy" BRT implementation is more effective than "light" BRT in producing economic benefits.
- If the trend seen in other BRT cities holds for Southeast Michigan, the region should see more land development and jobs, improvements in ridership and tax bases, and reductions in travel cost.
- Capital investment in a BRT system will produce a number of short-term, construction-related jobs. Due to the multiplier effect, these jobs will benefit the region economically during the construction process.

- Operational investment will generate long-term, government/transportation-related jobs (drivers, ticket checkers, maintenance and security staff, and others).

- Rather than simply duplicating a system that has been successful elsewhere, careful consideration should be given to the region's unique attributes (e.g., roadway characteristics, job locations, etc.) during the planning, design, and implementation stages, and the system should be tailored to meet the region's needs.

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I. INTRODUCTION

Bus Rapid Transit (BRT) has generated great interest among small and large cities across the United States (Detroit, MI, Grand Rapids, MI, and Aspen, CO, for example) as a means of improving mobility and accessibility, and optimizing use of street space, at a relatively modest cost per mile ($10-$27 million).[1] The main advantage of BRT is its ability to operate on all types of road infrastructures: mixed-flow arterials, mixed-flow freeways, dedicated arterial lanes, at-grade or fully grade-separated transitways, managed lanes, and tunnels.[2] Southeast Michigan officials have selected BRT as their preferred choice of future public transit. Within the next few years (most likely starting beginning in 2016), BRT will be planned and implemented phase by phase in the Southeast Michigan counties of Wayne, Oakland, Macomb, and Washtenaw. This study aims to synthesize available evidence regarding BRT (also other transit system) performance, cost and impact to identify the potential economic impacts of BRT for Southeast Michigan and to determine which among the various component elements and features available for BRT systems would potentially provide the greatest benefits, given the region's unique characteristics. Based on the literature review and data analysis, a range of comparative performance and cost indicators for a variety of BRT systems are presented as a part of this report.

WHAT IS BRT?

BRT has been defined by the Federal Transit Administration (FTA) as a *rapid mode of transportation that can provide the quality of rail transit and the flexibility of buses.*[3] Transit Cooperative Research Program (TCRP) Report 90 expanded this definition to "a rubber-tired form of rapid transit that can combine stations, vehicles, services, runways, and ITS (Intelligent Transportation System) elements into an integrated system with a strong image and identity."[4] In other words, BRT is an integrated system of facilities, equipment, services, and amenities that improves the speed, reliability (level of service), and identity of bus transit. In many respects, BRT is a hybrid, rubber-tired, light rail transit (LRT) with greater operating flexibility and relatively lower implementation cost.[5] While BRT provides substantial opportunity to address mobility problems at a lower cost, the size and population density of many US cities have posed unique challenges for BRT implementation, such as short-term inconvenience during construction. Especially, in older cities, such as Detroit and its metropolitan region, issues such as traffic impacts, physical separation, and underground infrastructure (utilities, power lines, gas pipeline, sewage system, etc.) are of great concern and may inhibit the fast and effective implementation of transit systems such as LRT and BRT. This is particularly true in areas where road infrastructure and street grids developed more than a century ago due to the potential for encountering unknown objects and systems that may require substantial time to remove.

WHY CONSIDER BRT?

According to TCRP Report 118, communities consider BRT a preferable mode of transportation for following reasons:[6]

- BRT can be implemented either incrementally in phases or all at once because it uses an existing right-of-way (ROW). Phase-by-phase implementation allows

time to assess public response and make appropriate adjustments. One of the advantages of completing the system all at once is the elimination of the need to repeat construction protocols, such as obtaining permits, performing environmental impact studies (EIS), etc.

- BRT is a flexible and cost-effective (from $10 to $27 million per lane-mile vs. LRT at close to $50 million per lane-mile) rapid-transit system that can serve a variety of urban and suburban constituents.

- BRT can provide express and local services on a single system.

- BRT has the necessary attributes (easy boarding, speed, attractive and environmentally friendly vehicles, and distinctive system identity) to attract patrons from other modes. Also, off-vehicle fare collection and multi-door access tend to expedite passenger boarding.

- BRT can be effectively integrated into the surrounding environment and has proven to generate significant urban development benefits based on the experience of the Ottawa Transitway system, the Pittsburgh East and West Busway, the Boston Silver Line, and others.[7]

SOUTHEAST MICHIGAN AND ITS FUTURE MODE OF TRANSPORTATION

The Southeast Michigan region considered for this study consists of four counties: Macomb, Oakland, Washtenaw, and Wayne, which includes the City of Detroit (core city of the region). These four counties comprise the region covered by the Regional Transit Authority of Southeast Michigan (RTA). As the metropolitan planning organization (MPO) designated for the southeast Michigan region, the Southeast Michigan Council of Governments (SEMCOG), along with local government elected officials, has selected BRT as the mode of choice for future public transportation.

As a part of the selection process (which was based on the multi-weighted scoring model), a group of professionals led by SEMCOG rated three alternatives against a set of criteria using a scale of 1-5, with 5 being the best (Table 1). Each criterion was given a relative weight by a panel of professionals. Reliability of the system was assigned the highest weight, followed by economic development.[8] It is estimated that BRT daily ridership will be around 35,000 along the Woodward Avenue corridor from downtown Detroit to Birmingham.[9] It is to be noted that existing daily bus ridership along this route is around 13,000.[10] For this selection process, no information is available about the composition of professionals or their individual scores.

While the multi-weighted scoring model may yield a numerical solution to the project selection process, the final decision is always made by people (in this case elected officials). Models are tools for guiding the evaluation process to ensure that decision makers consider relevant issues (criterion and weight). This is a much more subjective approach than calculation suggests; thus, from a statistical standpoint, the significance of differences among competing projects in total weighted scores is of lesser concern.

Table 1. Evaluation of Alternative Transit System in Southeast Michigan

Evaluation Criteria	Weight Sum = 1.0	Rating Scale 1-5 (5 = best) BRT Mixed Traffic	BRT Exclusive Lane	LRT Exclusive Lane
Phasing ability of Implementation plan	0.05	5	3	1
Feasibility of system	0.10	5	4	1
Integration with Existing Transit System (feeder routes)	0.05	4	4	2
Capital Cost	0.15	5	3	1
Operational/Maintenance cost	0.05	5	3	1
Ridership Potential	0.10	1	3	5
Economic Development Potential	0.20	3	4	5
Reliability of System	0.25	3	5	5
Social Equity	0.05	3	3	3
Total Score by Alternative		3.55	3.85	3.35

Source: SEMCOG.[11]

Given the selection of BRT as the preferred future mode of public transportation in Southeast Michigan, the objective of this study is to explore its probable economic impacts by examining attributes of various existing BRT systems.

Starting in 2017, the region will also include an M-1 Rail streetcar system. Since July 2014, using primarily private financing, a 3.3-mile-long M-1 Rail streetcar route has been under construction from downtown Detroit to Grand Boulevard (near the location of the Amtrak train station). It is planned to provide passenger service by late 2017. The streetcar's primary purpose is to serve the business community along the 3.3 mile segment. It will be operated by a private entity (M-1 Rail) for the first 7 years and then handed over to the Regional Transportation Authority (RTA). The planned BRT, on the other hand, is a one-hundred-percent public entity under the control of the RTA. Its primary purpose is to serve the residents of Southeast Michigan. Because M-1 Rail uses private financing, it is not required to adhere to "Buy American" standards or other federal requirements; the planned BRT must comply with federal requirements.

BRT FACILITIES IN THE USA

Bus Rapid Transit can be classified as light BRT and heavy BRT. Light BRT shares road infrastructure with other traffic and costs approximately $1 million to $3 million per mile, whereas heavy BRT uses dedicated lanes and costs approximately $10 million to $27 million per mile.[12] Various types of BRT vehicle configurations are presented in Appendix Figure A1. As shown in Figure 1, there are more than twenty existing BRT systems (red stars) across the USA, with others (gold stars) in the planning stages.

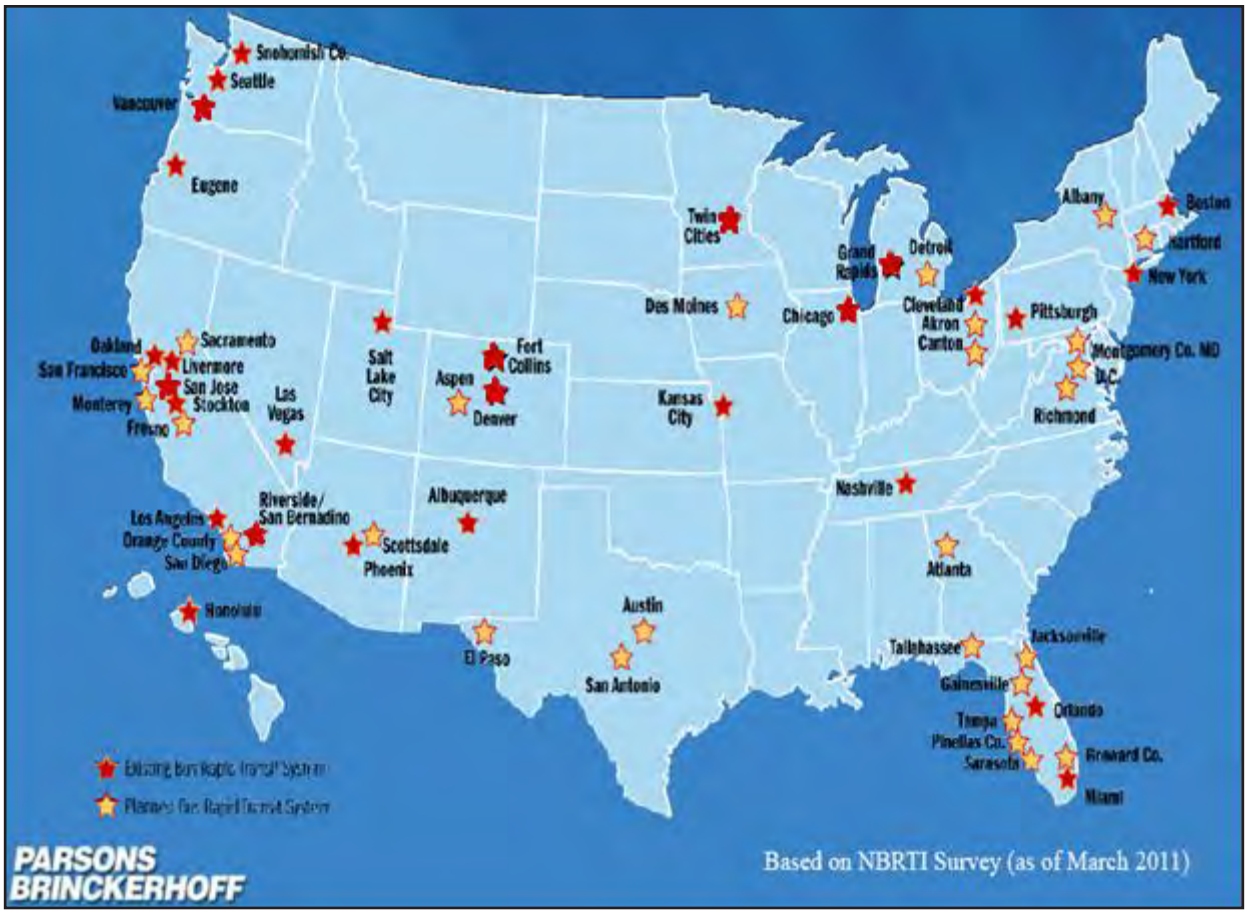

Figure 1. Existing and Planned BRT Systems in the US

Source: "What is BRT," Parsons Brinckerhoff.[12]

In addition to an improved riding experience due to reduced travel times, reduced passenger loading times, and improved climate control (compared to buses), most BRT systems in the US feature a higher level of station amenities and other unique features typically not seen with bus service.[13] Table 2 catalogs the physical features of 15 existing BRT systems. It indicates that:

- 80% have station amenities that include platform-level boarding, security cameras, public art, and landscaping.
- 33% use dedicated lanes.
- 100% use some form of a unique branding (a memorable name, for example, such as "HealthLine," rather than a generic name, such as "bus").
- 60% use Intelligent Transportation System (ITS) features, such as signal pre-emption.

Table 2. Physical Features by Existing BRT Systems in the USA

System (Location)	Dedicated Lanes	Station Amenities	Off-board Fare Collection	Branding and Marketing	ITS Features
Health Line (Cleveland, OH)	X	X	X	X	X
Franklin EmX* (Eugene, OR)	X	X	X	X	X
Gateway, EmX* (Eugene, OR)	X	X	X	X	X
Rapid Ride A (Seattle, WA)	X	X		X	
M15 (New York, NY)	X			X	
RTC Rapid (Reno, NV)		X	X	X	X
BusPlus (Albany, NY)		X	X	X	X
Metro Express 44 (San Joaquin, CA)		X	X	X	X
Boulder Hwy Express (BHX) (Southern, NV)		X	X	X	
Troost MAX (Kansas City, MO)		X		X	X
The Rapid (Livermore, CA)		X		X	X
Rapid Ride B (Seattle, WA)		X		X	
Mountain Links (Northern AZ)		X		X	
MetroRapid* (Los Angeles, CA)				X	X
Metro Rapid 741* (Los Angeles, CA)				X	
Total	**5**	**12**	**7**	**15**	**9**

* Indicates branding of BRT lines serving different corridors within the same region.

Source: Adapted from GAO.[14]

II. LITERATURE REVIEW

BRT has been in existence in North America for more than thirty years.[15] Data on the potential impact of BRT on ridership, development along corridors, job sectors, land values, and other elements are fragmented. As part of this study, the authors attempted to identify the influence of BRT in terms of employment sectors, ridership, system-related investment, property values, and job creation by examining the experiences of cities where BRT is in use. This review explores economic impacts by highlighting them from two different but closely connected categories: 1) impacts of BRT presence on the community and 2) investment-related impacts of BRT implementation.

IMPACTS OF BRT PRESENCE ON THE COMMUNITY

Nelson, et al. (2013) conducted a study to determine BRT-advantaged job/employment sectors by performing a shift-share analysis along the Eugene-Springfield BRT system.[16] A BRT-advantaged job sector is one whose growth rate within the BRT shed is greater than the growth rate for that sector in the larger metropolitan area during the same time period. The objective of this study was to assess the relationship between BRT and the change in share or concentration of jobs by sector in an urban area in the first decade of the twenty-first century. Shift-share analysis is a well-established technique for disaggregating regional measures into component parts, but the literature review shows it has rarely been used in transit analysis.[17] Employment sector data reported at the two-digit-level of the North American Industrial Classification System (NAICS) for two periods – 2004 and 2010 – were used in this context. Nelson, et al. concluded that a number of job sectors, specifically Retail Trade, Transportation and Warehousing, Finance and Insurance, Real Estate and Rental Leasing, Education, Administrative Service, Information, and Other Service, appear to be attracted to BRT station areas or zones (Table A-1). However, it was stated that a cause-and-effect relationship between BRT proximity and growth of certain types of jobs could not be conclusively established.

The Center for Transit-Oriented Development (CTOD 2014) showed similar findings for transit. That study analyzed job sectors by transit shed. (Transit shed is defined as the aggregate of transit zones for a transit region. A transit zone is the area within a half-mile radius of a station. See Figure A-6). According to CTOD, within the 37 transit sheds studied, a total of 29% of workers were employed in knowledge-based sectors (NAICS code 51–55) – which include Information, Finance and Insurance, Real Estate and Rental Leasing, and Management of Companies and Enterprises – and 26% are employed in Educational and Health Service sectors (NAICS code 61–62).[18] This is similar to the BRT-advantaged job sectors. It is to be noted that Eugene, Oregon, has a relatively high share (almost 30%) of transit-accessible employment due to its BRT system.

In another study, Miller, et al. (2014) applied shift-share analysis to the Independence Avenue BRT corridor in Charlotte, North Carolina, to identify BRT-influenced job sectors. This outcome was different. This study identified the Health sector as the only BRT-advantaged job sector. The Independence Avenue BRT corridor is atypical in that it contains are no passenger loading stations.[19] The authors of the current study believe that this lack of compliance with BRT “best practices” is the reason the corridor has been unable to attract jobs.

To examine the character of employment clusters located near transit, CTOD (2011) examined 34 metropolitan areas (regions) in the US that had commuter rail, light rail, trolley, streetcar, and/or bus rapid transit (BRT) corridors with designated lanes (Table 3). This study provides information regarding the influence of transit (including BRT) on the type and number of jobs in the various employment clusters. Systems were designated as small, medium, large, or extensive, based on the number of stations. Station Area (or Transit Zone) and Transit Region were defined as follows:

- Station Area/Transit Zone: the area surrounding a transit station defined by a circle with a half-mile radius.

- Transit Region: a metropolitan region containing at least one transit corridor that has been geographically designated as such by the Center for Neighborhood Technology.

Table 3. Regional Transit Systems by Size

Small (1-24 Stations)	Medium (25-69 Stations)	Large (70-200 Stations)	Extensive (200+ Stations)
Albuquerque	Atlanta	Los Angeles	Chicago
Buffalo	Baltimore	Pittsburg	New York
Eugene	Charlotte	Portland	Philadelphia
Galveston	Dallas		San Francisco
Harrisburg	Denver		
Houston	Miami		
Jacksonville	Sacramento		
Las Vegas	Seattle		
Little Rock	St. Louis		
Memphis			
Minneapolis-St. Paul			
Nashville			
New Orleans			
Salt Lake City			
Syracuse			
Tampa			

Adapted from CTOD 2011.[20]

The key findings of this study are:

- Approximately 25% of all jobs in the transit regions studied are located near a transit station. In 2008, 23% of all employment (14 million jobs) in transit regions were located within a half mile of an existing transit stop.[21] It is to be noted that this transit group includes heavy BRT, along with light rail, streetcar, trolley, etc.

- The greater the number of stations in a region's transportation system, the greater the share of its jobs were accessible by transit.

- Station areas exhibited a 1% increase in absolute employment despite positive and negative growth in individual job sectors.

- Sectors that exhibited especially strong growth in the area within a half mile of a station from 2002 to 2008 were arts, entertainment, recreation, food service and accommodation (each growing by 14%), health care (10% growth) and social assistance (9% growth). At the same time, a 22% drop in manufacturing jobs within the transit zones was observed.[22] It was stated that the drop in manufacturing jobs can be attributed to the relocation of these sectors to properties outside the transit zone and conversion of industrial land to high-density residential and commercial office use.

- In 2008, 42% of all public sector jobs were located in transit zones. Public sector jobs are placed near transit as a matter of policy to support the transit system.

- About 36% of jobs in professional, scientific, and technical services are located within a half mile of a transit station – that is, in the transit zone.

This study also documented the employment composition of transit regions and transit zones by industry group as shown in Table 4. NAICS job codes for job sectors are also included in Table 4. However, this classification is not identical to the previously cited classification. Some sectors, such as education and health care represent a mix of basic and non-basic industries. For example, elementary, secondary, and high schools, as well as community colleges, are primarily resident-serving entities. They are funded by government, and always located close to users. Community-serving hospitals under this category tend to be located where there is a need or demand. The education and health care sectors, which also include universities and research institutions, tends to serve larger populations and may draw funding from national or international sources. As such, they are less user-centric and more opportunistic in their location decisions. For example, people travel to Cleveland Clinic from all over the world; its location is not an issue. The same is true for institutions of higher education. Due to these similarities, the authors have consolidated these two sectors for purposes of this study.

Table 4 reveals the following:

- Transit zones tend to contain a far higher percentage (27%) of knowledge-based jobs than do transit regions (19%).

- Government jobs (public administration) comprise 6.4% of station-area jobs, but only 3.6% of jobs in the broader transit region.

- For health care and educational industry groups, zone and regional distribution are nearly equal (21.6% vs. 20.7%).

- Both retail (8% for the transit zone vs. 11% for the region) and production, distribution, and repair (PDR) jobs (12% for the transit zone vs. region 18% for the region) comprise a considerably smaller share of jobs in the station area than in the transit region as a whole.[23]

Table 4. Employment by Industry Share in Transit Regions and Zones – Year 2008

		Industry Share (%) of Jobs by Location	
Industry Group	**NACIS Codes**	**Transit Regions**	**Transit Zones**
Natural Resources	11, 21	0.6	0.3
Retail Trade	44-45	11.0	7.6
Production, Distribution and Repair (PDR)	31-33, 42, 48-49	17.6	12.4
Knowledge-Based	51-55	19.3	27.0
Education and Health Care	61-62	20.7	21.6
Entertainment	71-72	10	11
Public Administration	92	3.6	6.4
Others (Construction, Utilities, Waste Management)	22-23, 56, 81	17.2	13.7
Total of All Industries		**100**	**100**

Source: COTD, 2011.[24]

The Government Accountability Office (GAO) conducted a study in 2012 to quantify the economic development impact of BRT. As a part of this study, a set of questionnaires was sent to all 20 completed BRT projects funded through the FTA New Starts program since 2005. The GAO also analyzed trends in the assessed values of properties located within one-fourth mile of the selected BRT systems, considering data two years prior to and three years following implementation. A summary of economic development near BRT stations is displayed in Table 5.

A review of Table 5 yields the following conclusions:

- The Cleveland RTA (HealthLine) has attracted more than $4 billion worth of public and private investment. Cleveland BRT is a heavy BRT system (dedicated lanes). The Woodward Avenue corridor, the first phase of the tentative, preliminary plan of the route of the Southeast Michigan BRT, will pass a number of medical facilities, including Detroit Medical Center, Henry Ford Health System, and Beaumont Health System, with combined annual revenue of more than $11 billion – much more than the Cleveland Clinic served by the Cleveland RTA.[25]

- Emerald Express (EmX) of Eugene, Oregon, another heavy BRT system, also saw more than $100 million of investment. It is to be noted that the Cleveland RTA has sold naming rights to the Cleveland Clinic at a rate of $250,000/year for 25 years, resulting in total revenue of $3.25 million.[26]

- Even Kansas City's BRT (light BRT) was able to receive $25 million from federal grants for urban reinvestment.

- Metro Rapid of Los Angeles, CA, and RapidRide A Line of Seattle, WA, have experienced limited success in terms of attracting development.

- It appears that heavy BRT offers a much greater potential for investment than does light BRT.

Table 5. Summary of Economic Development Impacts near BRT Sheds

BRT System (City)	Impacts
HealthLine (Cleveland, OH)	Cleveland RTA officials told us that the HealthLine has contributed to rail-like economic development benefits, and the amount of development is impressive given Cleveland's economic challenges. Officials estimate that between $4-$5 billion worth of investment has occurred in the corridor since the HealthLine began operations; however, much of that development is associated with nearby institutions including hospitals and universities.
Franklin EmX (Eugene, OR)	City officials informed us that $100 million worth of construction projects are under way downtown near the Franklin EmX line, including a boutique hotel, office space renovation, and expansions to a community college. City officials also said that the University of Oregon is looking to lease space downtown and that there has been developer interest in new student housing. Although these officials expect land values to increase along Franklin Ave., they noted it is hard to measure the extent to which BRT is contributing to the increase.
Troost MAX (Kansas City, MO)	Local officials told us that BRT has helped Troost Ave. position itself for future development. The city recently received a $25-million federal grant for urban reinvestment, which is being used for a variety of streetscape improvements within a 150 square block area that includes three Troost MAX stations. According to transit agency staff, the area was chosen for federal investment in part due to its proximity to the BRT.
Metro Rapid System (Los Angeles, CA)	Metro staff attributed a few development projects to the presence of Metro Rapid lines, but noted that other factors have likely influenced most of the development. For instance, many Metro Rapid routes are already developed because they tend to follow the city's old streetcar routes, which concentrated development in these corridors. In addition, they told us that the BRTs run on busy streets that the city has been targeting for more density anyway.
RapidRide A Line (Seattle, WA)	Local officials told us development along the RapidRide A has been limited, but some developers are interested in the corridor, in part because of complimentary planned light rail service. In addition, they noted that other BRT corridors in the region are attracting transit-oriented development and that BRT will eventually connect most of the region's significant growth centers.

Source: GAO.[27]

The GAO also identified a set of factors conducive to economic development near transit:

- Physical BRT features that convey a sense of permanence. These are particularly important to potential developers and businesses.
- Existence of major institutional, employment, and activity centers (such as the Cleveland Clinic, Cleveland State University) along or near BRT routes that can support transit-oriented development (TOD).
- Transit-friendly local policies and development incentives.

Breakthrough Technology Institute studied a number of BRT systems in North America and Australia to examine their potential for development.[28] This study examined the experiences of various cities with BRT to assess the mode's ability to catalyze economic activity and transit-oriented development. The goal was to provide data that could be help guide planning efforts by policy makers, public agencies and development community. As part of the study, the authors interviewed numerous builders and government officials in each of the BRT cities (Cleveland, Ohio; Boston, Massachusetts; Ottawa, Ontario; and Brisbane, Australia). Their findings are summarized as follows:

- Both Cleveland and Boston were very successful in revitalizing their blighted corridors. In the case of Ottawa, the BRT was the focal point of a long-term growth management policy. Detroit has a number of blighted areas along planned BRT corridors for which BRT could be a catalyst for revitalization, either through TOD or improved access to distant employment by residents living near a BRT station

- The York Region (Ottawa, Ontario) is building a BRT network that will be used as part of regional strategy to manage growth by encouraging intensification of land use along BRT corridors.

- Boston's Silver Line along the waterfront demonstrated that BRT can provide the high-capacity rapid transit needed to encourage high-density development in a desired urban market. If this holds true for the planned Detroit BRT, then the Detroit downtown waterfront may experience a new surge of growth. It is to be noted that the Detroit Riverfront Conservancy was launched in 2003 as a three-way partnership between General Motors, the Kresge Foundation, and the City of Detroit for the purpose of revitalizing the riverfront. The Conservancy has helped pave the way for more than $1 billion in public and private investment along the riverfront over the past decade.[29]

Levinson, et al. (2003) emphasized the development potential of BRT, stating "reported land development benefits with full-featured BRT are similar to those experienced along rail transit lines." Their conclusion is based on the observation of $302 million in new and improved development in Pittsburgh, $675 million in new construction in Ottawa, and a more than 20% gain in property values in Brisbane, Australia, due to BRT. However, the degree of development may vary from city to city and with the circumstances characterizing its location.[30]

Currie (2006) noted several similarities between BRT and rail, including permanence, novelty (if dedicated BRT buses are used), high frequency of service, attractiveness to choice riders, and scale dilution due to comparable spacing of stations.[31] Kaplowitz (2005) observed that BRT attracts development due to its substantial investment in "permanent-seeming" infrastructure. He concluded that when stations are attractive, upscale developers are more likely to perceive them as permanent.

After examining two BRT stations and the surrounding TOD, Yildirim (2004) suggested the following policies for promoting TOD. Even though these policies might seem to be common sense, they should not be taken for granted.

- Transit agency and city officials must work together.

- Support of land developers, financiers, and regulators is essential.

- Financial incentives such as density bonuses and tax abatement are also essential.

Jennifer Blonn, et al. (2006) conducted a simulation study entitled "Transport 2020 Bus Rapid Transit: A Cost Benefit Analysis" to determine the benefits of implementing a BRT

system in the greater Madison (Wisconsin) metropolitan area. The authors computed net present value of benefits from heavy BRT (light BRT was not included) considering a discount rate of 3.5%, along with a system lifespan of 30 years (beginning in the year 2010, with all operations ceasing at the end of year 2039). An average wage rate of $15.66 for Madison area workers was used in converting riders' time-savings to a dollar value. Annual benefits were estimated by converting daily benefits using a factor of 280 days (the approximate number of yearly commuting days). As noted in Table 6, the total net present value of benefits from BRT in the Madison metropolitan area was projected to be more than $325 million,[32] which equals $449.2 million in 2016 dollars.

Table 6. Net Benefits of the Planned Madison-Area BRT System in Wisconsin

	Net Present Value of Benefits in Millions of Dollars	
Benefits Categories	**In Year-2000 Dollars**	**In Year-2016 Dollars***
Time savings for current transit riders	$70.20	$96.17
Reduced costs for new transit riders	$180.60	$247.42
Reduced vehicle air pollution costs	$54.00	$74.00
Reduced accident costs	$23.10	$31.64
Total Benefits	**$327.90**	**$449.22**

* Considering 2% inflation per year.
Source: Blonn, et al. 2006.[33]

Deng, et al. (2011) cited 12 BRT cities where positive land development impacts were noted between 1995 and 2009 (Table A-2). The cities included Curitiba, Brazil; Bogotá, Colombia; Ottawa, Ontario; Adelaide and Brisbane, Australia; Kent, United Kingdom; Seoul, Korea; and Boston, Los Angeles, Las Vegas, Orlando, and Pittsburgh. In Bogotá after only two years of BRT operation, it was observed that the closer a rental unit to a BRT station, the higher the rent the residents were willing to pay. Specifically, every five minutes less in walking time meant an additional 6.8% to 9.3% in rent. Los Angeles, Las Vegas, Orlando, and Pittsburgh also experienced positive growth but not to the extent of Bogotá.[34]

Victoria Perk, et al. (2009) conducted a before-and-after sales transactions analysis along the Boston Silver Line's Washington corridor. Data on sales transactions of condominium units within a quarter mile of the corridor were collected for the years 2000 to 2009. Since the Silver Line's Washington Street route was opened in 2002, this available data provided a comprehensive look at before and after sales trends. The results are summarized in Table 7.

Table 7. Change in Sale Price per Square Foot and Condo Price Index 2000 – 2009

Variables	2000	2005	2009	% Change 2000-2005	% Change 2005-2009	% Change 2000-2009
Sale Price per Sq. Ft.	$344.59	$590.55	$522.83	71.4	-11.5	51.7
Boston Condo Price Index	$100.26	$173.74	$154.40	73.3	-11.1	54.0

Source: Victoria Perk, et al. 2012.[35]

Findings of this study are:

- In 2000, almost three years prior to the opening of Silver Line, the average sale price per square foot of a condominium within a quarter mile of the corridor was $344.59. In 2005, the price per square foot was $590.55. In 2009, it was $522.83.[36]

- The condo price index for the greater Boston area was $100.26, $173.74, and $154.40 per square foot in 2000, 2005, and 2009, respectively.

- The price-per-square-foot of condos along the Silver Line Washington BRT corridor increased slightly less proportionately than the overall index for the Boston region between 2000 and 2005. However, other modes of transit also had similar impacts.

- Between 2000 and 2009, before and after the implementation of the Silver Line BRT service, sale prices of surrounding condominium units increased by 52% per square foot, while the Boston area condo price index increased by 54%.

- Condos along the Silver Line Washington BRT corridor fared similarly to other condos in the greater Boston area from 2000-2009.

American Public Transit Association (APTA) examined home values of five cities during the recent economic crisis and recovery, finding that residential properties near a transit line performed 42% better than homes outside the transit shed. A similar trend was also observed in commercial properties. It was stated that in Washington DC, 84% of all office floor space under construction is within a quarter mile of a metro station.[37]

Victoria Perk, et al. (2009) also studied Pittsburgh's Martin Luther King BRT corridor to determine the effects of BRT station proximity on property values.[38] Using ESRI's ArcGIS 9.2 software, the distance from each parcel to the nearest BRT station was calculated. Using regression analysis, they identified a model relating property value and distance with R^2 =0.8 and a F-value of 845.55. They found that the relationship between the distance to a BRT station and property value is inverse, decreasing as the distance from a station increases, but linear. Decreasing marginal effects were expressed as Equation 1.

Change in Cost (+/-) = 20.737-0.018*(distance from the BRT station) (EQN 1)

For example:

Moving a single-value family home one foot closer – say, from 101 feet to 100 feet – to a BRT station increases its value by 20.737-0.018*100, or $19.00.

Similarly, moving from a home from 1001 feet to 1000 feet from a station increases property value, but only by $2.75 (20.737-0.018*1000). Summing all of the reductions from each additional foot of distance (101, 102, 103 ….1000ft), a home located 100 feet from a BRT station, if moved to a location 1,000 feet from the station, loses $9,745 in value.[39]

The GAO (2012) also reviewed the BRT ridership data of a number of systems (Table 8) and found that one year after implementation ridership had increased significantly (in 12 out of 13 systems) when compared to the ridership data of the previous transit service (typically standard bus service).

The GAO study observed that:

- Seven of the thirteen BRT systems reported an increase in ridership of more than 30% during the first year of operation.
- Three reported that increases in ridership continued for additional years. For example, RTC Rapid in Nevada experienced a 5% increase in ridership per year for the first three years of service.[40]
- A reduction in travel time was cited as the prime factor influencing ridership increase. Headways of 10 minutes or less during peak hours also played an important role. Shorter headways also make it possible for student riders to live further from campus where rents are less expensive. According to FTA guidance, shorter headways are important factor in patrons' perception of service quality.
- A portion of the gains in ridership was attributed to an increase in choice riders.
- The wide range of increases in ridership among various cities was attributed to dramatic improvement in quality of service as well as to expansion of service compared to previous transit service. For example, Cleveland BRT replaced the busiest bus route within the city and surpassed its five-year projection in its second year of service.

Table 8. Percent Change in Ridership for BRT System after One Year of Operation Compared to Previous Transit Service

Bus Rapid Transit System (Location)	Percent Change in Ridership for BRT Systems
Franklin EmX (Eugene, OR)	80
Metro Rapid 770 (Los Angeles, CA)	70
BHX (Southern Nevada)	70
Mountain Links (Northern Arizona)	70
Metro Rapid 794 (Los Angeles, CA)	62
HealthLine BRT (Cleveland, OH)	50
RapidRide BRT (Seattle, WA)	35
The Rapid (Livermore, CA)	20
M15 (New York, NY)	15
Troost MAX (Kansas City, MO)	12
Metro Rapid 728 (Los Angeles, CA)	10
RTC Rapid (Washoe County, NV)	10
Metro Rapid 762 (Los Angeles, CA)	2

Source: Adapted from General Accounting Office (GAO), 2012.[41]

Niles, et al. examined the statistics of two heavy and two light BRT systems (Table 9). This study concluded that:

- Light BRT requires a much smaller capital investment ($0.13 to $0.24 million per mile), than heavy BRT ($6.1 to $26.0 million per mile). In terms of cost, light BRT is preferable; however, it does not project the same image or offer the same investment benefit as heavy BRT.

- The increase in ridership for heavy BRT was very significant (51% to 100%) as compared to light BRT (18% to 20%).[42]

- Travel time reductions for heavy and light BRT were very similar.

Table 9. Performance of Four BRT Systems

	Heavy BRT		Light BRT	
	L.A. Metro Orange Line (Median Busway, TSP*)	Lane County EmX Green Line (Median Busway, TSP*)	VTA Route 522 Rapid (On-street Running, TSP*)	L.A. Metro Rapid (On-street Running, TSP*)
Travel Time Reduction Compared to Previous Transit Service	16%	6%	20%	25%
Baseline Corridor Ridership Pre-BRT	41,580	2,700	18,032	388,400
Cited Corridor Ridership After BRT Implementation	62,597	5,400	21,300	464,400
Corridor Ridership Increase	21,017	2,700	3,277	76,000
Percent Ridership Increase	51%	100%	18%	20%
Capital Investment (Millions)	$350	$24.50	$3.50	$110
Route-Miles	13.5	4	26	450
Cost per Mile (millions)	$26	$6.10	$0.13	$0.24
Cost per New Daily Rider	$16,700	$9,100	$1,100	$620

* Traffic signal priority.

Source: Adapted Niles, et al.[43]

Fann, et al. (2010) attempted to correlate transit and employment. They stated that, despite strong expectations that reliable transit service would positively affect the employment status of low-income persons, evidence in the literature has been inconsistent, as shown in Table 10. While studies in Los Angeles found a positive impact of transit accessibility on employment, other studies show little or no evidence of any association between transit availability and employment participation. However, out of nine citations included in this report, five of them noted a positive influence of transit accessibility on employment. BRT, when fully implemented, will improve the job accessibility of Southeast Michigan residents.

Table 10. Transit and Employment: The State of the Practice

Author (Year)	Study Area/ Population	Methodology	Key Findings	Transit Impact
Kawabata (2003)	1,518 welfare recipients in Los Angeles, CA in 1999-2000	Multinomial logit regression of employment outcomes	Transit-based job accessibility increase employment probability for auto-less welfare recipients.	Yes
Ong, and Houston (2002)	565 carless, single women welfare recipients in Los Angeles, CA in 1999-2000	Logistic regression of employment outcomes	Transit service level at residences moderately increases employment probability.	Yes
Yi (2006)	2,008 individuals age 16-64 in Houston, TX in 1995	Multinomial logit regression of employment status	Transit accessibility increases employment probability and the positive effect is higher for captive transit riders than choice riders.	Yes
Sanchez (1999)	449 census block groups in Portland and 409 in Atlanta in 1990	Two-stage least squares regression of average employment levels	Transit-based job accessibility positively influences employment levels for Atlanta block groups but not for Portland block groups.	Partial
Thakuriah and Metaxatos (2000)	40,000 female welfare clients in northeastern Illinois area in 1998	Multinomial logit regression of job tenure	Auto and transit-based job accessibility positively influence employment retention for female clients with high school or higher educational degrees but not for non-high school graduates.	Partial
Cervero, Sandoval, and Landis (2002)	466 welfare recipients in Alameda County, CA in 1992-1993	Multinomial logit regression of employment status changes	Car ownership is much more important than transit service quality in getting people off welfare and into gainful employment.	No
Sanchez, Shen, and Peng (2004)	190,405 welfare recipients in Atlanta, Baltimore, Dallas, Denver, Milwaukee, and Portland Mas in 1999	Multinomial logit regression of recipients case status	Of transit and employment access variables, none performed consistently and in no cases were there statistically significant coefficients with the expected signs.	No
Bania, Leete, et al. (2008)	Welfare leavers in Cuyahoga County, OH in 1998-2000	Logistic/OLS regression of employment status, earnings and work hours	Auto and transit-based job accessibility shows no significant association with any of the job outcomes.	No

Source: Yingling Fan, et al., 2010.[44]

Summary of Literature on BRT Community-Related Impacts

In this section, the community impacts of BRT and transit as a whole are identified by examining the experiences of other cities. These benefits are not unique to BRT conclusively and can be achieved by other modes of transportation. In the case of Southeast Michigan, the selected preferred mode of transportation (BRT) should provide some or all of these community benefits.

- BRT has been very successful in attracting riders (choice riders, as well as riders from other modes). GAO reported that over 80% of the existing BRT systems experienced a ridership growth of more than 5% (ranging from 7% to 80%) during the first year of service (GAO 2012).

- Within a half-mile radius of the BRT route, BRT can play a positive role in attracting specific types of employment, namely Information, Finance, Real Estate, Management of Companies, Retail Trade, Education, Administrative Waste Management Services, etc. (Nelson 2013, GAO 2012, CTOD 2011).

- In some cities, BRT (mainly heavy BRT) has been very instrumental in the growth of TOD (more than $4 billion in Cleveland) (Niles, 2010, GAO 2012, Levinson, 2003).

- Property values adjunct to BRT increase in some but not all instances (Boston, for example, did not see an increase) (Perk, 2012; Deng 2011).

- The positive impact of BRT is strongly related to public perception of system characteristics such as permanence, frequency, speed, security, etc. (GAO 2012, Breakthrough Technology Institute 2008).

- Regression analysis, standard before-after analysis (very common analysis techniques in the transit field) were used to establish a relationship between land value and distance from the BRT station and to compare various scenarios before and after the implementation of BRT or other transit systems. However, the use of the shift-share technique to determine BRT-advantaged job sectors is new and unique. As previously stated, the shift-share technique is well established for decomposing regional measures into some component parts. The authors of this report do not see any major discrepancy with this technique. It is a standard practice in traffic engineering to evaluate the effectiveness of a traffic signal by comparing crash rates before and after implementation, under the assumption that traffic signals and crashes have cause-and-effect relationship. However, an increase in crashes at a given site could be due to other related attributes in addition to traffic signals. Similarly, in the case of BRT, it can be said that BRT has the potential to have a positive impact on job creation in some sectors, improve land values, attract TOD developers, attract choice riders, and induce other economic development, but this is still considered potential and is not conclusive. BRT is relatively young in comparison to rail service, but from various case studies, it is generally observed that BRT has the potential to spur economic growth and other developments.

INVESTMENT-RELATED IMPACTS

Arguments in favor of public tax support for transit (in the case of Southeast Michigan, the transit is BRT) generally can be categorized as follows:[45]

1. Transit is for people who have no alternatives. Low-income and disabled people who cannot afford or cannot operate cars need other means of transportation for their mobility. Society has a moral as well as social obligation to assist individuals in this context. Investment in this regard should be understood to improve the quality of life for all people.

2. Transit is the key to community building. A robust, reliable transit system provides a major tool to improve the quality of life by slowing the pace of sprawl; revitalizing

downtowns; creating compact, walkable communities; attracting choice riders; as well as providing other community-enhancing benefits.

3. Transit spending stimulates the local economy. Transit is a major business enterprise that employs a substantial number of people, and generates more jobs and economic activity through its capital project investments and operations expenditures.

4. Transit saves money and boosts the economy by reducing urban traffic congestion. A robust transit system is a key element of regional transportation and mobility activity that benefits businesses and individuals alike. The premise is that the economic benefits that result from reduced congestion outweigh the cost of investing in transit.

Our study goal is to examine argument number three within a context of BRT, Southeast Michigan, and capital/operational investment.

Investment in BRT (or any form of transit) facilities and systems affects the economy through the injection of spending on worker wages and purchasing of materials and services. However, the data available for investment related only to BRT is negligible compared to data on transit-related investment as a whole. For example, in 2011 total BRT-related capital and operational investment nationwide was only $80.9 million, which was 0.1% of the total transit investment for that fiscal year.[46] Therefore, the investment impact documented in this report represents all public transit (including BRT).

There are two types of investment in transit:

- **Capital investment** supports purchases of equipment and facilities, including but not limited to rolling stock, track, guideways, and construction of terminals, maintenance facilities, stations, parking lots, etc. New Starts funding grants from the Federal Transit Administration (FTA) are an example of capital investment.[47] The Regional Transportation Authority (RTA) of Southeast Michigan is planning to apply for FTA New Starts funds during the 2016-17 cycle.

- **Operations** includes support for associated jobs (drivers, maintenance workers, administrative, and other transportation agency workers), as well as procurement of supplies (fuel, electric power, parts, and materials) needed for continuing operations. The RTA will seek a new transit tax (mileage in a form of property tax) from the residents of the Southeast Michigan region to assist in BRT operations investment in 2016. It is to be noted that between 2008 and 2014 the Detroit Institute of Arts (DIA), the Detroit Zoological Society, and Suburban Mobility Authority for Regional Transportation (SMART) have been successful in getting voter approval for additional taxes despite the Detroit bankruptcy and a depressed economy.

These direct investments in public transportation projects (such as BRT in Southeast Michigan) and services can support short-term construction jobs and longer-term transit operation jobs (drivers, maintenance and security staff, administrative staff, etc.), as well as purchases of products/services that lead to indirect impacts on other business activity and

employment. The job sectors cited above are related to the implementation and operation of any transit system. Any differences between a national and local implementation in terms of impact should be small. For example, building a system requires construction, creating a need to hire construction workers. These workers pay city, state, and federal taxes. Any transit system, including BRT, requires drivers, maintenance personnel, security staff, ticket checkers, administrative professionals, and various other employees in order to operate. Thus, operational investment should create long-term jobs in the sectors mentioned above. Again, the growth in job sectors due to operational investment in transit is independent of local or regional context. According to the APTA, transit expenditures have a positive impact on the region in which they operate and those areas in which companies that provide transit agencies with products and services are located.[48]

Weisbrod, et al. (2009) conducted a follow-up study sponsored by the Transportation Research Board and supported by APTA to determine the economic impact of public transportation investment. "RIMS" and "IMPLAN" models were used in this effort. In addition, the authors reviewed "The Economic Impact of the Metropolitan Atlanta Rapid Transit Authority," "The Economic Importance of Oklahoma's Transit Systems," "Transportation Improvements Grow Wisconsin's Economy: The Economic Benefits of Transportation Investments," "Time is Money: The Economic Benefits of Transit Investment," and "Economic Growth Effects Analysis for the Bay Area to Central Valley Program-Level Environmental Impact Report and Tier 1 Environmental Impact Statement."[49] It is to be noted that "IMPLAN" and "RIMS" models were also used by the California and Wisconsin studies. Since Weisbrod's estimates at the national level were derived from multiple regional studies, it is reasonable to expect a similar impact in some job sectors. In the absence of a regional model, the project team has considered a similar trend when projecting likely regional job impacts of RTA capital and operational investment. The Michigan Department of Transportation (MDOT) uses the Regional Economic Models Inc. (REMI) TranSight Michigan models to forecast economic benefits of transportation investments. REMI TranSight is a modeling technique used by various state departments of transportation for evaluating the total economic effects of transportation projects.[50]

The economic impacts of capital and operations spending on public transportation can be categorized three ways:

- **Direct impact:** Engagement of workers and businesses in the manufacture of BRT vehicles and control equipment and construction of station facilities and guideways.

- **Indirect impact:** Impacts on businesses that supply goods and services to facilitate direct spending, such as job creation for suppliers of steel, concrete, wood, and other materials needed for BRT projects.

- **Induced impact:** Re-spending (multiplier effect) of worker income on consumer goods and services.[51]

According to APTA, $1 million of spending on public transportation could create anywhere from 30-60 jobs, of which 48% are direct impacts, 12% indirect, and 40% induced.[52,53]

The economic impact of investment in public transportation, including BRT, can also be measured in several different ways as presented below. It is to be noted that investment in only BRT represents a very negligible amount (0.1%) of total investment in public transportation (data available for 2011).

- Total business output (volume of business revenue and sales)
- Total GDP (gross domestic product: which represents business output minus the cost of labor and materials)
- Total labor wages paid (a subset of GDP)

Return of capital and operation investment in public transportation (including BRT) in terms of percent of investment is presented in Table 11. It is to be noted that these impacts are realized twenty years after investment. In this context, it is assumed that regional trend will follow the national trend.

Table 11. Economic Return of Investment in Public Transportation (Direct, Indirect and Induced)

	Percent of Investment Amount	
Economic Return	**Capital**	**Operations**
Business Output	290	310
GDP (Value Added)	130	200
Labor Income	90	140
Tax Revenue (Federal, State, Local)	26.6*	50

*For every $1 million invested in transit, tax revenue 20 years hence will be $266,000.
Source: Adapted from Weisbrod, G. et al.[54]

Table 12 presents a breakdown of the expected tax revenue impact of transportation investment (including BRT) in the year following the investment. Since Weisbord's projected tax revenue was generated by examining various regional studies along with a set of models, it is reasonable to assume a similar Federal tax generation rate in the case of Detroit. Still, these rates should be used only as guidelines. However, the use of state and local tax rates is not justified (varies by location). In addition, the corporate profit and dividend taxes cited in Table 12 may or may not materialize locally depending on the location of the corporation.

Table 12. Tax Revenue Generated as Percent of Transit Investment

	Federal Tax Revenue as Percent of investment	State and Local Tax Revenue as Percent of Investment
Corporate Profit and Dividend Taxes	0.31	1.4
Personal Income Tax	10.0	4.0
Sales and Property tax	0	6.1
Social Security Contribution	12.9	2.6

	Federal Tax Revenue as Percent of investment	State and Local Tax Revenue as Percent of Investment
Other Taxes and Fees	1.2	2.0
Total	**27.1**	**16.1**

Note: Almost 75% of tax revenue is generated by additional wages; the rest is generated by additional business activity.
Source: Adapted from Weisbrod, et al.[55]

According to Weisbrod, et al. (2014), $1 billion of capital and operational transit investment can create as many as 15,400 part-time and 24,200 full-time jobs, respectively, in the year following the investment.[56] A breakdown of job share by investment types, such as capital and operations, is shown in Table 13. The job sectors represent only investment-related sectors and do not include all job sectors of any transit region. Construction jobs will receive the most benefit from capital investment, whereas government- and transit-related jobs will benefit from investment in operations. There is no guarantee that capital and operational investment in metro Detroit will follow the national trend, However, the impact should be similar for those job sectors that are most impacted, namely construction (growth of 30% of capital investment) and government and transit (growth of 46% of operational investment). For example, jobs created by capital investment will almost always be primarily in construction, whereas jobs created by operational investment, should consistently be government- or transit-related. Table 13 displays the likely distribution of potential jobs that will be generated due to investment in the transportation sector. Please note that use of these growth factors for sectors other than Construction and Government and Transit is not recommended. At the same time, it is impossible to positively predict the exact number of jobs that will be created by these investments without conducting in-depth modeling.

Table 13. Share of Job Gains by Sector Due to Capital and Operational Investment in Public Transportation

Sector	NACIS Codes	Capital Investment[a]	Operations investment[b]
Construction	23	30	
Manufacturing	31-33	16	4
Retail Trade	44-45	7	7
Professional Service	54-55	7	5
Health an Social Service	62	6	7
Admin. Service	56	5	4
Hotel and Restaurant	72	5	5
Finance and Insurance	52	4	3
Transportation	48-49	3	0
Real Estate	53	3	0
Arts and Entertainment	71	1	0
Government and Transit	92	0	46
Wholesale Trade	42	3	3
Other Services	81	6	16

[a] Adapted from Weisbrod, G., et al. 2014.[57]
[b] Adapted from Weisbrod, G., et al. 2009.[58]

According to American Recovery and Reinvestment Act (ARRA) of 2009, government spending of $92,000 is needed to create one job year (one job for a duration of one year).[59] The Grow America Act (GAA) of the Department of Transportation (USDOT) stated that every $1 billion transportation investment creates 13,000 jobs.[60]

Litman (2014) stated that per capita gross domestic product (GDP) tends to increase with public transit ridership (Figure 2). This probably reflects the cumulative effects of various development impacts including improved accessibility and consumer savings, shifts in consumer expenditures that increase regional economic activity, the agglomeration of benefits and more efficient land use. This relationship was derived from US transit travel data. Even though the R^2 value is only 0.33, still this can be used to determine GDP growth due to the increase in per capita transit (in this case BRT) travel.

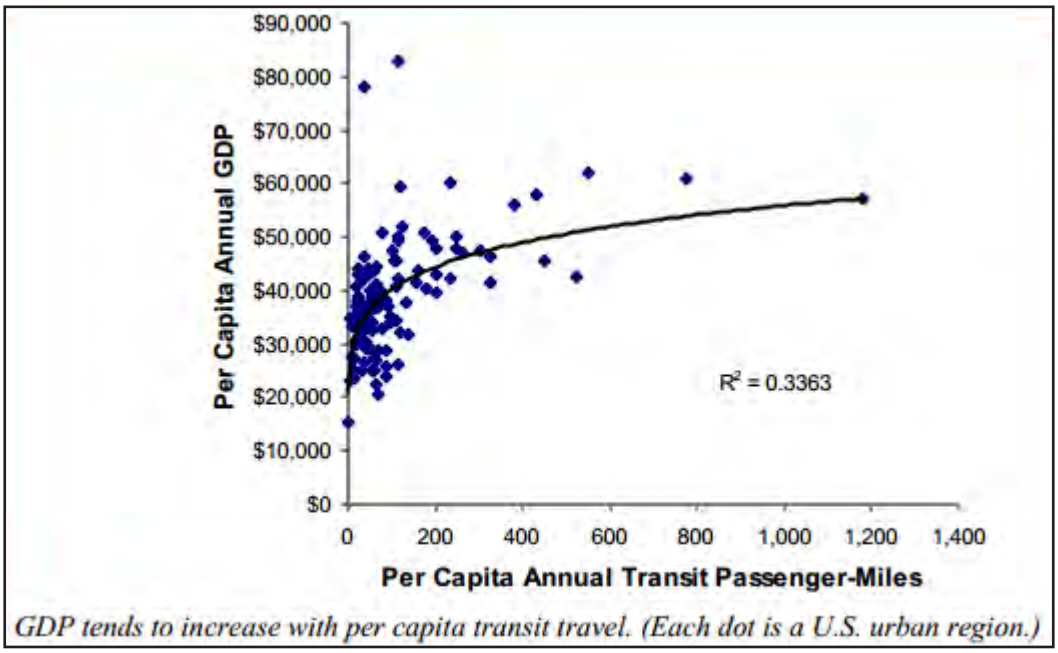

Figure 2. Relationship Between per Capita GDP and Transit Ridership

Source: Litman, T. A., "Evaluating Public Transit Benefits and Costs: Best Practice Guide."[61]

Summary of Literature on BRT Economic Impacts

- Capital and operations-related investments in public transportation (including BRT) have short- and long-range positive impacts on growth in specific job sectors.
- Capital investment mostly influences construction-related jobs (short-term impact).
- Operations investment is ongoing (long-term impact) and generates a significant number of government-related jobs.
- Per capita regional gross domestic product in large US cities is positively correlated with per capita annual transit passenger miles.

III. STATE OF THE SOUTHEAST MICHIGAN REGION

To identify the potential impact of the planned BRT in Southeast Michigan, the authors reviewed existing relevant data, such as population, job sectors, employment, road congestion levels, crash data, ridership patterns, vehicle miles of travel, and other elements and then attempted to predict their trends due to the introduction of BRT.

EXISTING TRANSIT IN SOUTHEAST MICHIGAN AND SURROUNDING COUNTIES

At this writing, there are seven transit service providers in the six counties that comprise Southeast Michigan**.** Two of the providers – the Detroit Department of Transportation (DDOT) and the Suburban Mobility Authority for Regional Transportation (SMART) – service three of the counties: Wayne, Oakland, and Macomb.

The seven providers and the areas they service are as follows:

1. DDOT in Detroit

2. SMART in Wayne, Oakland and Macomb counties

3. The Ride (Ann Arbor Area Transportation Authority (AATA)), Washtenaw County

4. University of Michigan (U-M), Ann Arbor

5. Blue Water Transit (BWATC), Port Huron, St. Clair County

6. Lake Erie Transit (LET), Monroe

7. Detroit People Mover (DPM), Downtown Detroit, Wayne County

Daily ridership of all seven systems is presented in Table 14. DDOT is the largest of these providers with a daily ridership of 124,514. SMART carries about 34,000 riders per day. The Detroit People Mover carries 4,000 patrons per day.[62] Please note that Ann Arbor, home to the University of Michigan, is encompassed in the Southeast Michigan region as a part of Washtenaw County.

Table 14. Daily Ridership of Southeast Michigan Transit Systems

	System	Average Weekday Ridership
Public Routes	DDOT	124,514
	SMART	34,301
	AATA	22,010
	Detroit People Mover	4,011
	BWATC	2,491
	LET	877
	University of Michigan	34,501
Total		**222,705**
Shuttles	Wayne State University	200-250
	College of Creative Studies	1,500
	Vanguard (DMC)	2,000-2,500
Total		**3,700-4,250**

Source: http://www.smartgrowthamerica.org[63]

Dependable transit is necessary to attract and retain young professionals, connect people to jobs, and address the mobility needs of a rapidly increasing older population. Southeast Michigan's transit service currently ranks below Pittsburgh, St. Louis, and Cleveland in the amount of service it provides, funding it receives, and ridership it attracts (Figure 3). According to SEMCOG,[64] among the 25 largest (based on population density) metropolitan areas in the United States, Southeast Michigan ranks:

- Twenty-second in transit ridership,
- Twenty-second in total operating funds per capita, and
- Twenty-third in hours and miles of transit service per capita.

Local government funding of transit varies widely across the US. Cleveland provides the highest level of funding, covering 73% of its transit systems' annual operating cost. Detroit offers the lowest level, funding only 32% of its transit cost.[65]

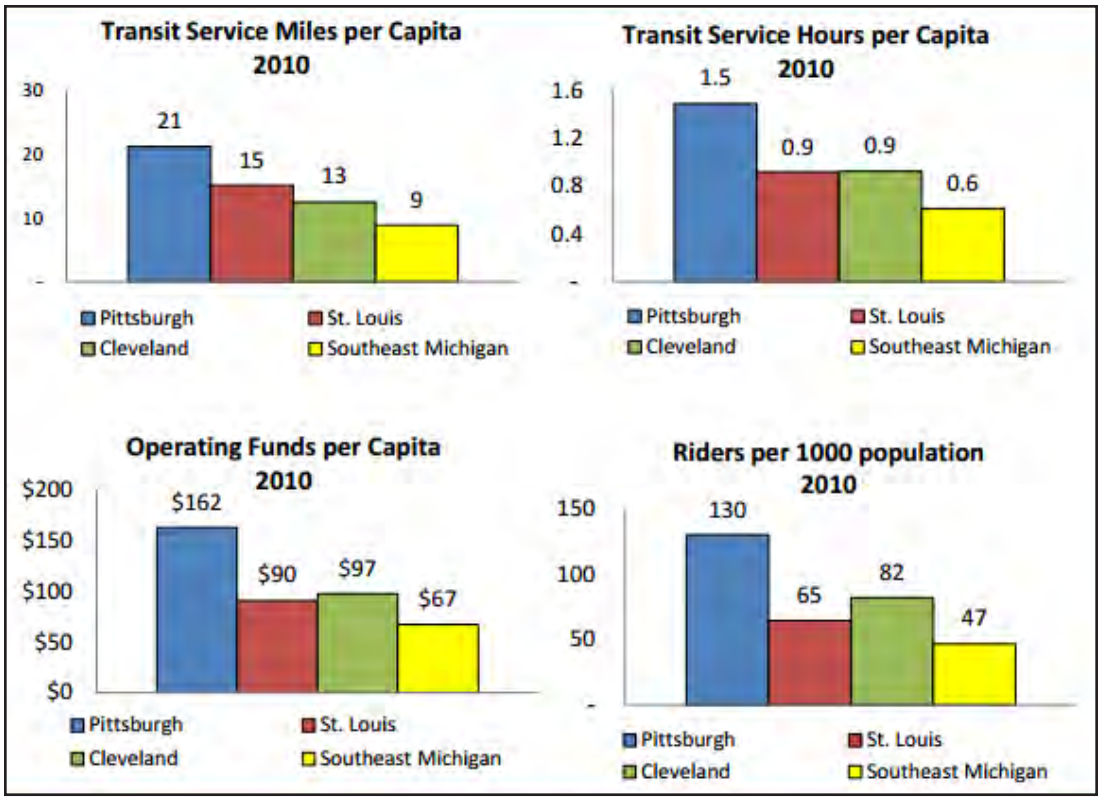

Figure 3. Transit Level of Service in Southeast Michigan in 2010

Source: SEMCOG.[66]

Quality of Transit Service in Detroit

SMART provides bus services in the suburbs adjacent to Detroit, with some routes also offering drop-offs (no pickups) within Detroit. DDOT services operate solely within the Detroit city limits. In recent months, a number of news stories have been published criticizing of the quality of service on the DDOT system. The SMART system has received no similar publicity.

- The January 7, 2014, issue of the Detroit News reported that the newly elected Mayor of Detroit observed that by 8:00 am, DDOT buses were late by two hours along the Woodward corridor, one of the busiest public transit routes.

- The Jan 7, 2014, issue of the Detroit News observed that DDOT has been served by four directors in the last two years.[67]

- On Oct. 21, 2013 DDOT drivers went on strike out of fear for their personal safety, after a gang of youths attacked a bus driver next to the Rosa Parks terminal.

- According to Ron Freeland (ex-director of DDOT) “Employees do not feel the pain of waiting bus patrons.”[68]

To gauge choice riders' perceptions about the quality of service offered by DDOT as the largest provider in the Detroit area, the authors invited six undergraduate students to ride DDOT buses for the first time and create an anecdotal report of their experiences. A summary is presented below:

> **"***Detroit transportation buses, also known as DDOT buses, are known by the citizens of Detroit as less than apt to be dependable.*
>
> *While waiting for a bus to arrive at its scheduled time, we talked to another waiting patron. She said that on multiple occasions, the bus had made her late for work and she even knew a few people that were fired for that very reason.*
>
> *Most travelers got on the bus silently; some were rejected for lack of payment. When this occurred, the bus drivers were rude. The bus was cold.*
>
> *In summation, the DDOT bus system is a good idea, but it needs some severe care. Not only is it unsanitary and late, but also it has struck fear into the citizens. The people ride the bus as a last resort because they do not feel safe taking it. This transportation system is supposed to be for the people, but, trust us, the people are not happy with it."*

TRANSIT-RELATED ATTRIBUTES OF SOUTHEAST MICHIGAN

This section discusses the population, property values, employment sectors, crash experience, vehicle miles traveled (VMT), age group, and other information relevant to transit of Southeast Michigan. Although SEMCOG represents seven counties, four of the counties – Oakland, Macomb, Wayne, and Washtenaw – are home to 90% of the region's population; thus, they the driving force. It is to be noted that the RTA will serve the residents of these four counties.

Taxable Real Estate Values

Figure 4 presents data on taxable real estate values from 2007 to 2016. The tax base related to property value has been declining since 2007. This trend must be changed to maintain an economically viable transit region. Improvement in job markets should assist in this effort. It is to be noted that the Detroit metro job market is in an upswing as of this writing. According to the US Bureau of Labor Statistics, total nonfarm employment in the Detroit metro region stood at 1,974,700 in June 2015, an increase of 49,400 or 2.6%, for the year to date, compared to an increase of 2.1% nationwide.[69] It was also stated that the Detroit metropolitan area has had employment increases each month since June 2010. According to SEMCOG, taxable real estate value is expected to grow by 1.7%, 2.6%, and 3.4% by 2014, 2015, and 2016, respectively.[70]

As shown in Figure A-2 in the appendix, 75% of the cities within the three major counties have experienced an increase in taxable real estate value. Implementation of BRT has the potential to both increase property values and attract new residents adjacent to stations, thus providing an improved tax base. This scenario was observed in Boston, Pittsburgh, Ottawa (Ontario), Brisbane (Australia) and Bogotá (Colombia).[71]

The Land Bank authorities of Detroit and Michigan are powerful entities who play active roles in various development activities in the region. The Michigan Land Bank has been very active in developing public-private partnerships.[72] It is to be noted that the mission of the Michigan Land Bank is to "promote economic growth in this state through the acquisition, assembly, and disposal of public property, including tax-reverted property, in a coordinated manner to foster the development of that property, and to promote and support land bank operations at the county and local levels." For example, the Michigan Land Bank signed an agreement with the Magic Plus LLC to develop the former state fairground of more than 100 acres, which has been vacant for over ten years.

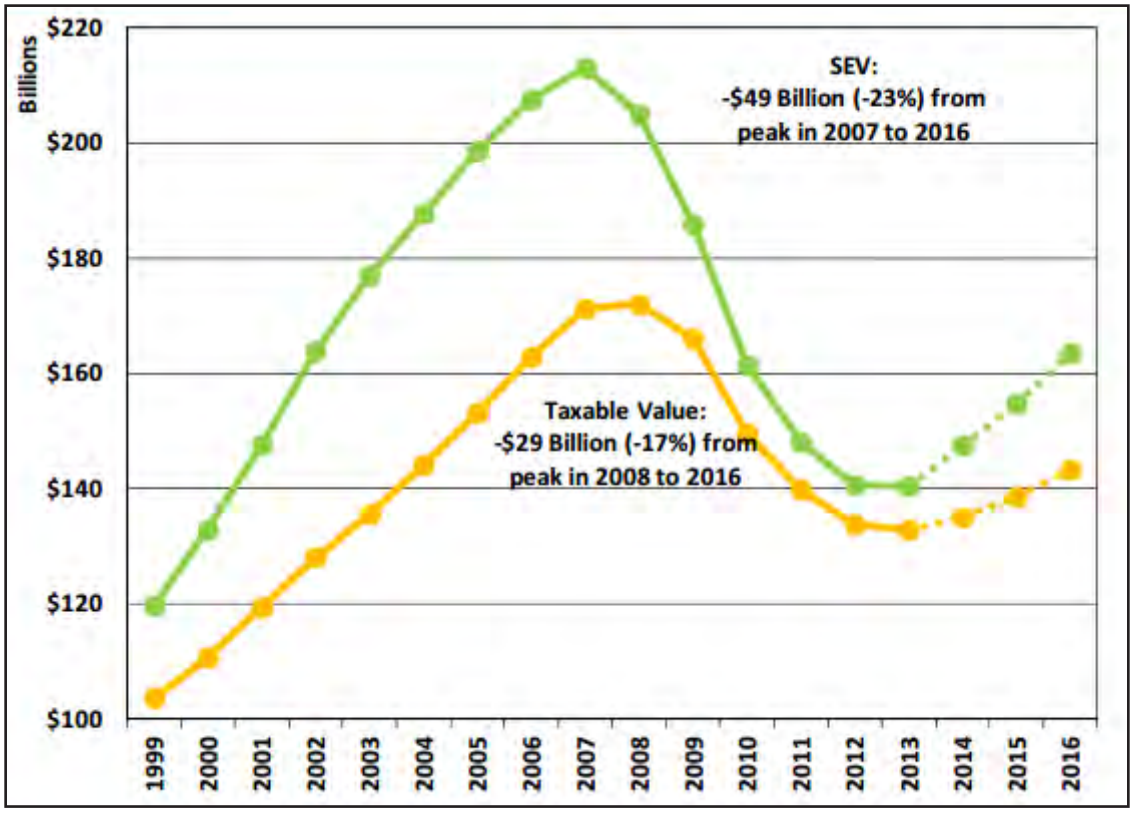

Figure 4. Taxable Value of Property in Southeast Michigan

Source: Southeast Michigan Council of Governments.[73]

Employment Sectors

As noted in Table 15, some employment sectors, specifically manufacturing, health, and government, showed a significant improvement in 2012. If this trend continues, it would provide an increased tax base for the region and attract transit-friendly "choice riders."

Table 15. Employment Sectors in Southeast Michigan 2000 – 2012

Industry	2000	2009 (July)	2012 (March)	Change from 2000 to 2009 Change	Change from 2000 to 2009 %	Change from 2009 to 2012 Change	Change from 2009 to 2012 %
Natural Resources, Mining and Construction	105,500	60,300	51,200	-45,200	-42.8%	-9,100	-15.1%
Manufacturing	432,400	197,200	231,600	-235,200	-54.4%	34,400	17.4%
Trade, Transportation, and Utilities	456,000	368,000	361,400	-88,000	-19.3%	-6,600	-1.8%
Information	48,300	32,700	29,700	-15,600	-32.3%	-3,000	-9.2%
Financial Activities	121,700	105,200	105,900	-16,500	-13.6%	700	0.7%
Professional and Business Services	434,300	315,700	361,300	-118,600	-27.3%	45,600	14.4%
Educational and Health Services	259,500	309,900	324,500	50,400	19.4%	14,600	4.7%
Leisure and Hospitality	196,100	199,300	182,800	3,200	1.6%	-16,500	-8.3%
Other Services	100,500	92,800	88,800	-7,700	-7.7%	-4,000	-4.3%
Government	297,100	267,800	280,000	-29,300	-9.9%	12,200	4.6%

Source: SEMCOG, 2012.[74]

Population

Southeast Michigan has been losing population for more than 10 years (Figure 5). Additionally the number of residents between the ages of 25 to 44 – the age group associated with higher levels of income and mobility[75] – has decreased rather dramatically (by 290,000) since the year 2000, as observed in Table 16. However, 2012 saw an increase in the region's population for the first time since 2002, (Figure 5). According to SEMCOG, population in the region also increased (by 12,000)[76] from 2013 to 2014. If this trend continues in conjunction with an improved job market, the percentage of residents in the 25-to-44 age group should also increase. Introduction of BRT can play a positive role in attracting this age group. Thus, even if BRT doesn't influence population growth, it may increase the region's transit ridership base. With the introduction of quality BRT service, a positive trend in this regard is expected. Note that more than 34% of the people living within a BRT shed in Cleveland, and 45% in Kansas City are between the ages of 25 and 44 (see Table 21 and Table 22). The existing population base of the metro Detroit region is at least twice the population of the Cleveland, Denver, Portland, and Kansas City BRT regions, thus it has the potential to support a viable BRT system.[77] Also, according to American Community Survey of 2011, 19% of the residents in the city of Detroit are disabled.[78] This fact should be taken into consideration when planning the system's amenities.

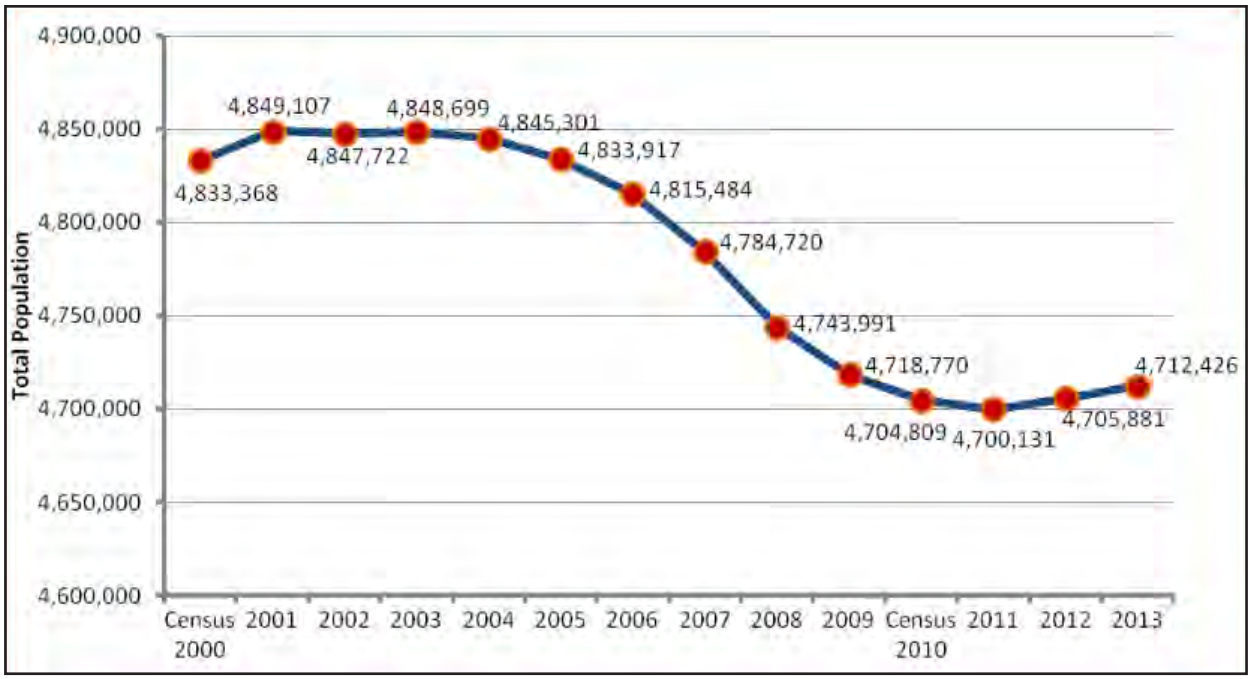

Figure 5. Population Trend (2001 – 2013)

Source: Southeast Michigan Council of Governments.[79]

Table 16. Population by Age Group in Southeast Michigan – 2000 and 2010

Age Group	Year 2000	Year 2010	Change
15-24	615,000	650,000	35,000
25-34	705,000	565,000	(145,000)
35-44	795,000	650,000	(145,000)
45-54	670,000	730,000	60,000
55-64	400,000	585,000	185,000
65-74	295,000	315,000	20,000
75-84	210,000	200,000	(10,000)
85+	80,000	90,000	10,000

Source: Complied from Southeast Michigan Council of Governments.[80]

The project team could not identify any study relating race or ethnicity to transit-oriented development. However, travel behavior differs among various ethnic groups. McGuckin, et al. (2004) studied travel behavior of ethnic groups using data from the 2001 US Nationwide Personal Transportation Survey (NPTS). The mean daily person-miles of travel by workers is shown in Figure 6. High-income workers and drivers travel more miles per day than low-income non-workers. Within all groups, men travel more miles than women. On any given day working, higher-income, Hispanic men travel the most miles, followed by working, higher-income, African-American men.

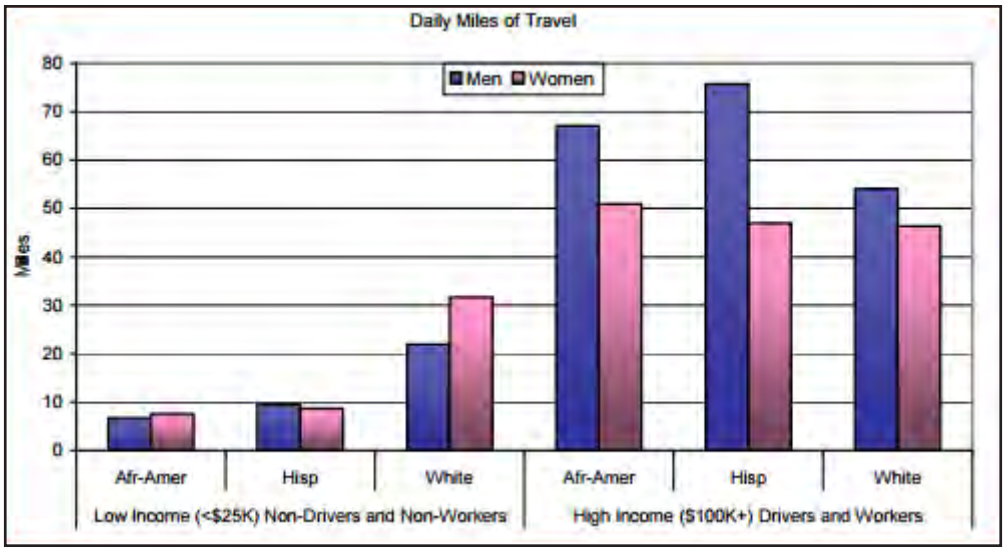

Figure 6. Mean Daily Person-Miles of Travel for Workers in Low- and High-Income Households by Race/Ethnicity and Gender

Source: Nancy McGuckin.[81]

Employment and Income Status

Southeast Michigan was hit hard during the decade of the great recession (2000-2010) with large-scale impacts on both unemployment and household income. As evidenced in Table 17, in 2010, the number of unemployed in the labor force of age 16 and above was three times greater than in the year 2000. The American Public Transportation Association (APTA) stated that every billion dollars investment in public transit (which includes BRT) creates close to 36,000 jobs.[82]

The implementation of a new BRT system may not create jobs at the rate of the APTA projection but it has the potential to positively impact employment for citizens of the region. In addition to the immediate increase in the number of available jobs due to construction and operations activities, the presence of a more reliable form of transportation (including planned BRT and feeder bus services) may increase the potential for success among those seeking work and increase job retention for employees who have had to rely on a bus system whose schedule was inconsistent.

BRT should positively impact employment opportunities and real estate values along some of the metro Detroit corridors. Some commercial developments are either in the planning stage or are already under construction. Examples include: 1) the planned stadium site for the Red Wings hockey team, and adjacent venues near Woodward Avenue and Temple; 2) the former site of the Michigan State Fair at Woodward Avenue and Eight Mile, which is currently under development by Magic Plus LLC; and 3) the John D. Dingell Dearborn Transit Center near Michigan Avenue, which scheduled to open in December 2014. The presence of this type of development along the BRT corridor will attract new residents to the area, along with riders. Note that the hockey stadium project is approved by the City Council, and a funding mechanism is already in place.

Table 17. Employment in Southeast Michigan in 2000 and 2010

	2000		2010	
	Population	**Percent**	**Population**	**Percent**
16 years and over	3,699,320		3,718,649	
In labor force	2,395,604	64.8%	2,359,243	63.4%
In civilian labor force	2,393,936	99.9%	2,276,297	99.9%
Employed	2,258,048	94.3%	1,972,494	83.7%
Unemployed	135,888	5.7%	385,257	16.3%
In Armed Forces	1,668	0.1%	1,492	0.1%
Not in labor force	1,303,716	35.2%	1,359,406	36.6%
65 years and over				
In labor force	67,303	11.9%	81,454	13.3%
Employed	62,747	93.2%	70,925	87.1%
Unemployed	4,556	6.8%	10,529	12.9%
Not in labor force	499,907	88.1%	531,879	86.7%

Note: Person 16+ in labor force as percent = 2,395,604/3,699,329*100 = 64.8%
Source: SEMCOG.[83]

Vehicle Miles Traveled (VMT)

VMT data from 2000 to 2012 (Figure A-3) indicated an upward movement since 2010. Counting trips of all types, the transportation system of Southeast Michigan supported over 118 million daily vehicle-miles traveled during 2012.[84] SEMCOG estimated that the projected BRT daily ridership along the Woodward Corridor (a major Southeast Michigan thoroughfare) will be around 35,000.[85] Current daily bus ridership is 13,000. Achieving this increase to nearly 300% of current ridership levels will be made possible only by attracting choice riders along with new “captive” riders (those who do not have immediate access to private transportation or who otherwise must use public transportation in order to travel).[86] If these projections are achieved, daily VMT could potentially be reduced.[87]

Safety

In 2012, the SEMCOG region logged over 300 fatal traffic crashes and approximately 2,000 severe-injury crashes (Figures A-4 and A-5). The annual cost of traffic accidents to the region’s economy is in the billions of dollars.[88] For the years 2002 to 2006, APTA reports that crash fatalities per transit passenger-mile represented just one twenty-fifth of the crash fatalities per highway-passenger-mile.[89] An improved public transit system may enhance traffic safety by reducing collisions, and, in so doing, reduce associated insurance-related and emergency response costs.

A Transit Cooperative Research Program (TCRP) study investigated nationwide transit-related crime by examining the National Transit Database (NTD)[90] for the years 2002 to 2006. This study divided transit crime in two categories: 1) Crimes in which there is a directly affected “victim,” such as homicide, rape, robbery, aggravated assaults, vehicle theft, etc. (designated “Part I” offenses in the TCRP study), and 2) so-called “victimless” crimes, such as fare evasion, nonviolent civil disturbances, vandalism, etc. (designated Part II” offenses). This study concluded that:

- There were many more “victimless” crimes than “victim” offenses in each of the five studied years.
- The number of extremely violent crimes – specifically, homicide and rape – was very low (between 0.01% and 0.2% of all “victim” offenses).
- Theft was the most predominant “victim” offense (50% to 60% of this category).
- Fare evasion was responsible for 90% of “victimless” offenses.
- The majority of “victim” crimes occurred on bus and heavy rail modes.
- The majority of fare evasion citations occurred on light rail systems.

Some transit advocacy groups claim that the media and the entertainment industry have exaggerated the dangers of public transportation systems, possibly contributing to public fears about mass transit. According to Nelson, “… crimes that might barely merit mention otherwise become headline news if they occur on a mass transit system. Selective media coverage perpetuates the myth that public transportation is unsafe.”[91] The latest transit crime data indicate a significant reduction in all categories of crime, as shown in Table 18. However, some “zeros” may be due to reporting errors.

Table 18. Reports of Violent Crime, Property Crime, and Arrests by Transit Mode 2009 – 2012

	2009	2010	2011	2012
Violent Crime (Reported)				
Homicide	9	14	11	14
Forcible rape	3	6	7	12
Robbery	2,849	2,077	99	124
Aggravated assault	300	0	0	0
Property Crime (Reported)				
Theft	9,267	5,959	4	6
Burglary	1,278	1,289	1	0
Arson	1	0	2	1
Reported Offenses, Arrests				
Other assaults*	2,702	2,139	780	916
Vandalism	1,184	843	5	3
Fare evasion	249,004	167,746	N/A	N/A

* Unlawful attacks or attempts by one person upon another where no weapon was used or which did not result in serious or aggravated injury to the victim. This includes simple assault, minor assault, assault and battery, injury by culpable negligence, intimidation, coercion, hazing, and all attempts to commit these offenses.

Source: US DOT Office of the Assistant for Research and Technology (RITA).[92]

Due to recurring incidents in recent months (an example is cited in section; “quality of transit service in Detroit”), DDOT has assigned plain-clothed security personnel to ride on randomly selected routes. Safety cameras and the presence of a security force must be elements of Southeast Michigan BRT. Funding from atypical sources, such as the US Department of Homeland Security, can be sought in this context.

Traffic Congestion

For many transportation facilities, the level of service (LOS) along a section of the facility is described by assigning letter grade of A – F. “LOS A” represents the best operating condition, whereas “LOS F” represents the worst, based on quantitative performance measures, such as speed, delay, and traffic density, among others. The congestion levels of major arterials of southeast Michigan were determined using the volume-to-capacity (V/C) ratio and Travel Time Index (TTI). SEMCOG considers a roadway link congested if the V/C ratio is greater than 0.80. According to Highway Capacity Manual, a V/C close to 0.8 represents a “C” level of service (most vehicles traveling at or near posted speed, but ability to maneuver through lanes is noticeably restricted and lane changes require more driver awareness than do higher service levels). TTI is calculated as the ratio of peak-period to non-peak-period travel time. This index indicates the additional time required for a trip made during peak traffic hours as compared to an identical off-peak trip. For example, a TTI value of 1.3 means that a trip that takes 20 minutes when traffic is flowing freely will take 26 minutes (an increase of (30%)) during the peak-hour period. The relationship between V/C ratio and TTI at various levels of congestion is shown in Table 19.

Table 19. Congestion Levels as Defined by SEMCOG

V/C Ratio	Travel Time index (TTI)	Congestion Level
<= 0.8	LT 1.5	No/Low Congestion
>0.8 and <= 0.9	1.5-2.0	Moderate Congestion
>0.9 and <= 1.0	2.0-2.6	High Congestion
1.0	GT 2.6	Severe Congestion

Figure 7 illustrates the percentage of Southeast Michigan’s total road-miles at each congestion level during morning, noon, and afternoon peak hours (six hours total) in 2010. Note that close to 54% of the region’s arterial miles were at moderate-to-high congestion levels.

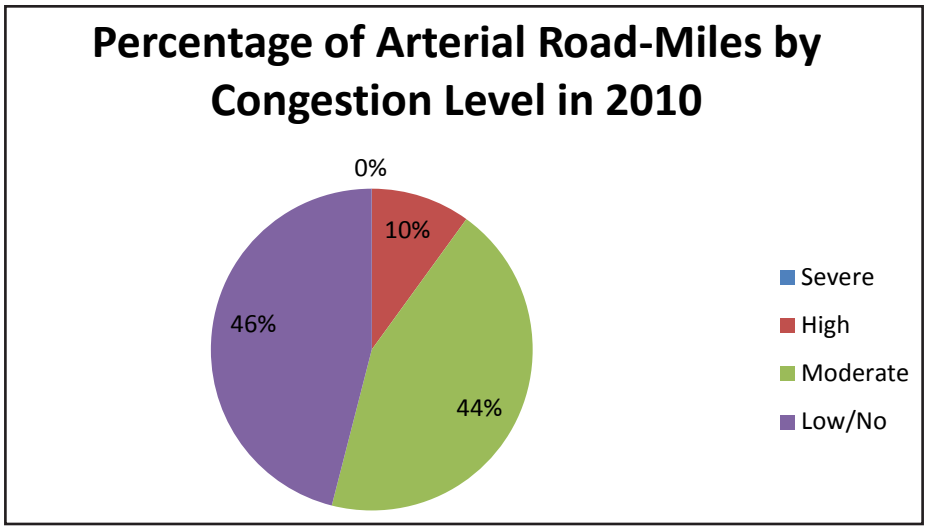

Figure 7. Percent of Arterial Road-Miles by Congestion Level – 2010 (Redrawn)

Source: SEMCOG.[93]

Finally, as the economy of Southeast Michigan and the entire state experiences post-recession recovery, implementing the economic development strategies recommended by SEMCOG (Figure 8) should improve the quality of life for Michigan residents. BRT has the potential to play a role in a number of these strategies, most notably in the "Community Assets" area.

Figure 8. Recommended Economic Development Strategies for Southeast Michigan

Source: Southeast Michigan Council of Governments (SEMCOG).[94]

IV. REGIONAL TRANSIT AUTHORITY AND BRT IN SOUTHEAST MICHIGAN

The tentatively planned (very preliminary) BRT routes known as the BRT triangle, which covers three counties (Wayne, Oakland, and Macomb), are presented in Figure 9. The first route selected for BRT service will be from Detroit to Birmingham along Woodward Avenue (a main thoroughfare). Other routes will be added in phases. However, the RTA will decide the final routing. Total average daily transit ridership in the SEMCOG counties as of 2012 was approximately 188,204. It is estimated that if BRT is introduced, average daily ridership will increase to 222,500 by 2030.[95]

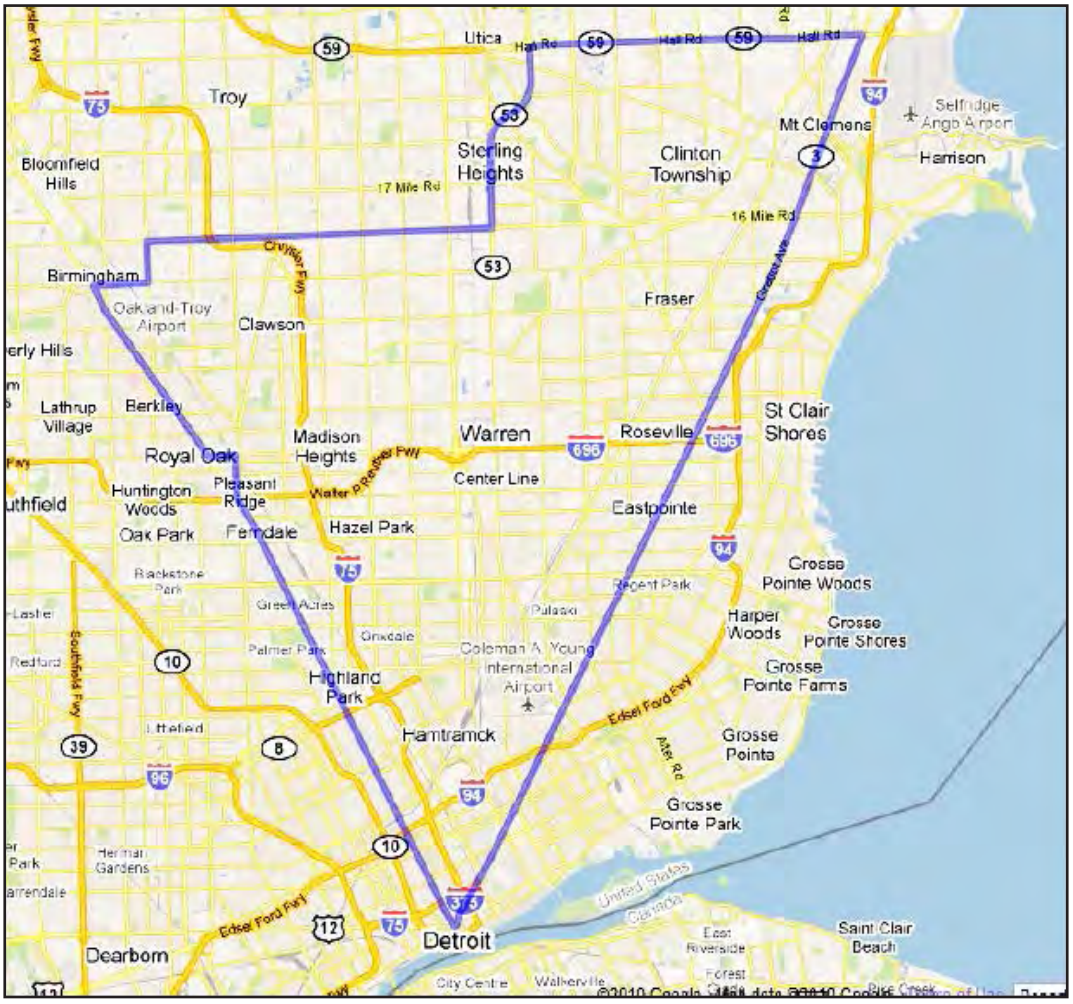

Figure 9. Planned Tri-County BRT Triangle Route

Source: Scott Anderson "Rolling Rapid Transit."[96]

The Regional Transit Authority for Southeast Michigan (RTA) was established (by enabling legislation) in 2013 to address the mobility needs of residents of the counties of Wayne (including the city of Detroit), Oakland, Macomb, and Washtenaw. The RTA is governed by a ten-member board that includes two representatives from each county, one representative from the city of Detroit, and one non-voting member appointed by the governor who acts as chair. The RTA will manage the planned BRT system. The RTA has

just hired its first chief executive officer (CEO). A BRT-related millage will be sought during the 2016 election cycle; thus, most BRT-related implementation activities will occur after the 2016 presidential election.

CHARACTERISTICS OF DETROIT AND SIMILAR CITIES

Population density and travel times for various cities, including Detroit, are presented in Table 20.[97] The selected cities outside of Michigan are the core cities of regions served by BRT. Population density is an essential component of public transit. Based on the 2010 census, Detroit's population density is close to that of Cleveland, Pittsburgh, and St. Louis, and is much higher than that of Atlanta – with 61% of Detroit's population density – and Denver – with 76%.[98] It is to be noted that household density (number of households per square mile) of Miami is significantly higher than any of the other transit-friendly cities. However, the number of people per household in Miami is very close to that of the other cities – in the range of 2.16 to 2.76. From the experience of other cities, the population density of Detroit (a core city) should be sufficient to justify a quality BRT system in the region.

EXPECTED SERVICE QUALITY OF THE PLANNED BRT SYSTEM

In light of the existing service quality of Metro Detroit transit systems, the planned regional BRT system must offer a level of service (LOS) that attracts choice riders and improves the experience of transit-dependent riders. Based on the literature review and visits to the transit systems in Cleveland, St. Louis, Atlanta, and Denver, the project team identified the following as necessary to achieve these goals:

- Reliable on-time service
- Security, including video cameras and enforcement officers on vehicle during hours of operation
- Climate control
- Respectful, dignified treatment of patrons by drivers
- Platform-level boarding to ease boarding/alighting and accommodate disabled passengers
- Features and materials that convey a sense of quality (upscale vs. cheap)

Each of these elements is essential in providing the safe, predictable, and pleasant travel experience that attracts and retains choice riders, whose impact on ridership has been observed by various BRT system operators. Cleveland's HealthLine is one of the top-tier BRT systems of this country, providing a superior level of service. According to Cleveland RTA officials, "… some riders are using the HealthLine for midday trips that they may have previously taken in cars."[99]

Ron Freeland, former director of Detroit Department of Transportation (DDOT), CEO of Maryland Transportation Authority (MdTA), and director of operations for Maryland Transit Administration (MTA), said in an interview with the authors that transit agencies must believe that "the person standing at the corner in the cold waiting for the ride is the most important person in the world and they only exist for that person" and act accordingly.[100] Based on the totality of the research, the authors believe this is the most important action item for all Southeast Michigan transit service providers. When the entire staff holds this attitude, riders feel they have been treated with respect and courtesy.

Table 20. Population Density and Travel Times of Various BRT Cities

Cities	Population Density in Thousand per Square Mile	Percent of Detroit Population Density	Mean Travel Time to Work in Minutes	Percent of Detroit Travel Time	Number of Households per Square Mile	Percent of Detroit Household Density
Detroit	5.14	100	26.2	100	1,953	100
Atlanta	3.15	61	25.8	98	1,340	69
Cleveland	5.10	99	24	92	2,193	112
Miami	11.13	216	27.3	104	4,156	212
Pittsburgh	5.52	107	22.7	86	2,437	124
St. Louis	5.21	101	24.4	93	2,268	116
Baltimore	7.67	149	29.2	111	2,945	150
Denver	3.92	76	24.6	94	1,661	85

Source: Adopted from US Census 2010.[101]

From the experience of other cities (highlighted in Table 2 and discussed in the literature review section), BRT features that enhance economic development include:[102]

- Dedicated lanes: These decrease travel time, increase predictability, and convey a sense of permanence.
- Station amenities: Amenities that enhance comfort and safety, such as climate control, security cameras, public art, and landscaping, differentiate BRT from standard bus service.
- Vehicle features: Stylized, higher-capacity vehicles that run on alternative fuels or hybrid technology, board at multiple doors, and provide platform-level boarding, appeal to choice riders' desire for a more upscale experience.
- Superior levels of service (LOS): Faster, more reliable, and more frequent service than standard bus service would entice transit riders. (BRT facilities should maintain headways of 10 minutes or less during peak hours).
- Fare collection: Prepaid or smart card technologies increase convenience and speed of fare collection, reducing boarding time.

- Branding: BRT should be marketed as a unique brand, different from standard bus service. Cleveland's BRT, branded "HealthLine," is an example worth examining.

- Traffic Signal Priority (TSP): Providing priority of BRT vehicles at intersections reduces travel time.

V. REQUIREMENTS OF BRT-RELATED ECONOMIC DEVELOPMENT, INCLUDING TOD

In recent months, Bus Rapid Transit has been adopted as an alternative mode of transportation by various cities, including Detroit. As suggested by the developers as well as by transit agency officials of various cities,[103] the following actions should be considered to create a positive image for BRT. Although, some may seem to be just common sense, the project team finds them worth stating:

- Cooperation among transit agencies, nonprofit entities, landowners, and private investors is essential.

- The permanence of BRT stations and BRT route alignment are the attributes most sought by prospective developers.

- Specific system attributes – namely, frequency, speed, and security – are very important to both current and potential transit riders (experience of Cleveland BRT).

- In downscale corridors, small measures, such as streetscape improvements that accompany BRT, may be at least as important as the transit service for attracting new investment.

- Based on the experiences of other BRT cities, a prominent visual profile for BRT and an aesthetically appealing infrastructure (for example, HealthLine of Cleveland) are very helpful in attracting choice riders and potential developers.

- Developers may be more motivated by an expedited permitting or rezoning process, since time is a critical factor in the economic viability of most development projects, than by economic incentives, such as tax breaks.

- Readily available zoning maps; inventories of establishments, parking facilities, and vacant land; and crime statistics (in GIS format) for each BRT station site can be helpful, decision-making tools for potential TOD (St. Louis is an example). These resources were unavailable at a number of transit facilities visited by the project team.

POTENTIAL IMPACTS OF BRT IN SOUTHEAST MICHIGAN

A group or sector is said to be “BRT-advantaged” when its population grows at a higher rate within a BRT shed than within the larger metropolitan region during the same time period. This section discusses the shift-share analysis used to identify BRT-advantaged age groups. The same approach was used by Nelson, et al. to identify BRT-advantaged job sectors.

BRT-advantaged age groups can be established by comparing related data before and after BRT implementation. Since post-implementation data are not yet available for Detroit, two BRT facilities in other cities (Cleveland’s heavy BRT, HealthLine, and Kansas City’s light BRT, Troost MAX) were adopted as surrogates for purposes of this analysis. Of the two cities, Cleveland, with heavy BRT, is closer to Detroit in demographics, job sectors, etc.

Shift-share analysis is used to decompose increases or decreases in various attributes within a given area at two or more points in time.[104] The authors have identified components of the changes that are attributable to regional influence, growth within the attribute (such as age group), or local influence (such as BRT shed). The technique provides a picture of how a region's mix of industries and age groups is changing within a given timeframe. For purposes of this analysis, age group data for the transit region, and transit shed for the years 2000 and 2010 were collected. This analysis decomposed age group data for the 2010 transit shed into three components:

- Regional share (RS)
- Age group mix (AM)
- Transit shed shift (TS)

Regional Share (RS) Component

RS is based on equation 2 and answers the following questions:

- What percentage of the age group of class (i) within a specific transit shed (s) should change due to regional (r) growth during analysis period?
- If the transit shed's age group grew at the same regional (r) growth rate, what would be the result?

$$RS_{is}^{t} = E_{is}^{t-n} \times \left(\frac{E_{r}^{t}}{E_{r}^{t-n}} \right) \qquad \text{(EQN 2)}$$

Where:

t = end of analysis period (year) t-n = start of analysis period (year)

i = specific age cohort group class s = specific transit shed

E_r^t = Sum of all age groups at end of the analysis period (t) for regional level (r)

E_r^{t-n} = Sum of all age groups at the start of the analysis period (t-n) for regional level (us)

E_{is}^{t-n} = Number of specific age group class (i) at start of the analysis period (t-n) for transit shed(s)

Age Group Mix (AM) Component

- Equation 3 defines the degree to which growth or decline of a specific age group class within a BRT shed is due to changes in those populations in the larger metropolitan region.

- AM estimates the share of growth of the transit shed (s) age group class (i) that is due to regional (r) growth in age group class (i).

$$AM_{is}^{t} = E_{is}^{t-n} \times \left[\left(\frac{E_{ir}^{t}}{E_{ir}^{t-n}} \right) - \left(\frac{E_{r}^{t}}{E_{r}^{t-n}} \right) \right] \qquad \text{(EQN 3)}$$

Where

E_{ir}^{t-n} = Number of specific age group class (i) at start of analysis Period (t-n) for region (r)

E_{ir}^{t} = Number of Specific Age group class (i) at the end of analysis period (t) for region (r)

Transit Shed Shift (TS) Component

- TS is the growth in the age group class (i) in the transit shed due to attractiveness of the BRT. This residual volume is interpreted as uniqueness of BRT.
- Identifies the shed's leading and lagging age group class

$$TS_{is}^{t} = E_{is}^{t-n} \times \left[\left(\frac{E_{is}^{t}}{E_{is}^{t-n}} \right) - \left(\frac{E_{ir}^{t}}{E_{ir}^{t-n}} \right) \right] \qquad \text{(EQN 4)}$$

Where

E_{is}^{t-n} = Number of specific age group class (i) at start of analysis period (t-n) for shed (s)

E_{is}^{t} = Number of specific age group class (i) at the end of analysis period (t) for shed (s)

APPLICATION OF SHIFT-SHARE APPROACH TO DETERMINE BRT-ADVANTAGED AGE GROUP

To identify BRT-advantaged age group(s), the authors analyzed head-of-household data for the Cleveland and Kansas City BRT sheds and metropolitan regions. Data and results of this analysis are presented in Tables 21 and 22. In both cities, the 15–34 age group was identified as the BRT-advantaged group. Again, an advantaged or leading age group is one for which the group's growth rate within the BRT shed is higher than its regional growth rate. Similarly, a lagging age group is one for which the group's growth rate within the BRT shed is less than its growth rate at the regional level. An assumption that was made for purposes of this analysis is that if BRT has no effect on a region's age group composition, it would be the same after implementation of BRT as it was before implementation. There may be factors other than introduction of BRT that occurred during that time that are more difficult to quantify. It should be noted that in the case of Cleveland, Kansas City, and other BRT cities, BRT was accompanied by changes in land policies that encouraged the 18–24 and 25–34 age groups to live close to BRT. However, this action resulted in displacement

of other age groups away from the BRT shed due to higher rent, noise, etc. The BRT Influence columns in Tables 21 and 22 show that the growth of various age groups in the BRT shed was due to the introduction of the BRT. Moreover, according to the AAA, from 2007 to 2011 the number of cars purchased by the 18–24 and 25–34 age groups fell by almost 34%. Only 44% of teens obtain a driver license within the first year of their eligibility, and only 54% are licensed before the age of 18.[105] A study by the University of Michigan's Transportation Research Institute (UMTRI) found that, in 2011, the 55–65 age group was 15 times more likely to purchase new vehicles than were young millennials (ages 18–24); moreover, consumers 75 years and up have been buying cars at higher rates than those in the 18–24 and 25–34 age groups.[106] Although 18–24-year-olds rank lower in car ownership, they nonetheless travel for work, school, and recreation. From the experience of Cleveland and Kansas City, it can be stated that public transit is playing a role in this context. Census data from 2010 (Table 16) indicates that more than 1.2 million (about 25%) of residents in Southeast Michigan are 18–34 years of age. Transit planners should accommodate this trend when planning public transit systems.

Table 21. Shift-Share Analysis of Household Age Group for Kansas City (Light BRT) 2000 – 2010

	Region			BRT Shed			Reason for Change in Share by Age Group 2000–2010			
Age Group	2000	2010	Change	2000	2010	Change	Region Influence	Age Group Influence	BRT Influence	% Growth Due to BRT
15-24	38,380	35,928	-2,452	1,344	1,465	121	1,500[a]	-241.9[b]	206.9[c]	14.1
25-34	130,110	135,977	5,867	3,060	3,751	691	3,415	-217.3	553.0	14.7
35-44	165,222	146,198	-19,024	2,173	1,836	-306	2,425	-502.5	-86.8	-4.7
44-54	141,246	167,930	26,684	1,976	1,896	-80	2,205	143.9	-453.3	-23.9
55-64	89,164	136,775	47,611	1,097	1,826	729	1,224	458.4	143.2	7.8
65-74	67,855	79,455	11,600	842	890	48	939	46.3	-96.1	-10.8
74-84	47,736	51,226	3,490	728	542	-186	812	-31.3	-239.2	-44.1
85+	14,766	21,604	6,838	331	232	-99	369	114.8	-252.3	-0
Total	694,468	775,093	80,625	11,551	12,438	887	12,892	-229.4	-224.6	-1.8

Source: Compiled from http://toddata.cnt.org/index.php[107]

Notes:

[a] (Number in age group class (shed) in year 2000)*(Total region age group in 2010/ Total Region age group in 2000) = 1344*(775,093/694,468)=1,500 (Equation #2)

[b] (Number in age group class (shed) in year 2000)*(Number in age group class (region) in 2010/Number in age group class (region) in 2000) – a = 1,344*(35,928/38,380)-1,500 = -241.9 (Equation #3)

[c] (Number in age group class (shed) in year 2000)*(Number in age group class (shed) in 2010/Number in age group class (shed) in 2000)-a-b = 1,344*(1,465/1,344) - 1,500 – (-241.9) = 206.9 (Equation 4)

Table 22. Shift-Share Analysis of Household Age Group for Cleveland (Heavy BRT) 2000 – 2010

	Region			BRT Shed			Reason for Change in Share by Age Group 2000 – 2010			
Age Group	**2000**	**2010**	**Change**	**2000**	**2010**	**Change**	**Region Influence**	**Age Group Influence**	**BRT Influence**	**% Growth Due to BRT**
15-24	44,746	31,187	-13,559	830	1,156	326	822.9	-244.4	577.5	50
25-34	144,144	120,522	-23,622	1,583	1,845	262	1,569.4	-245.8	521.4	28.2
35-44	198,105	152,448	-45,657	1,355	796	-559	1,343.4	-300.6	-246.7	-30.9
44-54	181,454	196,319	14,865	1,275	1,278	3	1,264.0	115.4	-101.4	-7.9
55-64	122,286	173,403	51,117	947	1,143	196	938.9	404.6	-199.9	-17.5
65-74	106,719	107,941	1,222	1,058	751	-307	1,048.90	21.2	-319.1	-42.4
74-84	82,279	77,479	-4,800	728	560	-168	721.7	-36.2	-125.5	-22.4
85+	22,282	34,963	12,681	327	300	-27	324.2	188.9	-213.1	-7.1
Total	**902,015**	**894,262**	**-7,753**	**8,103**	**7,829**	**-274**	**8,033.4**	**-97.5**	**-106.8**	**-1.3**

Source: Compiled from http://toddata.cnt.org/index.php[108]

POTENTIAL IMPACT OF BRT ON SOUTHEAST MICHIGAN REGION AND SUGGESTED COURSES OF ACTION

The project team attempted to identify the probable impact of BRT on the Southeast Michigan region based on the experience of other cities, APTA studies, and its own analysis.

Job Sectors

Job sectors that will be most impacted by BRT and BRT-related capital and operational investment are shown in Table 23. At the time of this study, the amount and timeline of investment (capital or operational) had not been defined, thus the project team made qualitative estimates, such as types of jobs likely to be created due to BRT-related capital and operational investments. However, as soon as investment amounts are identified, a preliminary estimate on job sector impacts can be quantified using the tools included in this report. For example, one probable BRT route under consideration is from downtown Detroit to Birmingham along Woodward Avenue. The length is about 20 miles. At a cost of $15 million per mile, there is a possibility of more than $300 million in capital investment in 2016. To estimate the job creation potential of a $300 million capital investment, the project team sought the assistance of MDOT. MDOT Statewide and Urban Travel Analysis staff ran a scenario on the spending-only impacts of $300 million in capital investment using a REMI TranSight model (TranSight Michigan 84-Area v3.2.5) with respect to the Detroit metro region. The project team also applied Weisbord's estimate as well as AARA and GAA formulas to predict the job creation potential of a $300 million capital investment. The results of these analyses are presented in Table 24. It is to be noted that Weisbord's estimate represents national job growth due to a $300 million transportation investment in the Detroit region. However, construction-related job growth should be local. The total job creation potential estimated using various techniques ranges from 3,200 to 4,600. Although the total number of potential jobs produced by the REMI model is 1,200 fewer than the Weisbord estimate, the REMI Model estimates a greater number of construction-related jobs (1,920) compared to Weisbord's estimate (1,386). According to Glen Weisbord,[109] regional job growth should account for approximately two-thirds of total national job growth. REMI's prediction of regional job growth is very close to two-thirds of Weisbord's national estimate. It is to be noted that total job growth predicted by the REMI model with respect to the Detroit metro region is close (+/-10%) to the total job growth computed by the ARRA and GAA formulas, which do refer to regional growth but not specifically to Detroit region.

Also BRT will contribute to the region's GDP. As cited previously, an increase in ridership of close to 20% can be expected across the region due to BRT (from 188,204 in 2012 to 222,500 in 2030) and this should upwardly influence the SEMCOG region's GDP.

It is to be noted that BRT can be successful, and these impacts realized, only if the system is properly planned, designed and implemented, taking into consideration local attributes.[110] Well-planned BRT is a potential catalyst for the stimulation of the identified advantaged job sectors. Knowing which job sectors have a track record of thriving in a BRT shed will help communities and their planners target the appropriate job sectors in their marketing efforts.

Table 23. Potential Impact of BRT on Job Sector Growth in Southeast Michigan

Job Sectors	NACIS Codes	Employment in 2012	Percent of Total Employment	Source of Job Sector Share Influence		
				BRT-Advantaged	Capital Investment	Operational Investment
Natural Resources, Mining and Construction	11, 21-23	51,200	2.5		X (short-term)	
Manufacturing	31-33	231,600	11.5		X	X
Trade, Transportation and Utilities	22, 44-45, 48-49	361,400	17.9	Trade and transportation only	X	X
Information	51	29,700	1.5	X	X	X
Financial Activities	52	105,900	5.2	X	X	X
Professional and Business Services	54-55	361,300	17.9		X	X
Educational and Health Service	61-62	324,500	16.1	Only education	Only health	Only health
Leisure and Hospitality	71-72	182,800	9.1	X	X	X
Other Service (Except Government)	81	88,800	4.4	X	X	X
Government	92	280,000	13.9			X
Total		**2,017,200**	**100**			

Table 24. Estimates of Job Growth Potential from $300 Million Capital Investment Using Various Approaches

Approach	Total Number of Jobs	Total Job Creation Factor	Construction-Related Jobs	Construction-Related Job Creation Factor
Weisbord's Rstimate	4,620	15.4 jobs per million dollar investment	1,386	31% of total job
ARRA 2009 Formula	3,260	10.8 jobs per million dollar investment		Not available
Grow American Act Formula (GAA)	3,900	13 jobs per million dollars investment		Not available
REMI TranSight Model Considering Detroit Metro Region*	3,480	11.6 jobs per million dollars investment	1,962	6.54 jobs per million dollars investment

* Includes direct, indirect and induced. Statewide and Urban Travel Analysis Section, Bureau of Transportation Planning, Michigan Department of Transportation. Contact Susan Gorski, Manager.

Travel Time and Emissions

The latest data available on the Southeast Michigan region indicated that close to 90% of arterial miles were at low-to-moderate congestion levels (Figure 6). Therefore, a reduction in auto travel due to the introduction of BRT will yield neither a significant savings in travel time nor a significant reduction in emissions and noise. These are therefore not considered benefits of BRT in this region. However, while time spent on actual travel may not be reduced, BRT will eliminate the time required to find parking and walk to one's final destination from the parking location. Moreover, BRT will reduce the cost of travel for riders

by eliminating, at minimum, the cost of parking. Parking in downtown Detroit facilities costs from $7–$15 per day, which is at least twice the standard transit fare.

Transit Ridership Base

The shift-share analysis conducted using data from Cleveland and Kansas City identified 15–34 as the BRT-advantaged age group. In 2010, more than 1.2 million people within this age group lived in Southeast Michigan (Table 16). Based on the experiences of Cleveland and Kansas City, when BRT is implemented in Southeast Michigan many of these residents should be motivated to live within the shed, broadening the transit ridership base which, in turn, has the potential to increase BRT ridership. Moreover, many workplaces and institutions of higher learning are located along the planned BRT routes, including the Detroit Institute of Art (DIA), the Detroit Zoo, Detroit Medical Center, Henry Ford Health System, Beaumont Health System (the largest employer in Oakland County), Wayne State University (with a student population of more than 35,000), Oakland Community College, and the Michigan Science Center. Choice riders visiting the these facilities may find it more convenient to take BRT due to savings in parking costs.

Land Development

Most cities with BRT (Table A-2) have seen a positive impact on land development after the implementation of BRT. As stated previously, land development benefits related to BRT are similar to those experienced along rail transit lines, yet the investment required for BRT is substantially lower. Southeast Michigan's planned BRT route will traverse a number of blighted corridors. If the experience of other cities is replicated, these blighted corridors could see a rebirth of development in the near future.

Michigan RTA officials can perform a sensitivity analysis using Equation 1 to examine the impact of BRT routes on the land value as a part of strategic planning. (This approach is explained in the literature review section with an example). Like Cleveland's BRT, Detroit's system will pass a number medical facilities. In addition, it will pass Wayne State University (student population 35,000), a pro baseball stadium, a pro football stadium, a pro hockey stadium, museums, and the Detroit Zoo. With such attractions lining the route, a quality, well-planned BRT should attract transit-oriented developments. However, policy makers, elected officials, the land bank authority, and real estate developers should plan to play an active role in this regard. To encourage TOD, the following actions should be considered:

- Use public-private partnerships (PPP) to fund TOD and walkable streets (a transit mall would be a good example of PPP). Detroit's M-1 rail is an example of such an effort. Work closely with the Michigan Land Bank, with the assistance of the Urban Land Institute.

- Encourage local government to contribute more than 32% (Detroit's current local contribution) of yearly operations costs.

- Pursue HUD and USDOT grants that support transit-oriented development (TOD).

- Provide GIS-based economic, demographic, land use, transit, and walkability data for potential TOD developers to encourage and facilitate their plans around BRT.

- Work with cities along the main transit corridors to develop consistent corridor-wide zoning. The RTA could suggest best practices for TOD-favored zoning (or even a master plan).

- Consider Smart Street concepts when building transit routes. According to Smart Growth America, "*Complete Streets* are *streets* for everyone. They are designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities. *Complete Streets* make it easy to cross the street, walk to shops, and bicycle to work."

- Work closely with existing agencies, such as the Woodward Avenue Action Association (WA3) and Golden Spike, to promote TOD concepts along the Woodward corridor and other transit corridors.

- Promote the tax benefits of riding public transit (including BRT). Federal tax code allows employers to purchase BRT passes through employers with pre-tax dollars.

Ridership

If BRT is implemented along the Woodward Avenue route, it is estimated that the route's average daily ridership will be around 35,000 – close to three times the current ridership. As noted in Table 8, introduction of BRT in various cities has increased ridership on specific routes by anywhere from 2% to 80% within a year. Twelve out thirteen cities with BRT have experienced ridership increases of 10% or more; it is reasonable to expect Detroit to follow this trend. However, this increase will not materialize without participation by choice riders. In 2012, average daily vehicle miles traveled (VMT) (Figure A-2) on Southeast Michigan roadways was 118 million. As stated earlier, a planned, multiphase implementation BRT has the potential to increase daily ridership by 34,000. From the experience of other BRT cities, it can be stated that choice riders (those who will use BRT, instead of their cars) will play a role in this increase. Thus, there is a potential for a decrease in daily VMT, resulting in reduced traffic and emissions.

Federal, State, and Local Treasury Impacts

Investment in transit, both capital and operational, should generate additional tax revenue at federal, state and local levels in the form of corporate/dividend taxes, personal income taxes, and social security contributions. However, transit-related investment, like most public investment, rarely yields direct equivalent returns. For example, the Federal government invested more than $30 billion to rescue General Motors, and was unable to recoup this amount directly; yet the investment was considered beneficial to the nation in the long run. The benefits of BRT will be realized in the form of TOD, job growth, increases in land value and property taxes, and other long-term impacts, but care should be taken to educate stakeholders and the public that under no circumstances can BRT produce direct equivalent returns on capital investments. Although it presents national rather than regional

data, Table 12 can be used as reference guide for expected rates of return; however, these rates may increase or decrease depending on legislative action.

Median Income

Between 2000 and 2010, six BRT regions experienced an increase in median income by more than 13% (Table A-3) compared to 8% for the Detroit transit region. If Southeast Michigan's experience follows suit, implementation of BRT in should contribute to an increase in the rate of income growth.

VI. CONCLUSIONS

In this report, a framework has been developed to identify the probable economic impacts of BRT in Southeast Michigan. The authors investigated a number of cities that have implemented BRT, including Cleveland, Kansas City, and Pittsburgh, to identify BRT/transit-advantaged job sectors and age groups. The authors also examined specific attributes of Southeast Michigan, such as job sectors, population by age group, vehicle miles traveled, median income growth, and crash frequency, and discussed BRT's potential influence on them. This study identifies the job sectors and age group most likely to be advantaged by BRT, based on the experiences of other cities and the specific attributes of Southeast Michigan.

The planned BRT system is currently in the very early stages of development. The RTA has not established any detailed plan regarding routes or other courses of action. BRT in Southeast Michigan has the potential to deliver economic benefits comparable to those of other cities if the design, planning, and implementation follow the suggested course of actions outlined in this report. This following list briefly summarizes the features necessary to derive maximum economic benefits from BRT:

- Dedicated lanes (heavy BRT)
- Vehicle features as described
- Upscale branding distinguishing the system from standard transit
- Improved levels of service
- Station amenities as described
- Security system (video camera)
- All-season climate control
- Off-vehicle fare collection with modern payment options
- Responsiveness to the local population (e.g., disabled population)

The formula for computation of land value impacts (Equation 1) may be used to perform sensitivity analysis to determine future BRT routes. The implementation of BRT in Southeast Michigan is still a few years away, and it will have to overcome a number of political and funding hurdles. In addition, integration of all regional transit systems under the RTA, will be a formidable task. However, public transit systems in Cleveland, Denver, and St. Louis have been coexisting and integrating without major issues.

The data provided in Table 23 and in the investment-related benefits described in Section 2 can be used to develop initial estimates of economic and other impacts of specific investments. The RTA and other policy makers can use these estimates for guidance.

Finally, to produce the maximum economic benefits, the planned BRT must be able to attract choice riders as well as to enhance the experience of transit dependent riders.

Findings of this study are:

- Southeast Michigan has the population density, travel time to work, and average household size comparable to those of other BRT cities.

- Heavy BRT has a greater potential to produce economic benefits.

- Arterial corridors in Southeast Michigan are currently at low-to-moderate congestion levels; therefore BRT will not significantly improve travel times or reduce emissions and noise. However, other benefits – namely land development, job growth, improved ridership base, reduction in travel costs, and an improved tax base – can be expected.

- Tax incentives and the high cost of parking at work can attract choice riders. Federal law currently allows employers to offer employees the opportunity to purchase BRT passes with pre-tax dollars, providing a financial incentive for using transit. The benefit is available only through employers.

- Making development-related data readily available and fostering cooperation among agencies will encourage transit-oriented development.

- Capital investment will produce a significant number of short-term construction-related jobs. Due to the multiplier effect, these jobs will benefit the region economically in the near term.

- Operational investment will generate long-term government and transit-related jobs, specifically, drivers, maintenance personnel, and security and administrative staff.

- Roadway characteristics, job locations, demographics, and other unique local attributes should be taken into account at every stage of development rather than simply duplicating a successful system located elsewhere. For example, 19% of Detroit residents are physically disabled. Facts such as this should be considered when choosing system amenities, such as automatic level boarding.

- A few years after the implementation of BRT, a shift-share analysis should be performed to determine the job sectors and age group advantaged by BRT implementation. Such an analysis will validate this study's models for use by other regions that may be considering BRT.

The planned BRT system has the potential to foster greater sustainability in the region, more efficient public transportation, and most important, a more reliable mode of transportation for those who must rely on transit and those who would choose to forego dependence on automobile travel if a viable alternative were offered. At the same time, there are challenges that must be faced. It is the authors' hope that the current leadership has the will and desire to embrace strategies (some of them already envisioned by SEMCOG) that will make Southeast Michigan a more vibrant community in which to live, work, and raise a family.

APPENDIX A

Figure A-1. BRT Vehicle Configurations

Source: Parsons Brinckerhoff.

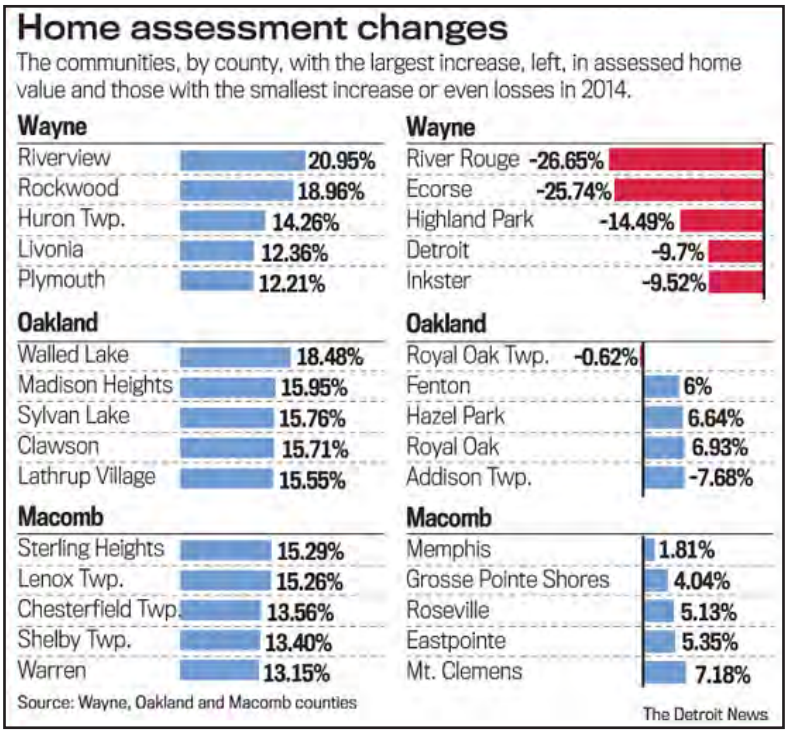

Figure A-2. Change in Home Assessment Value – Year 2014 by Counties

Source: Detroit News.

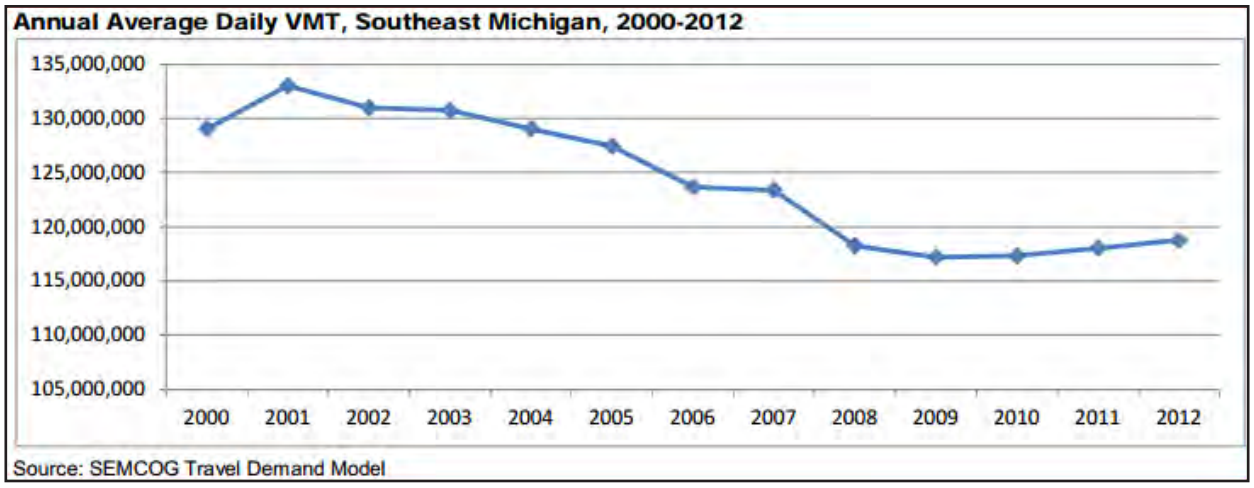

Figure A-3. Southeast Michigan Daily Vehicle Miles Traveled (VMT) 2000–2012
Source: SEMCOG.

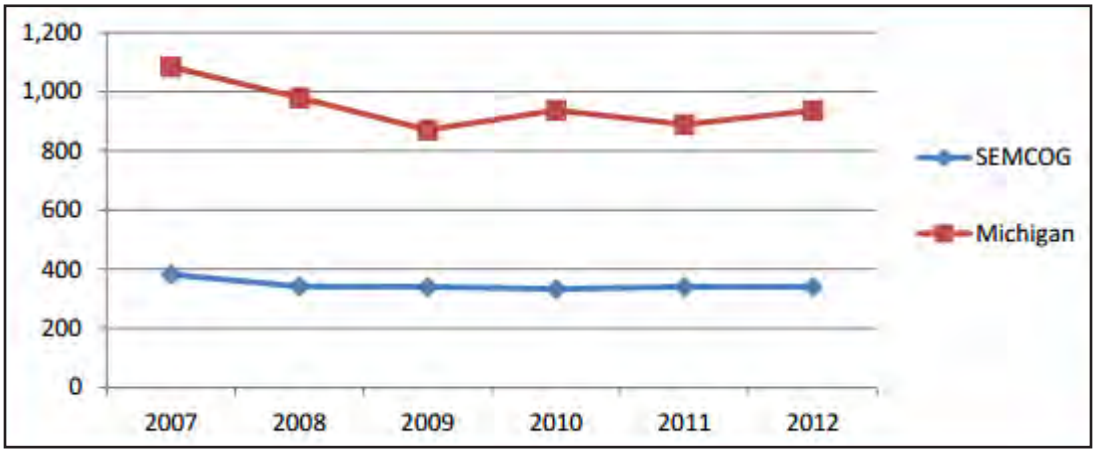

Figure A-4. Traffic Fatality 2007–2012
Source: SEMCOG.

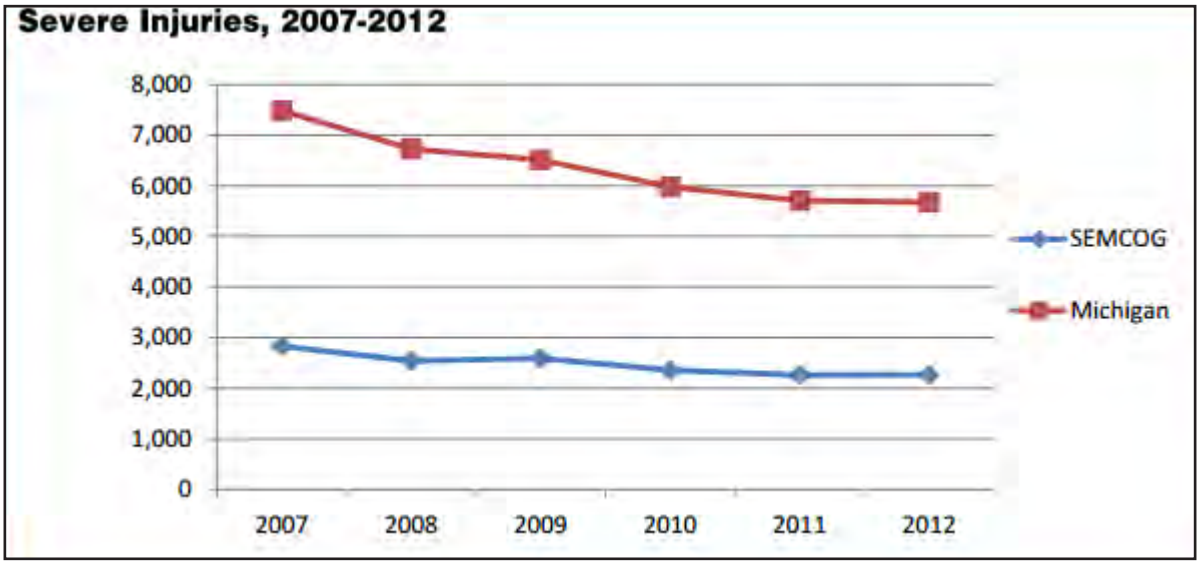

Figure A-5. Traffic Injuries in SEMCOG Region and Michigan 2007–2012
Source: SEMCOG.

Station Area/Transit Zone: The area surrounding a transit station defined by a circle with a half-mile radius.

Transit Shed: the aggregate of transit zones for a transit region.

Transit Region: A metropolitan region containing at least one transit corridor that has been geographically designated as such by the Center for Neighborhood Technology.

Figure A-6. Transit Zone, Shed, and Region Illustrated

Source: CTOD.[111]

Table A-1. Shift-Share Analysis: Impact of Distance from BRT Facilities on Jobs by Industry – the Eugene-Springfield Experience (2004 – 2010)

	Shift in Number of Jobs by Industry in BRT Station Areas	
Economic Sector (NAICS code)	**Within 0.25 miles**	**Within 0.50 miles**
Utilities (22)	(38)	(8)
Construction (23)	(8)	(22)
Manufacturing (31-33)	(41)	(50)
Wholesale Trade (42)	(103)	(113)
Retail Trade (44-45)	118	177
Transportation and Warehousing (48-49)	69	156
Information (51)	361	276
Finance and Insurance (52)	187	298
Real Estate and Rental Leasing (53)	111	143
Professional, Scientific and Technical Services (54)	(7)	(7)
Management of Companies and Enterprises (55)	281	238
Administrative/ Support/Waste management/Remediation Services (56)	848	504
Educational Services (61)	95	104
Health Care and Social Assistance (62)	(615)	(373)
Arts/Entertainment/Recreation (71)	(134)	(79)
Accommodation and Food Services (72)	26	(106)
Other Services (except Public Administration) (81)	91	114
Public Administration (92)	(542)	(543)
Total	**698**	**710**

Source: Adopted from Nelson, A.C. et al.[112]

Table A-2. Impact on Land Development of Selected Bus Rapid Transit Systems

Authors	City	Year Opened	BRT System	Land Development Impact
Rabinovitch and Hoehn (1995)	Curitiba	1974	Surface Metro	High-density residential and commercial development along BRT corridors.
Rodriguez and Targa (2004)	Bogotå	2000	Trans Milenio	After only 2-years of operation of BRT, residential rental costs increased between 6.8% and 9.3% for every 5 minutes walking time to BRT stations.
Rodiguez and Mojica (2009)	Bogotå	2000	Trans Milenio	Network effects were found from the extension of BRT. The asking price of properties in the BRT catchment area was found between 13 % and 14 % higher than that in the control area.
Munoz-Raskin (2010)	Bogotå	2000	Trans Milenio	Within a 10 minute walking distance to Autopista Norte trunk corridor and to the Portal Norte feeder lines, the average annual property value increased 2.2%and 2.9% respectively.
Diaz, et al. (2009)	Boston	2002	Silver Line	Development has accelerated along the Washington Street corridor. Silver Line Phase I has generated at least US $93 million in new development, involving a mix of retail, housing and institution uses.
	Las Vegas	2004	MAX	One casino operator has already invested in pedestrian facilities and an additional station.
	Orlando	1997	LYMMO	The local authority has used the BRT as a tool to promote development. 5 new office building with about 1 million square feet per building and 6 new apartment communities have been developed in downtown, possibly resulting from BRT.
Levinson, Zimmerman, Clinger, Rutherford, et al. (2003) and Levinson, Zimmerman, Clinger, Gast, et al. (2003)	Pittsburgh	1983	East Busway	59 new developments within a 1500-ft radius of station. $302 million in land development benefits, of which $275 million was new construction.
	Ottawa	1987	Transit-way	The construction of the Transitway has led to up to US $675 million in new construction around transit stations.
	Adelaide	1986	Guided Busway	Tea Tree Gully area is becoming an urban village.
	Brisbane	2001	South-East Busway	Property value near BRT stations grew 2 to 3 times faster than those located in non-busway suburbs.
DFT (2008)	Kent	2006	Fastrack	The second route was fully funded by the developer as part of the first major mixed-use regeneration project in the Thames Gateway.
Cervero and Kang (2009)	Seoul	2004	BRT	Land use along BRT corridors was intensified. Within 300 metres of BRT stations, residential land values gained premiums ranging from 5% to 10%; within 150 meters of BRT stations, non-residential land values gained premiums varying between 3% and 26%.

Source : Deng, T. et al.[113]

Table A-3. Comparative Change in Median Income Between Detroit Transit Region and a number of BRT Regions

Transit Region and BRT project in the region	2000	2009	Change (%)
HealthLine (Cleveland, OH)	$42,434	$47,982	13.70
EmX (Eugene, OR)	$36,942	$42,859	16.02
Busway (Pittsburgh, PA)	$37,574	$46,682	24.24
Troost MAX (Kansas City, MO)	$46,914	$56,672	20.80
Metro Rapid (Los Angeles, CA)	$45,293	$58,715	19.63
BHX (Las Vegas, NV)	$43,025	$54,254	26.10
Detroit Transit Region	$49,415	$53,581	8.438

Source: CTOD.[114]

ABBREVIATIONS AND ACRONYMS

AATA	Ann Arbor Transportation Authority
APTA	American Public Transportation Association
BRT	Bus Rapid Transit
BWATC	Blue Water Area Transportation Commission
CEO	Chief Executive Officer
CTOD	Center for Transit-Oriented Development
DDOT	Detroit Department of Transportation
DPM	Detroit People Mover
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GAO	Government Accountability Office
GIS	Geographic Information System
HealthLine	Bus Rapid Transit System in Cleveland
HUD	United States Department of Housing and Urban Development
ITS	Intelligent Transportation System
LET	Lake Erie Transit
LOS	Level of Service
LRT	Light Rail Transit
MDOT	Michigan Department of Transportation
MetroLink	The Light Rail System of St. Louis
MPO	Metropolitan Planning Organization
NCHRP	National Cooperative Highway Research Program
PPP	Public-Private Partnership
RTA	Regional Transit Authority of Southeast Michigan
SEMCOG	Southeast Michigan Council of Governments
SMART	Suburban Mobility Authority for Regional Transportation
TCRP	Transit Cooperative Research Program
TOD	Transit-Oriented Development
TSP	Traffic Signal Priority
UDM	University of Detroit Mercy
U-M	University of Michigan
US DOT	US Department of Transportation
VMT	Vehicle-Miles Traveled
VTPI	Victoria Transport Policy Institute
WA3	Woodward Avenue Action Association

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