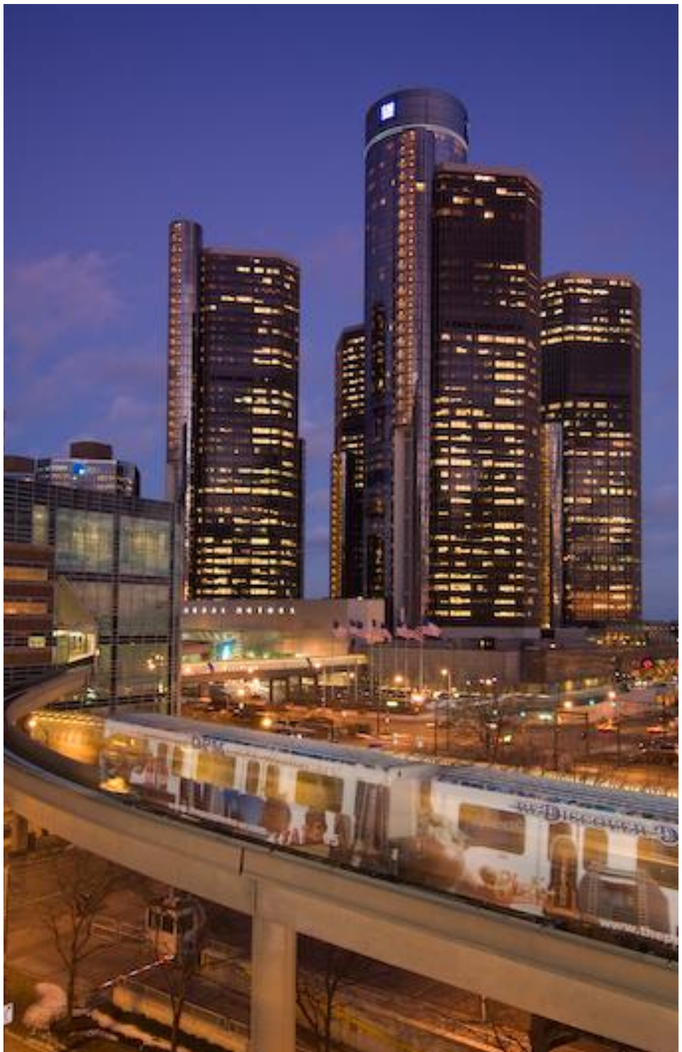

Transit Oriented Development Study for the Detroit People Mover

Final Report

April 29, 2016

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Executive Summary

While the direct benefits of the Detroit People Mover (DPM) to its users are clear, it is generally accepted that the overall benefits of these trips extend beyond just transit riders. Through improved mobility, safety, air quality and economic development, the DPM also benefits users of the roadway network and the community at large. The overall benefits of public transit can be divided into two broad categories: **social benefits** (representing a net gain in society's welfare) and **economic impacts** (accounting for the multiplier effects of spending on the economy). The social benefits can be further broken down into:

- **Transportation cost savings**, which consist of out-of-pocket cost savings (i.e., vehicle operating cost savings), travel time cost savings, travel time reliability benefits, pavement cost savings, accident cost savings and environmental emissions cost savings – these are essentially the benefits of takings cars off the roads;
- **Low-cost mobility benefits**, which consist of affordable mobility benefits (the economic value to access services such as healthcare and education for transit dependent people) and cross-sector benefits (budget savings for welfare and medical services due to the presence of public transit) – these are essentially the benefits of providing an affordable mode of transportation to low-income people; and
- **Community (or transit oriented) development benefits**, which represent the impact on property values of proximity to rail transit stations – these benefits can be measured by means of hedonic analysis.

In addition to these social benefits, public transit can contribute to the economy through transit expenses and reduced congestion.[1]

In 2013, transportation cost savings generated by the DPM totaled $4.49 million. Out-of-pocket cost savings ($1.53 million), travel time cost savings ($1.68 million), and safety cost savings accounted for nearly all of transportation cost savings.

Table ES-1: Transportation Cost Savings

Benefit Category	**$ Millions**
Generalized Cost Savings	$3.21
Travel Time Cost Savings	$1.68
Out-of-Pocket Cost Savings	$1.53
Travel Time Reliability Cost Savings	$0.00*
Emission Cost Savings	$0.05
Non-Carbon** Emission Cost Savings	$0.02
Carbon Emission Cost Savings	$0.03
Safety Cost Savings	$1.22
Pavement Cost Savings	$0.01
TOTAL	**$4.49**

* Greater than $0, but less than $10,000.
** Nitrogen oxides (NOx), sulfur dioxide (SO2), volatile organic compounds (VOC), and fine particulate matter (PM2.5).

[1] Economic impacts associated with the reduction in congestion (as measured by vehicle miles traveled and vehicle hours traveled) due to the presence of the DPM are minimal and are not shown.

Low-cost mobility benefits are relatively small for the DPM given the profile of riders (many of them are visitors) and the fact that very few trips would be foregone in the absence of the DPM (due to the relatively short distance of trips) as indicated by the results of the passenger survey. Overall, low-cost mobility benefits associated with the DPM amounted to just $0.17 million in 2013.

Table ES-2: Low Cost Mobility Benefits

Benefit Category	$ Millions
Affordable Mobility Benefits	$0.11
Cross-Sector Cost Savings	$0.06
TOTAL	**$0.17**

Through a hedonic analysis,[2] the DPM is found to have contributed to increases in commercial property values by 38 percent, while other price determinants (building attributes, socio-economic characteristics of residents, etc.) are held constant. This means that the DPM has caused nearby commercial properties to be 38 percent more valuable and that the average property value would be 38 percent lower in the absence of the DPM. Note that this is not an annual percentage increase in property value. The difference between the prices of properties within and outside the DPM half-mile impact area is called transit premium. The magnitude of DPM's premium reflects the maturity of the system and, thereby, that the system's TOD benefits are fully capitalized into property prices. There is also evidence that the DPM has contributed to increases in residential home values. For residential homes nearby DPM stations, prices on average are 34 percent higher than those outside of the impact area. Overall, the contribution of the DPM to property values is estimated at $119.77 million (in 2000 dollars). Note that, unlike transportation cost savings and low-cost mobility benefits, these are not annually recurring benefits.

Finally, Detroit Transportation Corporation's expenses generate direct, indirect, and induced effects[3] on the economy. These effects were estimated with REMI's TranSight model. Capital expenses generated more than $12 million in business output (total volume of sales) in 2013, including $6.75 million in value added (total volume of sales minus the cost of intermediate purchases; roughly equivalent to the gross domestic product). They also created 89 (full-time and part-time) jobs in the local economy.

Table 1: Economic Impacts

Impact Metric	$ Millions
Business Output	$12.17
Value Added	$6.75
Personal Income	$4.78
Employment	89

[2] Hedonic analysis is a regression technique that estimates the value of a good (e.g., residential property value) based on its characteristics:

- Structural characteristics (e.g., square footage, lot size, property age);
- Location characteristics (e.g., distance to DPM station);
- Neighborhood demographic and economic characteristics (e.g., number of children per household, unemployment rate, median household income).

The contribution of each characteristic to the value of the good is determined by its regression coefficient.

[3] The indirect effect (i.e., supply chain effect) and induced effect (i.e., employee spending effect) are often called "multiplier" effects because they can make the total economic impact substantially larger than the direct effect alone.

Chapter 1 Introduction

Transit oriented development (TOD) aims to promote social, economic, and intellectual interactions between people and it plays a key role in driving community livability, resident quality of life, and business viability. Through transit, residents, visitors, and workers can reach desirable destinations for leisure, education, worship, and employment. Moreover, connections to transit become part of a larger infrastructure network that sustains and helps grow the community.

Detroit Transportation Corporation (DTC) has retained HDR to conduct a TOD study to assess the social benefits and economic impacts of the Detroit People Mover (DPM). Benefits are broadly defined. They represent the extent to which people impacted by the DPM are made better-off, as measured by their own willingness-to-pay. In other words, central to the benefit estimation is the idea that people are best able to judge what is “good” for them, or what improves their well-being or welfare. Aside from those social benefits, the economic impacts of the DPM are measured in terms of changes in employment, personal income, and gross domestic product (GDP).

The study consists of two phases. Phase One focuses on the development of a modeling tool to measure the economic benefits generated by the DPM. Phase Two deals with the implementation of the model and the assessment of benefits. The results of the study will be used by DTC and other local stakeholders to demonstrate the economic worthiness of transit investment and inform the need for planning and funding strategies to support local and regional rail transit in Southeast Michigan.

The report is organized as follows. Chapter 2 presents in detail the methodology used to estimate the different economic benefits generated by the DPM. Chapter 3 covers the hedonic analysis of the DPM. Chapter 4 presents the results a passenger survey conducted by HDR in March 2015 and provides a summary of other model inputs. Chapter 5 presents the results of the transit benefit analysis, including two case studies. Chapter 6 includes the final version of the user manual for the economic model. The report also includes a number of appendices including the survey instrument, the consumer surplus approach, the complete survey results, a summary table of the TranSight model output (provided by Michigan Department of Transportation) for the economic impact analysis, and a list of acronyms used throughout the report.

Chapter 2 Benefit Assessment Methodology

The approach to assess the economic worthiness of the DPM recognizes a number of principles, or pillars, upon which the accuracy, credibility, and usefulness of any economic assessment rest. The guiding principles are summarized below.

- **Account for all positive and negative effects of the DPM** – Positive effects are treated as benefits (or cost savings), while negative effects are treated as costs in the model;
- **Assess the "incrementality" of benefits** – In accordance with this principle we measure the incremental cost savings associated with (i) individuals switching from personal vehicles and other less affordable transportation modes to the DPM, (ii) the change in the total number of trips as a result of the DPM, and (iii) the change in property values due to the presence of the DPM. The scenarios that allow for incremental impact comparisons with and without the DPM, are referred as to as Build and No-Build respectively;
- **Avoid double-counting** – Benefits should not be estimated more than once. This is important because the economic value of some effects can arise in more than one category[4]; and
- **Acknowledge the uncertainty surrounding model assumptions** – To account for uncertainty, the analysis is conducted within a risk analysis framework, thereby providing the full distribution of potential outcomes in lieu of single point estimates.

The output metrics that are monetized are additive. The mathematical property of the metrics allows scalability of the inputs and thus enhances the flexibility of the model. Results from the risk analysis however, are not additive because of they are probability distributions. Lastly, economic benefits and impacts, measured in monetary terms and in employment counts respectively, are not additive.

Estimation of Benefits

This section presents the methodology to estimate DPM benefits associated with community development, congestion management, safety enhancement, and environmental sustainability. Other benefit estimations demonstrate that DPM can be a provider of affordable mobility and benefits to transit dependent sectors such as education and healthcare.

Estimation of Community Development Benefits

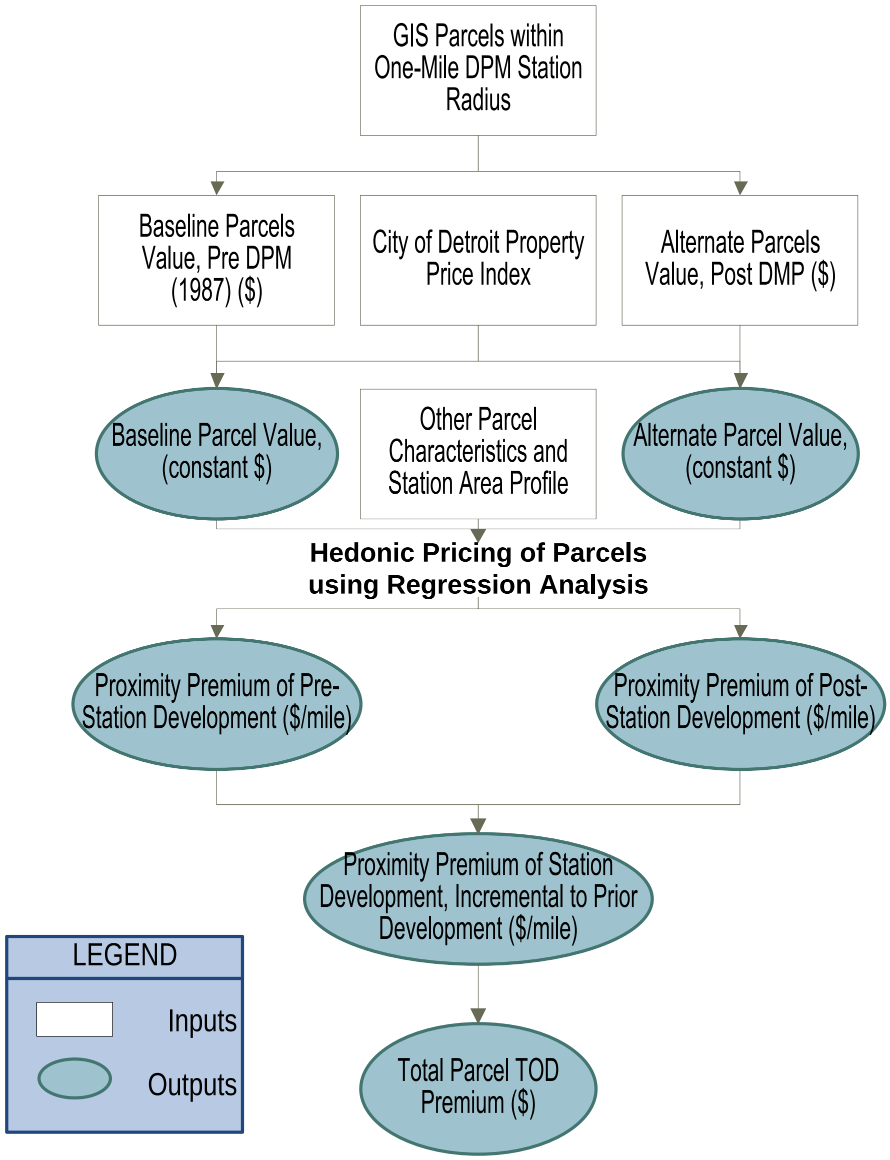
Together with strategic community planning, transit can deliver development benefits by connecting people to economic, social, educational, and cultural activities. The resulting development can be referred to as livable communities and the benefits are often capitalized in real estate property values (also known as property value or TOD premiums). To account for the route and station location impact of the DPM on property values, a hedonic analysis of property prices is conducted. Incremental impacts of the DPM are estimated through an econometric model that explains prices through property and location characteristics. The resulting TOD

[4] For instance, car insurance should not be included in vehicle ownership and operating costs if it is already accounted for in accident costs.

premiums that are aggregated over all station area properties yield an estimate of community benefits generated by the DPM.

A structure and logic diagram depicting the analytical process is provided in Figure 1.

Figure 1: Structure and Logic of Community Development Benefits Estimation



Initial data analysis for the model rely on geographic and spatial processing (in ESRI's ArcGIS) of station area real estate properties and associated neighborhood and socioeconomic characteristics. The geo-spatial profile forms the basis for the hedonic price model for properties along the DPM. The profile's coordinate system is established using the DPM route base map (obtained from ESRI) and is joined with the following geographical information system (GIS) shapefiles:

- Station locations (created in GIS);
- City of Detroit Parcel data (2013);
- Data Driven Detroit Motor City Mapping Parcel Survey (2014)[5]; and
- ESRI US Census Demographic Profile (at the block group level).

An econometric model is used for estimating hedonic price of access to the DPM to reveal willingness to pay for community development. It models property prices (adjusted using the Case Shiller Home Price Index[6] and Moody's/ REAL Commercial Property Price Index[7]) as a function of parcel structural information (such as building square footage, lot size, and age of structure), neighborhood characteristics (such as population, ethnic composition, and income), and proximity to transit. Impacts are separated by residential versus commercial parcels, so that different types of developmental impacts are estimated. The results are used to infer the value premium near DPM stations, based on the changes in property prices with respect to station locations pre- and post-DPM opening. Additional factors being controlled for in the model include potential impacts of the following events on transit and property values:

- Changes in transit service and management in 1994;
- DPM service interruptions in 2002-2004;
- Opening of Rosa Parks Transit Center in 2009;
- Economic recession in 2008-2011;
- Announcement of the M-1 RAIL in 2010; and
- Opening of the Z (retail and parking structure) in 2014.

Estimation of Congestion Mitigation Benefits

Public transportation enhances the economic competitiveness of a central business district (CBD) by improving mobility within the study area as a result of reductions in generalized travel cost. In estimating congestion management benefits, impacts to a variety of roadway users (automobile drivers, transit riders (bus and DPM), taxi riders, bicyclists, and pedestrians) are considered. The framework for estimating user benefits is based upon the theory of demand, and involves the estimation of changes in consumer surplus (refer to Appendix C for explanation of the concept).

Demand for travel is composed of the number of trips taken and the associated willingness-to-pay or cost for each trip. The relationship between the two components is illustrated in Figure 2. Holding everything else constant, the greater the number of trips taken, the lower the cost associated with each trip. Benefits to existing trip-makers are represented by the red rectangle under the travel demand curve in Figure 2 on the next page. They are estimated as the difference between the generalized cost of travel in the No-Build case and the Build scenario, times the number of existing trips.

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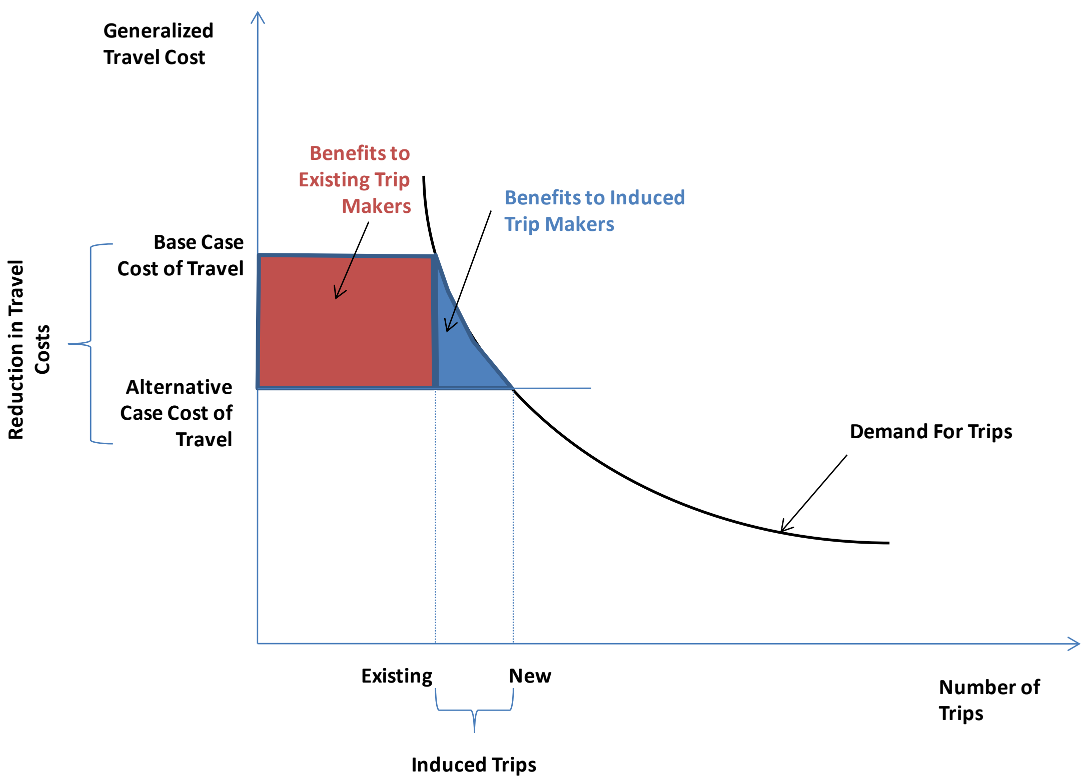
[5] Data Driven Detroit (D3), http://d3.d3.opendata.arcgis.com/datasets/7cfed5afb7654e2495ef4c1ead320aa5_0; downloaded on 13th October, 2014. Information is also based on a conversation with GIS specialist Joshua Long at D3.
[6] Federal Reserve Bank of St. Louis, http://research.stlouisfed.org/fred2/series/SPCS20RSA/downloaddata; downloaded on 13th October, 2014.
[7] Real Capital Analytics, https://www.rcanalytics.com/Public/rca_cppi.aspx; downloaded on 13th October, 2014.

In addition, as the generalized cost of travel is being reduced, additional trips (beyond those diverted from other modes) are expected. These induced trip-makers represent a portion of all potential trip-makers who did not make a trip (or as many trips) in the No-Build scenario, but are now "attracted" to the lower generalized cost allowed by the investment.

User benefits resulting from new trips are depicted by the blue triangle in Figure 2. They are estimated using the "rule-of-a-half", which halves the change in cost times the change in the number of trips taken to represent the area (blue triangle) under the demand curve. The change in generalized cost from the No-Build scenario to the Build scenario only represents the change in user costs (travel time plus out-of-pocket costs). Social costs, including air emissions, accident occurrences, and congestion externalities are assumed not to affect trip making or modal decisions in the analysis of generalized travel cost.

Figure 2: Framework for the Estimation of User Benefits

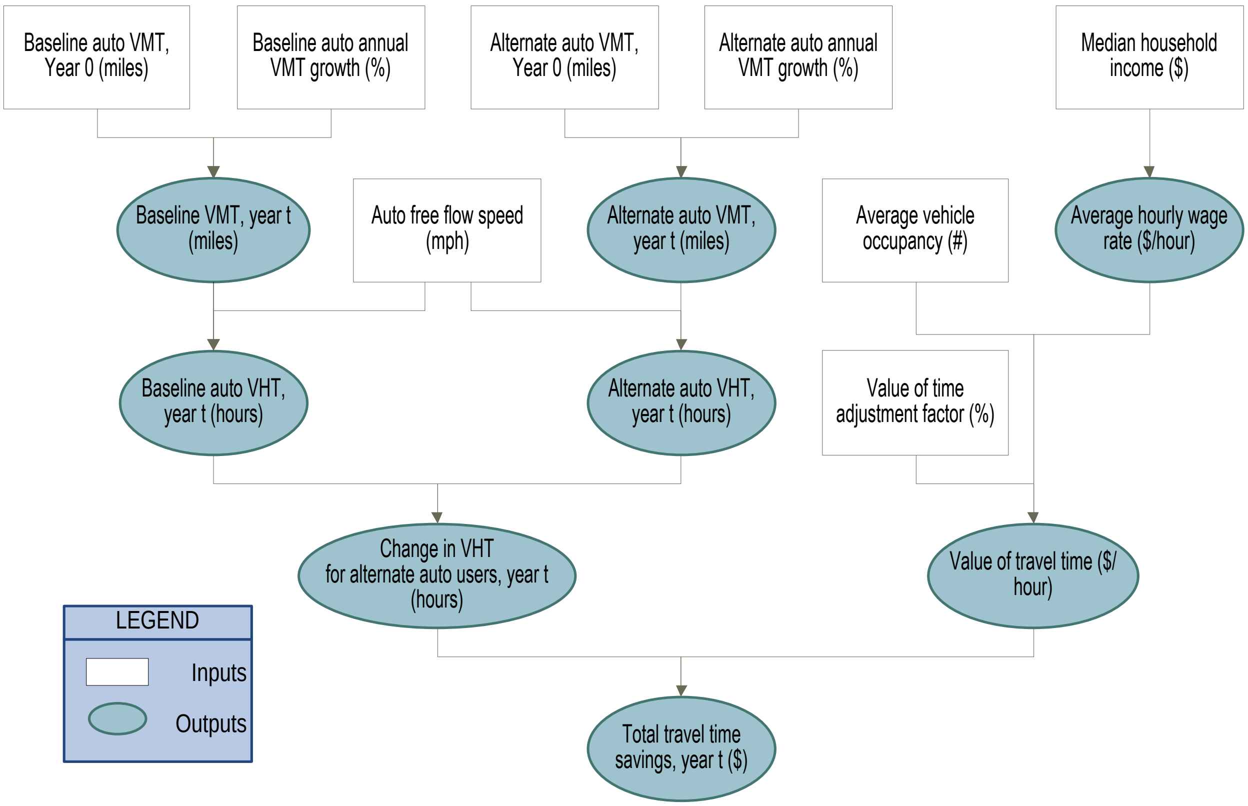


Using the framework presented above, generalized travel cost savings are computed for:

- Automobile roadway users who divert to DPM;
- Remaining automobile roadway users;
- Previous bus users diverting to DPM; and
- Bicyclists and pedestrians diverting to DPM.

The generalized travel cost has two components: travel time cost and out-of-pocket costs. Travel time savings for travelers are dependent on the reduction in time spent on traveling (travel time) and travelers' value of time (VOT). Auto users who remain on the roadway network experience a reduction in travel time as a result of the reduction in congestion that arises as capacity improves and travel routes are optimized, depending on their origin and destination. Their VOT is then applied to each reduction in travel time to estimate the reduction in travel time costs. A structure and logic diagram depicting the analytical process using changes in vehicle miles traveled (VMT) is provided in Figure 3.

Figure 3: Structure and Logic of Automobile Travel Time Savings Estimation



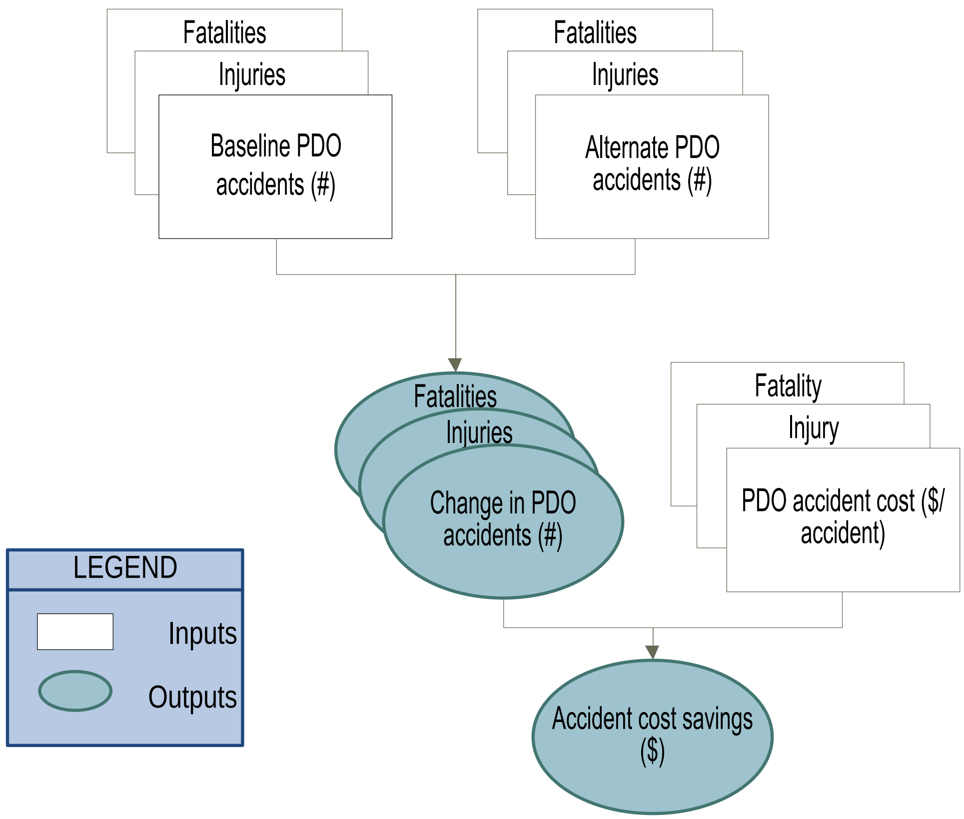
Out-of-pocket costs are estimated based on changes in trip costs involved in operating and maintaining automobile for transport. The changes reflect how transit has impacted roadway conditions for drivers. The out-of-pocket costs are combined with parking cost to estimate the total out-of-pocket cost per trip for auto users. The decrease in out-of-pocket cost in the Build scenario represents out-of-pocket cost savings for remaining auto users. For travelers who divert from other modes to DPM, the out-of-pocket savings are estimated by changes in fare payments (if applicable) and out-of-vehicle time costs.

Estimation of Safety Benefits

The DPM can reduce the likelihood of surface transportation-related accidents, as roadway conditions are expected to improve with fewer automobiles. Changes in automobile VMT is expected to lead to changes in the probability of accidents on the roadway network. Additionally, DPM is operated on one-way, elevated guideway, so it is relatively safer than other transportation modes (including other transit modes such as buses). Given the alternative of a safer mode of transport along with improved roadway conditions, the number of accidents is expected to decrease, which in turn results in a net societal safety benefit.

Changes in the number of accidents, like other variables, are dependent on the type of transport infrastructure improvement and expansion. The rates for fatal, injury, property damage only (PDO) accidents are combined with VMT estimates. Safety benefits are calculated as the difference between the total cost of accidents under the Build scenario and that under the No-Build scenario using changes in VMT. A structure and logic diagram depicting the analytical process is provided in Figure 4.

Figure 4: Structure and Logic of Accident Cost Savings Estimation

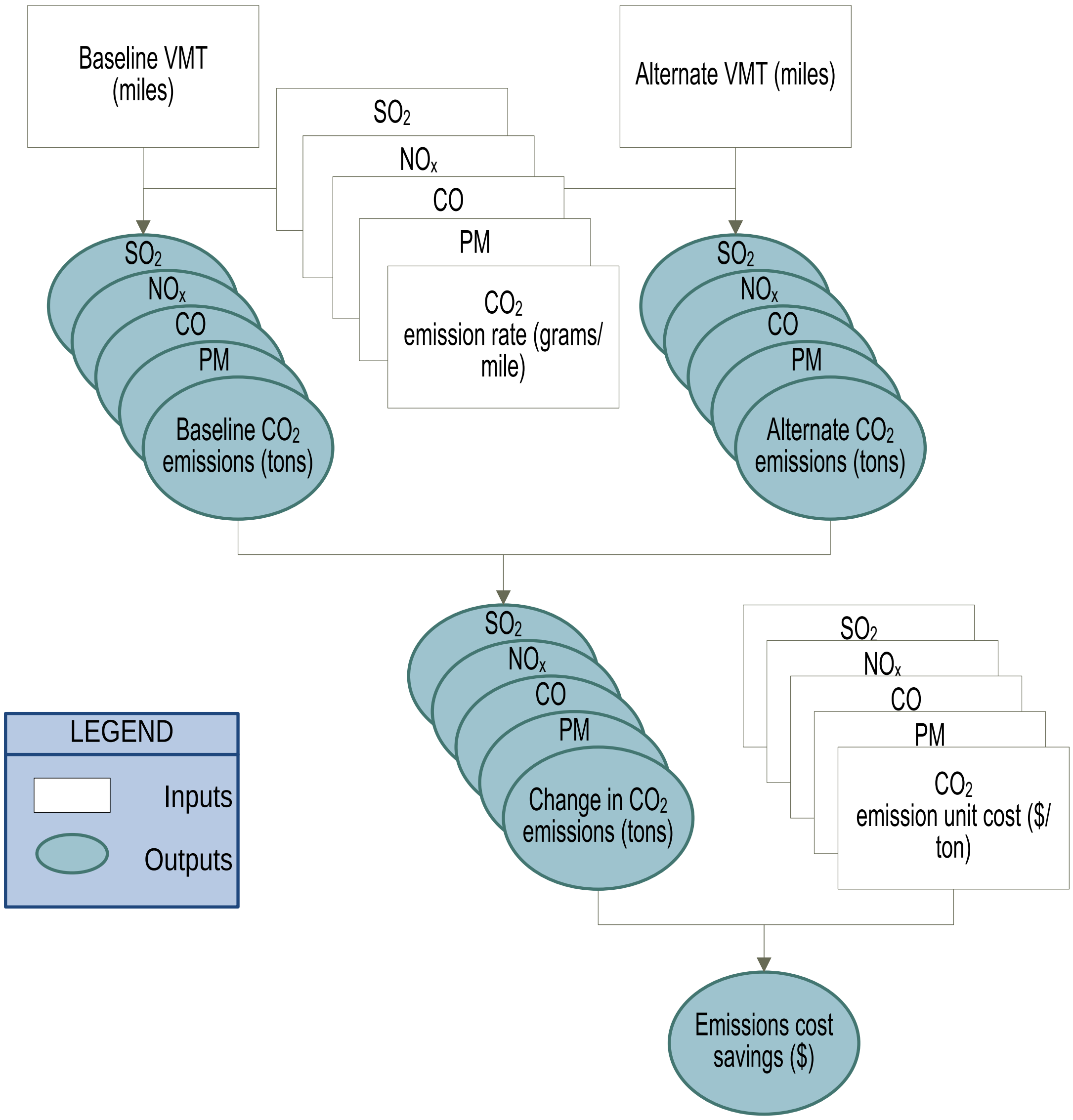


Estimation of Environmental Sustainability Benefits

The DPM may generate positive environmental impacts in addition to the roadway impacts by altering motorized vehicle usage and thus changing fossil fuel consumption. For the project, two categories of environmental impacts are considered: reduction in greenhouse gas emissions and reduction in air pollutant emissions. Greenhouse gas emissions are measured in carbon dioxide (CO_2) equivalent and air pollutants include carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), volatile organic compounds (VOC) and fine particulate matter (PM2.5).

Reductions in emission volumes are dependent upon the fuel efficiency of automobiles on the roadway network. The emission rates are obtained from Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator (MOVES). Per-unit emission costs are then applied to the changes in emission volumes dues to changes in roadway conditions. A structure and logic diagram depicting the analytical process is provided in Figure 5.

Figure 5: Structure and Logic of Emission Cost Savings Estimation



Estimation of Other Benefits

The affordable mobility benefits of DPM can include providing an affordable and high quality alternative for commuting to work, accessing medical, educational, recreational, and shopping facilities. The benefits under this category can include the impacts on key mobility vulnerable sectors for seniors and persons with disabilities. For example, the percent of lost medical trips (which can lead to home health care) and lost work trips (which can lead to unemployment) generate added home care visits and lost jobs. The incremental costs for each added home health care visit is multiplied by the number of added visits to estimate the monetary value of these trips. Likewise, the added food stamp costs and unemployment compensation benefits per lost job is multiplied by the number of lost jobs to arrive at estimates of the monetary value of lost jobs.

Estimation of Economic Impacts

The regional effects of DPM infrastructure investment and operations (as well the effects of reduction in congestion) are measured using the Regional Economic Models, Inc. (REMI) model, a dynamic system that relies on econometric equations and an input-output (I-O) model[8]. REMI captures stable and long term employment changes due to the DPM within related industry sectors in the Detroit, which are derived from temporal and spatial impacts occurring over time.

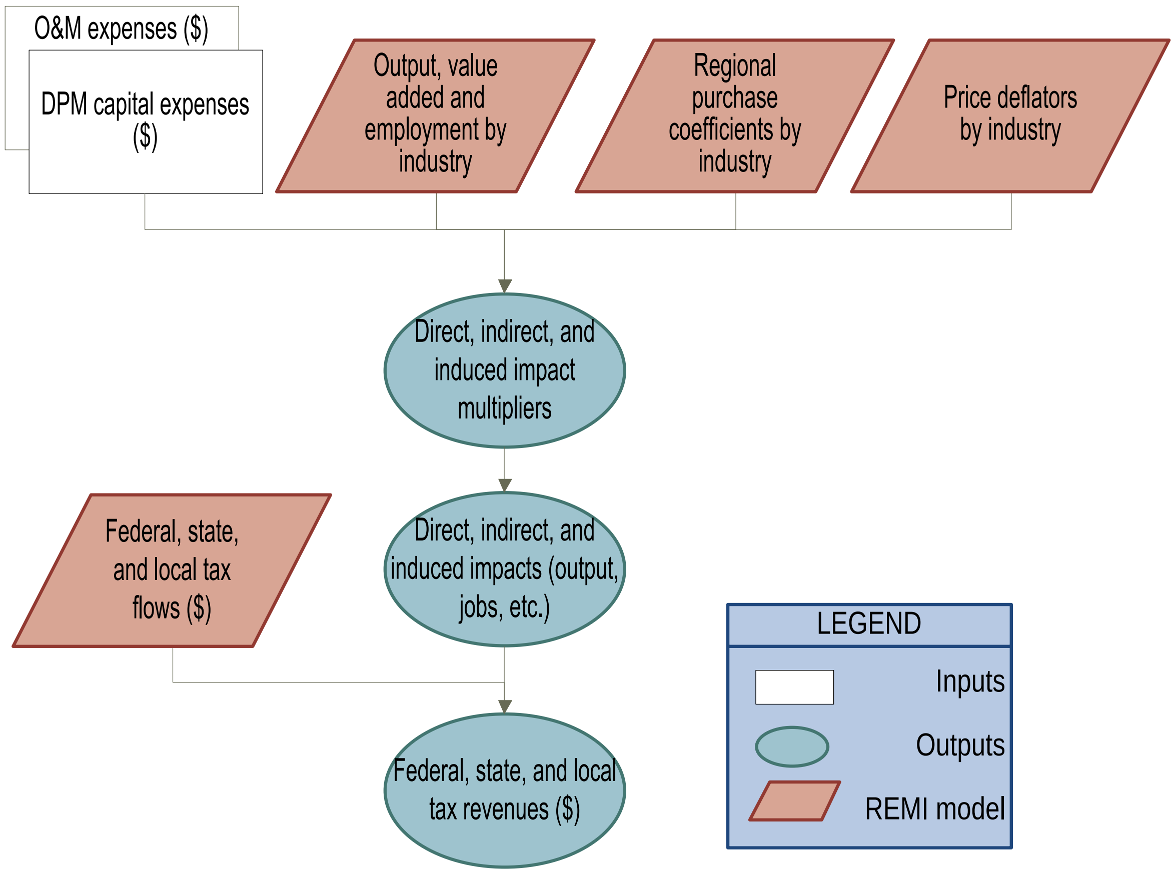
The assessment estimates job creations based on the multiplier (or “trickle-down”) effects of DPM capital and operational expenses, as well monetized travel time savings. Job creations are based on three distinct outcomes of the REMI model:

- **Direct impacts** refer to the economic activity (output, income, and employment) occurring as the result of direct spending for the DPM (such as O&M expenses). Results include employment of workers, sales of locally produced goods and services, and generation of local tax revenue.
- **Indirect impacts** refer to other economic activities that are directly attributable to the operation of the DPM. For instance, they can be the result of purchases by local firms who are the direct suppliers to the DPM such as parts to rehabilitate the DPM vehicles. The spending by these supplier firms for labor, goods and services necessary for the production of their product or service creates output from other firms further down the production chain, thus bringing about additional employment, income, and tax revenue.
- **Induced impacts** represent the increase in economic activity over and above the direct and indirect impacts, generated by successive rounds of spending (often referred to as re-spending). Induced impacts are changes in business output, employment, income, and tax revenue that are the result of personal (or household) spending for goods and services – including employees of the DTC, employees of direct supplier firms, and employees of all other firms comprising the indirect impact.

The modeling process of the monetizing economic impacts of DPM capital and operation and maintenance (O&M) expenses is illustrated in Figure 6. Capital spending (track, signals, systems, rolling stock, etc.) is averaged over several years to yield annual expenditure estimates so that year-to-year fluctuations are accounted for.

[8] An I-O model calculates impact multipliers, which are then used to compute direct, indirect, and induced effects – output, value added, employment, and tax revenue generated per e dollar of direct spending.

Figure 6: Structure and Logic of Economic Impacts of DPM Capital and O&M Expenses



During the model construction phase (Phase One) of the TOD study, a literature review of recent transit-related hedonic analyses of property values has been conducted to inform the best practices and state-of-the-art of methods. Parallel to the literature review is a data collection effort, which helps refine the potential methods being applied. Lessons learned from the review and data collection have been incorporated into the benefit assessment methodology. For example, the number of parcels within the originally proposed quarter-mile study area is insufficient. Upon reviewing other studies with similar data issues, the DPM study area buffer has been expanded to one mile, so that there are sufficient observations for a meaningful and robust analysis.

Chapter 3 Hedonic Analysis

To assess the economic development benefits of the DPM, a hedonic pricing model of property values is used. The model accounts for factors that contribute to changes in property prices, including transit investment near real estate properties. The types of properties analyzed in hedonic pricing models usually include residential and commercial parcels, as changes in economic activities can drive real estate prices. Prices of civic and institutional parcels such as places of worship and schools are not considered to be influenced by transportation-related economic development and are therefore not part of the assessment.

Property prices are driven by a number of factors that include structural, location, and neighborhood demographic and economic characteristics. Larger and newer properties with access to desirable destinations usually command higher prices. Properties located in more affluent and economically viable neighborhoods also tend to be more expensive. By accounting for all measureable factors that contribute to changes in prices, the impact of transit (DPM) should be a net result that is free of other physical, location, demographic, and economic price determinants.

Data & Study Area

For the hedonic model of properties impacted by the DPM, HDR obtained the following datasets:

- 2013 City of Detroit residential and commercial parcels (recorded by parcel identification number (PIN) and geographic coordinates) – lot size in square feet, building square footage, year built, last transaction value and date, current improvement (or building) tax assessment value, current land tax assessment value, previous (year 2012) assessment values, and land use[9];
- 2014 parcel data survey from Data Driven Detroit (recorded by parcel PIN and geographic coordinates) – number of units in building;
- ESRI ArcMap DPM route and City of Detroit street map;
- US Census 1990, 2000, and 2010 block group level boundary shapefiles (identified by 12-digit geographic identification number (GeoID)[10] and geographic coordinates);
- Wayne County Census block group level demographic and economic profile (identified by GeoID) – population, ethnic composition, labor force, income, education attainment, number of households without children, and number of workers commuting to work without using car, truck, or van;
- 1976-2000 Bureau of Labor Statistics producer price index (PPI) for finished goods[11];
- 2000-2013 Capital Analytics Commercial Property Price Index (CPPI);
- 1970-1990 Census median home price value; and

[9] Parcel land use is not consistently reported. Land use is separated into two fields, *Commercial Occupant* and *Residential Occupant*. Apartments can be listed under Commercial and/ or Residential. Single-family homes versus multifamily homes are not consistently recorded. Other missing information that is usually available in tax assessment data includes number of bedrooms, number of bathrooms, and number of units, for residential parcels.
[10] The first two digits account for the state, then the next three digits denote the county. Census tract contains four digits and block group has three.
[11] Federal Reserve Bank of St. Louis PPI: Finished Goods, series number PPIFGS_NBD20000101.

- 1984-2013 Moody's Analytics Case Shiller Home Price Index (HPI).

Additionally, the study team created the following data shapefiles to support the spatial aspect of the study using ArcMap:

- DPM station locations (13 created using ESRI street map); and
- Parcels within one-mile radius[12] of DPM stations with distance (measured in feet) from nearest DPM station, DPM route, and proximity to nearest highway on- / off-ramps.

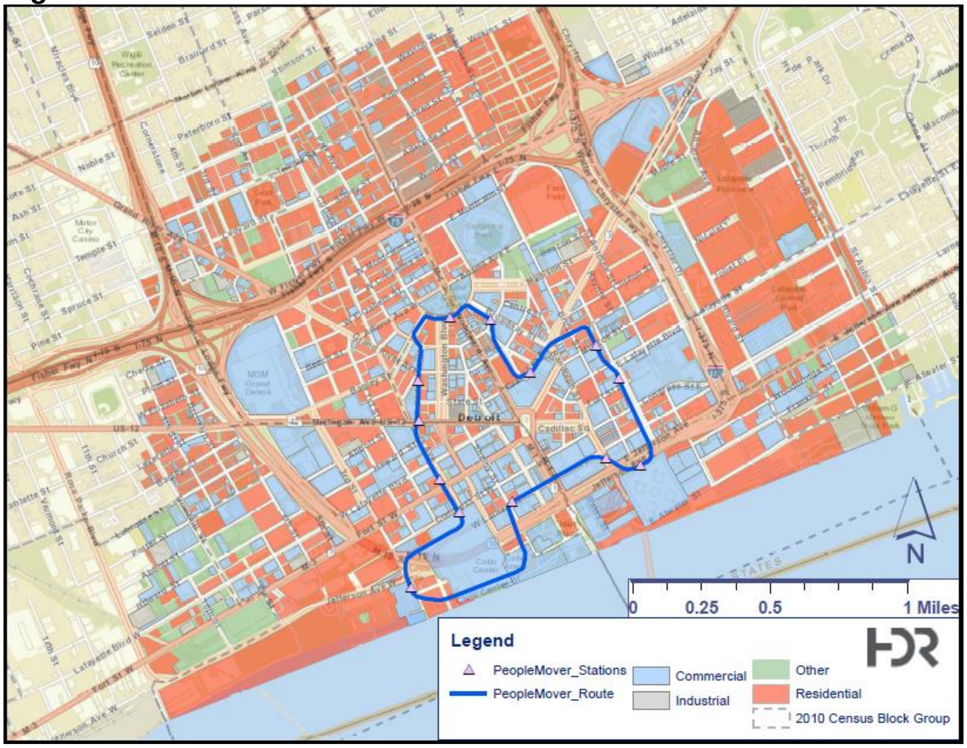
Based on the station location, ArcMap records the closest station to each parcel and computes the straight-line distance between the station and the parcel. The distance measure is a proxy for the proximity of the amenity benefits generated by the DPM station. Similarly, the value of access to highway is estimated through distance to nearest on- / off-ramps.

All the datasets with spatial information are joined within ArcMap using the geographic coordinates of the parcels. Three specifications are made for the joint process[13]:

- A parcel is considered within the one-mile radius of DPM if its centroid falls completely within the buffer zone. Parcels that are within the one-mile radius of DPM are displayed in Figure 7;
- A parcel belongs to a block group if it touches the boundary or falls completely within the block group; and
- A parcel is assigned to one of 13 station "areas" if that one station is the closest to that property. Although individual station areas are not analyzed in separate analyses due to data limitations, each station's land use intensity, diversity, and vacancy are assessed. The land use characterizations are detailed in the data processing sections.

[12] Common practice is to use one-quarter- to half-mile radius. A larger catchment area is used to increase the robustness of the statistical analysis.
[13] Note that Census block group boundaries and GeoID are different among Census 1990, 2000, and 2010 and three separate spatial joints with the parcel data are performed.

Figure 7: Parcel Lane Use of One-Mile Buffer from DPM Route



Once the parcel data are joined spatially with the Census boundary shapefiles, demographic and economic data are matched to each block group using the 12-digit GeoID. Census data used in the analysis include:

- Median household income (adjusted to year 2000 dollars using the consumer price index);
- Total population;
- Percentage non-white (computed as 100 percent minus white population percentage);
- Percentage college graduates (computed as number of persons aged 25 and above with a college degree);
- Percentage of households without children;
- Percentage of workers (number of civilian unemployed labor aged 16 and above) not using a personal vehicle (drive alone or carpooled) to commute; and
- Percentage unemployed (computed as number of civilian unemployed labor force member aged 16 and above).

Data Processing

After all the data are merged, the complete database is adjusted for the statistical analysis. Prices are adjusted with price indices (CPPI and HPI) using the year 2000 as the base. The price adjustment provides a meaningful comparison of prices among different years. In earlier years during which property price indices are yet not available, PPI or Census median home values are used instead. However, when a parcel's transaction value (but not transaction date) is missing, assessed improvement (or building) value and land value are used for an estimate of the transaction price. The total assessed value is adjusted from 2013 (assessment year) based on the month during which the transaction took place. Parcels with missing information on land use, size, age, and transaction are removed. Also, parcels without Census block level information are removed.

Aside from a half-mile radius dummy variable that controls for proximity to DPM station for properties sold after 1987, there are other location variables used to assess property values. The variable *Distance to DPM Station* is used to control for proximity to specific destinations of the city. The variable captures the amenity effects of downtown locations that later became DPM stations. Any additional amenity generated by the DPM will be captured by the interaction term *Half-Mile DPM Station Dummy Variable*Post 1987 Dummy Variable,* from which the transit premium is generated. The other station area control variables concern land use diversity, intensity, and vacancy.

The Land Use Diversity Index measures the mix of parcel acreage within a station area. The index is computed for each of the DPM stations and is based on the land use of the parcels closest to each station – each parcel is "assigned" a station in ArcGIS based on the shortest distance between a parcel and the stations. The index is computed following Goetz et al. (2010):

$$Land\ Use\ Diversity = 1 - \frac{\left|\frac{r}{T} - \frac{1}{4}\right| + \left|\frac{c}{T} - \frac{1}{4}\right| + \left|\frac{i}{T} - \frac{1}{4}\right| + \left|\frac{o}{T} - \frac{1}{4}\right|}{{}^{3}/_{2}}$$

$$= \begin{cases} 1 & if\ there\ is\ perfect\ mixing \\ 0 & if\ there\ exists\ one\ exclusive\ land\ use \end{cases}$$

For

r = total land area for residential use (single-family and multifamily)
c = total land area for commercial use
i = total land area for industrial use
o = total area for other land use
T = *r* + *c* + *i* + *o*

The *Station Area Land Use Intensity* measures the density of the station area. It is based on the total building area over the total land area and is also referred to as floor area ratio. When the ratio is over 100 percent, building area is greater than land area and the use is relatively more intense. The variable can be a proxy for population or production density.

A summary of the parcel data with associated Census profile is provided in Table 2:

Table 2: Summary of Parcel Characteristics Used in Hedonic Analysis

Variable	Residential Property	Commercial Property
Number of Observations	332 out of 2,145*	257 out of 496
Median sale value (in year 2000$)	$65,294**	$369,311

Variable	Residential Property	Commercial Property
Median building age	50.0	81.0
Median building square footage	1,617	12,800
Median building lot size (in sq. ft.)	2,744	7,579
Median number of buildings	2.0	1.0
Average percent college graduates	14.3%	13.5%
Average percent unemployed	14.4%	15.2%
Average percent non-white	65.8%	Not Applied
Average percent non-car/ truck/ van in commute	45.0%	49.2%
Average percent households without children	76.3%	Not Applied
Average household income (in year 2000$)	$26,025	$28,854
Average distance to closest DPM station (in feet)	3,128	1,664
Average distance to DPM route (in feet)	2,999	1,489
Station area average land use intensity	96.4%	184.0%
Station area average land use mix	41.9%	40.2%
Station area average vacant land	20.3%	26.0%

*Notes: * 875 of the 2,145 have prior transaction information and additional 926 have no structural information. The City of Detroit GIS Sales a d Service Center suggests that many of the data are missing information because of parcel vacancy, property foreclosures, and that the buildings have not been assessed in the past several years. In terms of prices, over 200 parcels have transaction price below $100,000, which explains the low median home value.*
*** The mean value of this sample is over $600,000.*

Methodology

A hedonic pricing model[14] is constructed for assessing the impact of the DPM on property values. For the DPM, one output of the hedonic analysis is the transit premium – the amount of DPM livability or economic development benefit that has been capitalized in property prices. The other outputs are the incremental amount that property owners are paying for additional amount property characteristics.

The general conception of pricing function, f, can be written as:

$$p_{i,t} = f(S, N, L\ )_{i,t}$$

where,

[14] Formally, the outputs of a hedonic model are consumer willingness to pay for a product's individual characteristics and they generally represent the benefits associated with incremental amounts of the product being consumed.

- $p_{i,t}$ is the price of property i sold at time t;
- $S_{i,t}$ is a set of structural attributes for the ith property sold at time t;
- $N_{i,t}$ is a set of socio-economic and demographic characteristics for the Census block group in which property i sold at time t is located; and
- L_{i} includes relevant location attributes for the property in relation to a network (e.g. transit).

Using statistical methods to estimate the pricing function, implicit prices for the characteristics are determined by the change in property prices resulting from variations in structural, neighborhood, and location characteristics. As the stations are located near one another, amenity/ livability benefits may overlap among stations as studies have found that station area impacts can extend to and beyond half-mile radius from stations. To avoid double-counting of station impacts, the analysis evaluates an average station proximity effect, rather than an accumulation of individual station effect.

The full conceptual pricing function is estimated in the statistical software EViews using a linear regression of the following logarithmic specification:

$$
\begin{aligned}
\ln(sale\ value) = {} & a_0 + a_1 \ln(building\ age) + a_2 \ln(building\ lot\ size) \\
& + a_3 \ln(building\ square\ footage) + a_4 \ln(Household\ Income) \\
& + a_5\ Percent\ College\ Graduates + a_6\ Percent\ Unemployed \\
& + a_7\ Percent\ Non-White\ Population + a_8 \ln(Population) \\
& + a_9\ Percent\ of\ Household\ Not\ Using\ Car, \\
& \quad Truck\ or\ Van\ to\ Commute\ to\ Work \\
& + a_{10}\ Percent\ of\ Households\ without\ Children \\
& + a_{11}\ Half-Mile\ DPM\ Station\ Dummy\ Variable \\
& \quad *\ Post\ 1987\ Dummy\ Variable \\
& + a_{12}\ Distance\ to\ DPM\ Station \\
& + a_{13}\ Distance\ to\ Nearest\ Highway\ On-Off\ Ramps \\
& + a_{14}\ Station\ Area\ Percent\ Vacant \\
& + a_{15}\ Station\ Area\ Land\ Use\ Diversity\ Index \\
& + a_{16}\ Station\ Area\ Land\ Use\ Intensity \\
& + a_{\dots}\ Dummy\ Variables\ for\ Special\ Events + error\ term
\end{aligned}
$$

The logarithmic specification of the function allows the coefficients, $a_{.}$, to be interpreted as elasticity or semi-elasticity measures. The transit premium, ρ, reflects the amenity benefits of the DPM and is measured by the incremental price difference in property value based on proximity to DPM stations defined by a half-mile radius, pre- and post- DPM operations. The value is computed using the exponential function (anti-logarithmic function) as:

$$
\begin{aligned}
Transit\ Premium \equiv \rho & = Percentage\ Change\ in\ Prices\ Near\ DPM\ Stations \\
& = [exp(a_{11}) - 1] * 100\%
\end{aligned}
$$

Lastly, dummy variables are added to account for historical special events that may have impacted property prices as well as operations of the DPM. Statistical tests are performed to ensure that all the variables are necessary to explain property prices in the model. The resulting function includes only variables that are tested to be statistically contributing to model.

Model Results

The results for the two types of properties being investigated are reported in Table 3. Unless indicated, all the coefficients are statistically significant at the five percent confidence level, meaning that there is only less than five percent likelihood that the coefficient is statistically identical to zero. Standard errors of the coefficients are reported in parentheses (). Variables that are tested as redundant are denoted with "-" in the table as they are removed from the analysis. Variables assumed to be irrelevant are denoted by empty and colored cells.

Table 3: Hedonic Analysis Results

Independent Variable	Residential Property	Commercial Property
Constant	6.78 (0.54)	8.72 (0.72)
Logarithmic (building age)	-0.76 (0.09)	-0.36 (0.10)
Logarithmic (building square footage)	0.61 (0.05)	0.33 (0.04)
Logarithmic (building number)	-0.69 (0.08)	-
Logarithmic (building lot size)	0.17 (0.07)	0.36 (0.07)
Logarithmic (population)	-	-
Percent college graduates	-	-
Percent unemployed	-5.13 (0.39)	0.20 (0.34)*
Percent non-white	-	
Logarithmic (household income)	-	-
Percent household using non-car/ truck/ van in commute	-	-0.34 (0.19)**
Percent households without children	2.91 (0.47)	
Half-mile dummy post 1987	0.30 (0.17)**	0.33 (0.17)
Distance to DPM station	-	-0.0003 (0.00)
Distance to Nearest Highway On-/ Off-Ramps	0.001 (0.00)	-0.0001 (0.00)*
Station Area Vacant Land	-	-2.57 (0.32)
Station Area Land Use Diversity	-	-
Station Area Land Use Intensity	0.14 (0.08)**	-
Post 1994 Dummy Variable	-	0.61 (0.14)
Between 2008 and 2011 Dummy Variable	-0.61 (0.09)	
Post 2008 Dummy Variable		-0.34 (0.11)
Number of observations*	308	238
Adjusted R-Square	0.82	0.79
F-Statistics	142.74	83.78

*Notes: * May not be statistically different from zero. ** Statistically significant at ten percent, meaning that there is only less than ten percent likelihood that the coefficient is statistically identical to zero. *** The count reflects a number of outliers that are removed after initial model fitting.*

Structural Variables

The results from both models suggest price sensitivity to changes in property structural attributes is consistent with findings from other hedonic analyses of light rail systems[15]. For the City of Detroit, the results show that newer and larger parcels can be more expensive. One percent reduction in age and one percent increase in size can influences prices between 0.17 to 0.76 percent for residential homes and between 0.33 to 0.36 percent for commercial properties[16]. In particular, incremental changes in age and building square footage can bring about higher prices for residential homes than for commercial properties. Lot size, however, may be priced higher for commercial properties, possibly because of the need for parking.

The variable *Building Number* suggests that for residential properties of the same size and age, among other relevant variables being controlled for, multifamily homes may be priced lower than for single-family homes. However the types of residential homes are not consistently reported in the parcel data and *Building Number* is a proxy that reflects how different types of homes may be priced differently.

Demographic and Economic Variables

A number of demographic and economic variables are included in the hedonic models to account for neighborhood characteristics. Not all of the variables introduced earlier are included in the model as some can be highly correlated and are ultimately removed to avoid redundancy.

The model estimates the anticipated directional relationship between employment and home prices. One percent increase in unemployment rate is estimated to potentially reduce home prices by 5 percent. The coefficient of percentage of household without children suggests that after controlling for age and size of properties, household without children may have higher disposable income and are residing in more expensive homes. On average, home prices are 2.91 percent higher in neighborhoods with one percent more households without children.

There is no statistically conclusive evidence to support the impact of employment rate on commercial properties. There also is a negative relationship between prices of commercial properties and the percent of households not using car, truck, or van to commute. The model suggests that one percent decrease in percent of households not using car, truck, or van to commute can bring about a 0.34 percent[17] increase in property prices[18]. This suggests that higher automobile dependency can have a positive influence on commercial property prices in the city.

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[15] DTC TOD Study Literature Review conducted by HDR in 2014.

[16] Calculation of elasticity/ percentage change for non-dummy variable coefficients: If $\ln(y) = a_0 + a_1 \ln(\mathrm{x}) + a_2 \mathrm{z}$, then $d\,[\ln(y)] = d[a_1 \ln(\mathrm{x})]$ and elasticity, $\varepsilon_x \equiv {}^{dy}/_{dx} * {}^{x}/_{y} = a_1$. Also, for semi-log variables, ${}^{dy}/_{dz} * {}^{1}/_{y} = {}^{\%\, change\ in\ y}/_{unit\ change\ in\ z} = a_2 \equiv \varepsilon_z$. Elasticity/ percentage change for coefficients of dummy variables is identical to the calculation provided for transit premium.

[17] $\rho = [exp(0.30) - 1] * 100\% = 34.3\%$

[18] Grengs (2010) finds low accessibility of transit in Detroit in his study on employment and commute, which helps explain the positive relationship between automobile use and commercial properties prices.

Location Variables

Four variables are used to control for the station area characteristics pertaining to commercial clusters that later became DPM stations, land use vacancy, diversity, and intensity. Since relatively fewer residential homes are located near DPM stations, commercial clustering near the stations is not found to be impacting home prices. For commercial properties, a decrease in distance (which is equivalent to increase in proximity) to locations that later became DPM stations has a small positive impact on prices (-0.034 percent using the anti-logarithmic function). Also, a one percent drop in parcel vacant rate can improve prices by 2.57 percent. Together, the results suggest the presence of “foot traffic” or “spillover” effect on neighborhood commercial properties.

Aside from controlling for station area characteristics, highway access is also a location variable included in the model. The models suggest that one percent increase in distance to highway access improves prices by 0.1 percent for residential homes while it reduces prices by 0.01 percent for commercial properties. The results show that roadway access can have opposing effects on the two different types of properties: proximity to highway access may be nuisance to residential homes while it facilitates transportation of goods for businesses.

To control for DPM operations, an interaction term of DPM station proximity (half-mile radius) and DPM opening (the year 1987) is used. The model coefficient on the variable is the estimate transit premium. For residential properties, the model does not provide evidence (at over 95 percent certainty) whether or not the DPM has impacted property values. <u>At 90 percent likelihood, the model suggests that DPM contributes to 34.3 percent increase in property prices. For commercial properties, the model suggests that DPM contributes to 38.6 percent increase in property prices.</u>

Dummy Variables

The variable *Post 1994* is used to test or indicate the hypothesis that DPM service and management improvement has contributed to higher amenity benefits of the system for properties sold after 1994. *Between 2008 and 2011* and *Post 2008* variables are used to account for potential downward price pressure of the real estate market (for properties sold during those periods) following the US economic recession. Additional factors tested include potential impacts of the following events on transit and property values:

- DPM service interruptions between 2002 and 2004;
- Real estate market boom between 2000 and 2007;
- Opening of Rosa Parks Transit Center in 2009;
- Announcement of the M-1 RAIL in 2010; and
- Announcement of the Z (retail and parking structure) in 2012.

The results show an 84 percent increase in commercial prices since 1994 due to service improvements. This estimate is extremely high and is likely to be capturing some other economic activities that are not measured or tested in this study.

The economic recession has impacted residential and commercial properties differently and two different dummy variables are used in the model to account for the respective impacts. After accounting for structural, location, demographic, and economic factors, the model suggests that the recession had reduced home prices between 2008 and 2011 by 45.8 percent while it has lowered prices for commercial properties sold after 2008 by 28.9 percent.

Conclusions

Through a hedonic pricing analysis, the DPM is found to have contributed to increases in commercial property price by over 38 percent, while other price determinants are held constant. There is also some evidence that the DPM has contributed to increases in residential home prices. This finding may be strengthened with the addition of structural and property type information that are missing from or incomplete within the parcel data. Differentiation of condominiums (one owner per unit or parcel) within the *Apartment* (many units with one owner or under one parcel) property type category may also increase the robustness of the study.

References

Downtown Detroit Partnership. (2014). *Downtown Development Update* PowerPoint presentation.

Goetz, E. G., Ko, K., Hagar, A., Ton, H., & Matson, J. (2010). *The Hiawatha Line: impacts on land use and residential housing value* (No. CTS 10-04).

Grengs, J. (2010). *Job accessibility and the modal mismatch in Detroit*. Journal of Transport Geography 18. 42-54.

HDR, Inc. (2014). *DTC TOD Project Literature Review*.

Chapter 4 Model Inputs

The analysis of the economic benefits of the DPM relies on a vast amount of data compiled from various sources at the local, state, and national levels. For instance, transit operating statistics and financial data have been obtained from DTC, the Michigan Department of Transportation's online Public Transportation Management System (PTMS), the National Transit Database (NTD) and the American Public Transportation Association (APTA). Also, some model inputs are derived from the findings of other study tasks (hedonic analysis of property values in downtown Detroit and survey of DPM passengers, in particular).

Passenger Survey

As part of the model implementation, HDR conducted a passenger survey for the DPM.

The survey focused on the current trip made by the respondent. The primary objectives of the survey were to determine trip purpose and rider behavior in the absence of the DPM. Responses would then be used in the transit benefit model:

- To allocate ridership by trip purpose (work, medical, shopping, etc.);
- To estimate the percentage of trips diverted to other transportation modes (personal vehicle, taxi, etc.); and
- To estimate the percentage of trips foregone in the absence of the DPM (in order to determine the extent to which the DPM provides basic mobility to riders).

Given that the average trip length on the DPM is very short, the questionnaire was designed so as to elicit responses quickly and ensure that the survey can be completed in less than two minutes. A copy of the survey instrument is provided in Appendix A.

Based on annual ridership of approximately 2.1 million and using a 95 percent confidence level and a 3.5 percent margin of error, it was estimated that 758 responses would be required to ensure that the survey results were statistically significant.

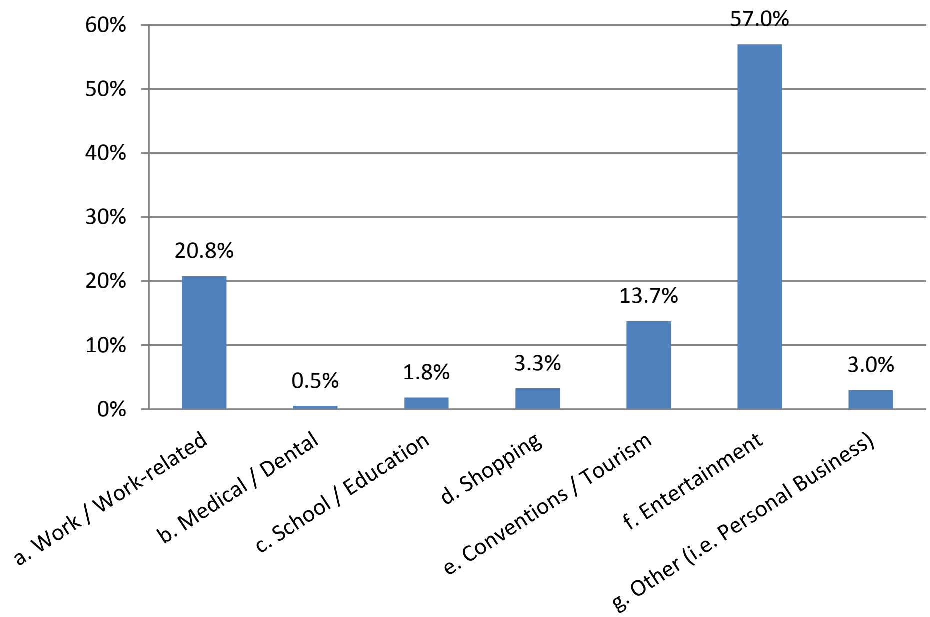
The survey was conducted over the course of three days from Thursday, March 5, 2015 to Saturday, March 7, 2015. The survey period was selected to ensure that the population surveyed was representative of all DPM riders (daily commuters, weekend shoppers, etc.). Survey personnel were positioned at several DPM stations at different times of the day (including morning rush hour and evening) to hand out paper surveys, answer questions from riders, and collect completed surveys. Riders were also given the option to complete the survey online at a later time. Survey responses were monitored several times a day to detect potential issues.

After completion of the survey, paper surveys were scanned and the responses compiled and combined with online responses. The survey dataset was subsequently reviewed, cleaned, and edited where necessary. In particular, HDR evaluated the quality of the responses to check for inconsistencies prior to analyzing the data.

Overall, 974 complete, valid responses were analyzed (28.4 percent more than initially required), thereby reducing the margin of error to just 3.1 percent. Responses were nearly equally divided between the morning period (8:00 a.m. to 2:00 p.m.) and the evening/ night period (4:00 p.m. to 9:00 p.m.). As expected, the top three stations, in descending order of the number of responses, were Cobo Center (37.3 percent), Greektown (24.2 percent), and Renaissance Center (13.2 percent).

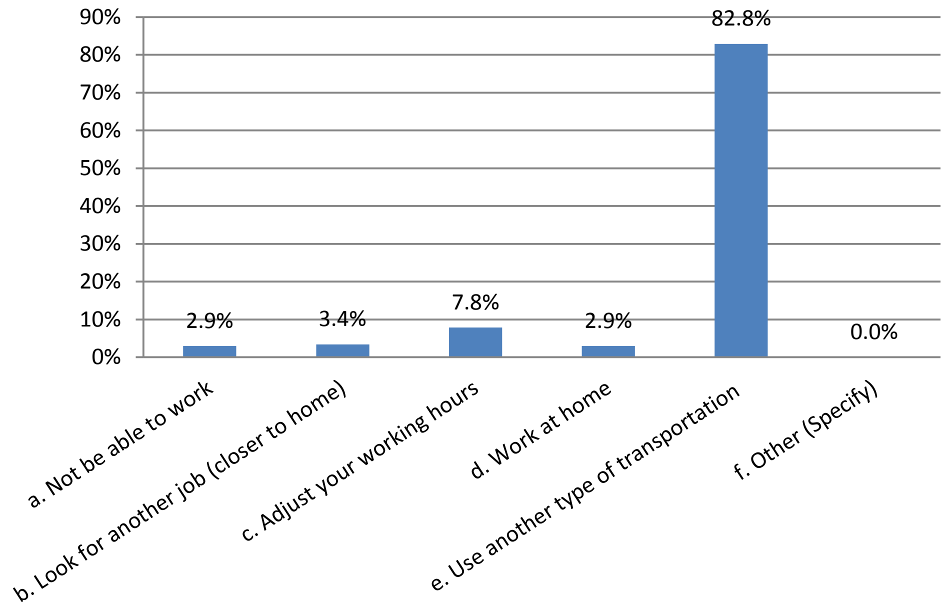
A majority of respondents (57 percent) stated that the main purpose of their trip was entertainment. Only 20.8 percent of respondents rode the DPM to go to/ return from work. The complete breakdown of respondents by trip purpose is provided in Figure 8 on the following page.

Figure 8: Trip Purpose



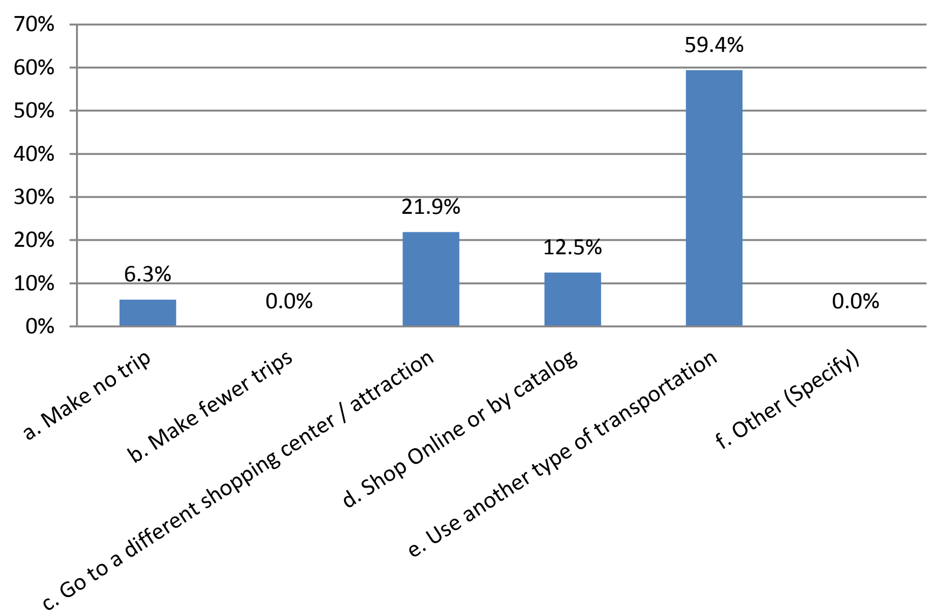
As shown in Figure 9 on the next page, for those who rode the DPM for work purposes, a large majority (82.8 percent) would use another mode of transportation in the absence of the DPM. About 8 percent of respondents would have to adjust their working hours. And more than 6 percent stated they would not be able to work or would have to look for another job (closer to home).

Figure 9: Riders' Responses in the Absence of the DPM – Work Trips



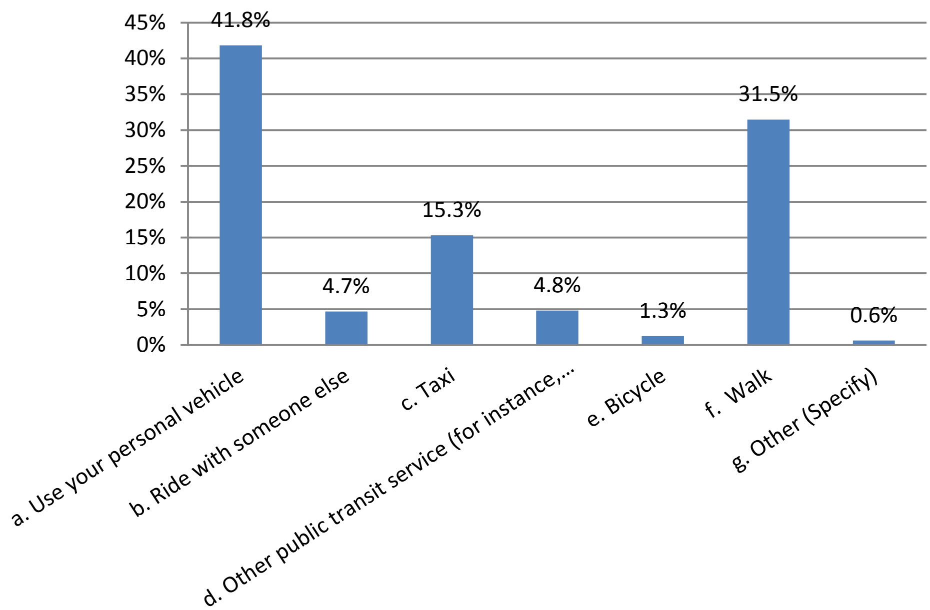
On the other hand, of those who rode the DPM for shopping purposes, 59.4 percent would use another mode of transportation in the absence of the DPM (see Figure 10). More than a third would go to a different shopping center or shop online. Only 6.3 percent of respondents stated that they not make the trip.

Figure 10: Riders' Responses in the Absence of the DPM – Shopping Trips



Finally, those who answered that they would use another mode of transportation in the absence of the DPM (795 responses) were asked to specify the mode. Only one answer was allowed per respondent so that mode diversion rates could be accurately computed and used in the model to estimate the economic benefits of the DPM. As expected, the first alternative transportation mode was the personal vehicle (41. 8 percent). Perhaps more surprisingly, nearly a third of respondents stated they would walk (31.5 percent) or ride a bicycle (1.3 percent). And more than 15 percent would use a taxi as an alternative transportation mode. The complete breakdown of responses by alternative transportation mode is provided in Figure 11 on the following page.

Figure 11: Alternative Transportation Mode in the Absence of the DPM



The complete survey results (count and percent estimates) are available at the end of the report in Appendix B.

Other Model Inputs

The development of the Tool entailed an extensive data collection effort. Various methods and sources were used to gather all of the necessary information to estimate the economic benefits of the DPM.

Transit operating and financial data were provided by DTC or extracted from online sources, including Michigan Department of Transportation's online Public Transportation Management System (PTMS), the National Transit Database (NTD) and the American Public Transportation Association (APTA). In particular, we collected data on the following variables:

- Annual passenger trips;
- Fare per trip (in dollars);

- Average trip length (in miles);
- Average headway (in minutes);
- Average travel time (in minutes)
- Annual number of accidents (by severity);
- Annual operating and maintenance expenses (in dollars); and
- Annual capital expenses (vehicle overhaul, building improvements, automated train control upgrade, etc.).

Historical data on capital expenses were provided by DTC for 2009-2014. Each expenditure category was matched with its corresponding industrial sector using the North American Industry Classification System (NAICS). Table 4 below shows the breakdown of capital expenses by industrial sector and by year. These estimates were used to calculate the economic impact of DTC's capital expenses on the City of Detroit using REMI's TranSight model.

Table 4: DTC Capital Expenses by Industrial Sector (2009 – 2014)

Industrial Sector	2009	2010	2011	2012	2013	2014
Railroad Construction	$2,296,957	$66,522	$2,484	$278,333	-	$2,327,740
Specialty Trade Contractors	$514,400	$577,289	$714,011	$28,806	-	-
Elevator & Moving Stairway Manufacturing	$87,797	$80,305	$14,973	-	-	-
Computer & Electronic Product Manufacturing	$20,161	$747,990	$1,415,152	$1,671,098	$279,240	-
Railroad Rolling Stock Manufacturing	$512,076	$280,712	$49,808	$16,567	-	-
Institutional Furniture Manufacturing	$38,364	$7,823	$1,676	-	-	-
Automobile Dealers	-	-	$18,586	-	-	$24,836
Support Activities for Rail Transportation	$4,254,265	$2,574,514	$938,831	$414,331	$1,760,333	-
Telecommunications	$65,018	$11,624	-	-	-	-
Total	**$7,789,038**	**$4,346,779**	**$3,155,521**	**$2,409,135**	**$2,039,573**	**$2,352,576**

Source: DTC

Note that he complete list of model inputs along with references are provided in the Tool (see User Manual).

Chapter 5 Model Results

Based on the methodology described in Chapter 2 and the passenger survey results and other model inputs discussed in Chapter 4, the overall benefits of the Detroit People Mover have been estimated. This chapter presents the results of the analysis. Social benefits (i.e., Transportation cost savings and low-cost mobility benefits) are discussed first, followed by the results of the economic impact analysis.

Social Benefits

In the presence of transit, a number of vehicles are removed from the roads, resulting in a decrease in VMT. Transportation cost savings are the cost savings of these additional VMT to users of the roadway network and the community at large.

Transportation Cost Savings

When people use the DPM instead of a more costly alternative (personal vehicle or taxi) they save money on transportation. These out-of-pocket cost savings are the most recognized benefits of public transit. In addition, the DPM can help reduce congestion in downtown Detroit, resulting in travel time savings, accident cost savings, and emissions cost savings. While travel time savings and accident cost savings accrue solely to users of the roadway network, emissions cost savings benefit the community at large.

As shown in Table 5 below, out-of-pocket cost savings ($1.53 million), travel time cost savings ($1.68 million), and safety cost savings account for nearly all of transportation cost savings. Travel time reliability cost savings, emission cost savings, and pavement cost savings are negligible. Overall, transportation cost savings generated by the DPM totaled $4.49 million in 2013.

Table 5: Transportation Cost Savings

Benefit Category	$ Millions
Generalized Cost Savings	$3.21
Travel Time Cost Savings	$1.68
Out-of-Pocket Cost Savings	$1.53
Travel Time Reliability Cost Savings	$0.00*
Emission Cost Savings	$0.05
Non-Carbon Emission Cost Savings	$0.02
Carbon Emission Cost Savings	$0.03
Safety Cost Savings	$1.22
Pavement Cost Savings	$0.01
TOTAL	**$4.49**

** Greater than $0, but less than $10,000.*

Low-Cost Mobility Benefits

A number of residents of the Detroit Metropolitan Area do not have access to a personal vehicle and depend entirely upon public transit for their mobility needs. In the absence of public transit, many of them would have no choice but to forego their trips. This implies that some people would lose their job and apply for public assistance, or require home care, or move to a nursing home facility. Therefore, by providing an affordable transportation alternative, public transit creates economic value (affordable mobility benefits) and generates cost-savings in other sectors of the economy (cross-sector benefits).

As shown in Table 6 below, low-cost mobility benefits are relatively small for the DPM given the profile of riders (many of them are visitors) and the fact very few trips would be foregone in the absence of the DPM as indicated by the results of the passenger survey (due to the relatively short distance of trips). Overall, low-cost mobility benefits associated with the DPM amounted to $0.17 million in 2013.

Table 6: Low Cost Mobility Benefits

Benefit Category	$ Millions
Affordable Mobility Benefits	$0.11
Cross-Sector Cost Savings	$0.06
TOTAL	**$0.17**

Economic Impacts

In addition to the social benefits discussed above, there are macroeconomic impacts attributed to the DPM. These impacts are associated with:

- DTC expenses; and
- Reduction in VMT (due to the operation of the DPM).

The on-going operation of the DPM requires inputs (purchases) of labor, materials, equipment and services supplied by local producers. These operating and maintenance expenses in turn spur indirect and induced economic activity throughout the economy. In the same way, DTC's expenses on capital goods (such as vehicle parts and computer equipment) contribute to economic growth.

The total economic impacts of DTC's capital expenses are reported in Table 7 below. These impacts reflect the direct, indirect, and induced effects and were estimated by Michigan DOT with REMI's TranSight model. Capital expenses incurred by DTC in 2013 generated more than $12 million in business output (total volume of sales), including $6.75 million in value added (total volume of sales minus the cost of intermediate purchases; roughly equivalent to the gross domestic product). They also created 89 jobs in the local economy.

Table 7: Economic Impacts of DTC Capital Expenses

Impact Metric	$ Millions
Business Output	$12.17
Total Value Added (GDP)	$6.75
Personal Income	$4.78
Employment	89

Note that the amenity impact associated with the reduction in VMT is minimal and is not reported. More detailed results of the economic impact analysis are provided in Appendix D.

Summary of Findings

A summary of the results is provided in Table 8 below. Overall, the social benefits associated with the DPM totaled $4.66 million in 2013, including $4.49 million (or 96 percent) for transportation cost savings. On a per trip basis, these benefits amounted to $2.11, compared to a regular fare of $0.75. The contribution of the DPM to the Detroit economy is estimated at $12.17 million (output) or 89 jobs. Finally, the presence of the DPM contributed to increasing the value of nearby residential and commercial properties by nearly $120 million.

Table 8: Summary Results

Summary Metric	Value
Social Benefits ($Million)	$4.66
Benefits per Trip	$2.11
Annual Benefits per Household	$406
Job Impact	89
Output Impact ($Million)	$12.17
Increased Property Values ($Million)*	$119.77

** Based on results of hedonic analysis (see Phase One report). One-time (not annually recurring) benefits.*

In addition, HDR conducted two case studies. The Tool was used to show the impact of two large events in downtown Detroit: the Auto Show held at Cobo Center on January 19 – 27, 2013 and YOUMACON held at Cobo Center and Renaissance Center on October 30 – November 02 2014. Daily ridership estimates at those stations (247,887 for the Auto Show and 65,997 for YOUMACON) were provided by DTC and plugged in the model to assess the benefits generated by the DPM. Transportation cost savings were estimated at $0.5 million for the 2013 Auto Show and $0.13 million for YOUMACON 2014.

Chapter 6 User Manual

To assist the Detroit Transportation Corporation in evaluating the benefits of the Detroit People Mover, HDR has developed a spreadsheet-based tool. The Tool assesses past economic performance of the DPM and incorporates forecasting capabilities for projections of economic impacts. The results of the study, in terms of monetized economic benefits as well as job creation, can be used to provide justification of transit investment and will inform the need for planning and funding strategies to support local and regional rail transit.

The targeted users are local and regional transit agencies as well as stakeholders, and therefore the Tool is intended to be user-friendly, scalable, flexible and thus suited for other rail systems. This User Manual provides a description of the different model components, as well as detailed instructions on how to use the Tool.

Introduction

The purpose of the model is to quantify the benefits of the Detroit People Mover (DPM), with potential capabilities to assess benefits of other transit service. The benefits pertain to both users and non-users of the DPM, and they can be categorized as:

- **Transportation cost savings –**
    1. Generalized travel cost savings, includes out-of-pocket and travel time
    2. Safety cost savings
    3. Emission cost savings
    4. Pavement maintenance cost savings
- **Low-cost mobility benefits –**
    1. Affordable mobility benefits (the economic value to access services such as healthcare, education, retail and attractions)
    2. Cross-sector benefits (budget savings for welfare and social services, such as unemployment and homecare, due to presence of transit)
- **Transit-oriented development (TOD) benefits** − livability or economic community development benefits that are capitalized in property values

The estimated benefits are further broken down by socioeconomic sectors based on ridership by trip purpose: work, healthcare, education, shopping, recreation and tourism, special events, and other. In addition to the transit benefits, the Tool measures the job and output impacts on the Michigan economy resulting from: (i) transit operation and maintenance expenditures (excluding depreciation); and (ii) out-of-pocket cost savings accruing to transit riders.

While the primary purpose of the model is to estimate the benefits of the DPM, benefits can be estimated at different geographical and jurisdictional levels. Additional baseline information can be added to assess the transit benefits for other agencies and services beyond DPM.

Note that this updated version of the manual accounts for improvements that were made to the Tool based on feedback received from participants to a training session that was held at DTC on May 20, 2016. In particular, changes were made to the following sheets:

- ProjectInputs
  - Formatting improvements were made to the interface (e.g., ability to scroll down/up);
  - When a trip purpose is a user input, other trip purpose values are automatically updated so that the total dos not exceed 100%;
  - For Single Year Analysis, the results are automatically updated when the Year of Analysis is changed.
- Executive Summary
  - The executive summary table no longer displays zeroes if the columns are blank;
  - Units were added in column I (Implication to Beneficiary).
- Parameters
  - Verified all of the parameters and updated the sources where necessary.

Overview of the Tool

The economic model within the Tool is designed to estimate benefits of the DPM. It is a "stand alone" spreadsheet-based (Microsoft Excel) model designed to be used with minimal direction and minimal data entry. That is to say, it is not linked to external files, contains all necessary model inputs and requires minimal proficiency in MS Excel.

The Tool is an MS Excel workbook with eighteen (18) sheets. To facilitate both user navigation and the update of the model, color codes are used. In general, purple and grey fonts are used in cells that contain a formula, and thus should not be overwritten or modified. Black font denotes a cell that does not contain a formula (e.g., model inputs). Green fonts with grey backgrounds indicate areas for user inputs. Sheet tabs are also color-coded (purple, grey, blue, etc.) to help the user navigate. Inactive sheets are place-holders for refinements of the model that will be completed during Phase 2 of the study.

In terms of user-interface, the only sheets that should be modified by the user are ProjectInputs and Executive Summary, where indicated. Though the Calculation sheets can be viewed, they are protected to ensure the integrity of the formulae and the methodology. Their contents cannot be modified unless the model's protection is deactivated. The current password to unprotect/protect the sheets is "DTCTOD2014." It can be changed by the user after the sheets have been unprotected.

Introductory Sheets (Grey sheet tabs)

1. **Welcome**: Introductory sheet presenting the name and version of the model.
2. **Read Me**: Provides overview of model purpose and structure.
3. **Start:** General structure and organization of the model; brief description of model components; and hyperlinks to each sheet.

Input Sheets (Blue sheet tabs)

4. **ProjectInputs:** Selection of level of analysis and other options (year of analysis and risk analysis); user-specified input values for quick update or scenario analysis; and summary of key modeling results.

5. **Parameters:** List of data inputs and the associated unit of measure and description of its meaning, as well as the sources and references used in the model.

Calculation Sheets (Light Purple sheet tabs)

6. **Benefits:** Calculations of transit benefits by socioeconomic sector and benefit category.
7. **Transportation:** Calculations of transportation related inputs, such as ridership by sector, diversions by sector, and vehicle miles by sector.
8. **CongestionMgmt_Calc:** Calculations of generalized travel cost savings.
9. **Reliability_Calc:** Calculations of travel time reliability cost savings.
10. **Emission_Calc:** Calculations of emission cost savings.
11. **Safety_Calc:** Calculations of accident cost savings.
12. **TOD_Calc:** Calculations of community development benefits capitalized in property values.
13. **AffMobility_Calc:** Calculations of affordable mobility and cross-sector benefits.
14. **PvmtMaint_Calc:** Calculations of pavement maintenance cost savings.
15. **EI_Calc (INACTIVE):** Calculations of economic impacts resulting from transit operations and maintenance (O&M) expenses, and the re-spending of vehicle ownership and operating cost (VOC) savings accruing to transit riders.
16. **@Risk (INACTIVE):** List of risk variables and detailed risk analysis statistics used in the model.

Results Sheets (Dark Purple sheet tabs)

17. **ExecutiveSummary:** Tables and graphs summarizing all the results of the analysis.
18. **I-O Results (INACTIVE)**: Input-output results for different economic impact metrics (output, value added, employment, and tax revenue). These results are provided by HDR and do not need to be updated by the user.

Component Presentation and Instructions

The following sections explain, in detail, the different model components and provide instructions on interfacing with the Tool and entering/ updating input values.

Installation

The model is a stand-alone, spreadsheet-based model that does not require installation aside from saving a local copy. Simply copy the file “DTC TOD Study Benefits Model.xlsm” to a local folder and double click to open it.

It is highly recommended that the user make a backup copy of the original file. It is also recommended that the user save dated copies of the file whenever major updates are made to the model inputs.

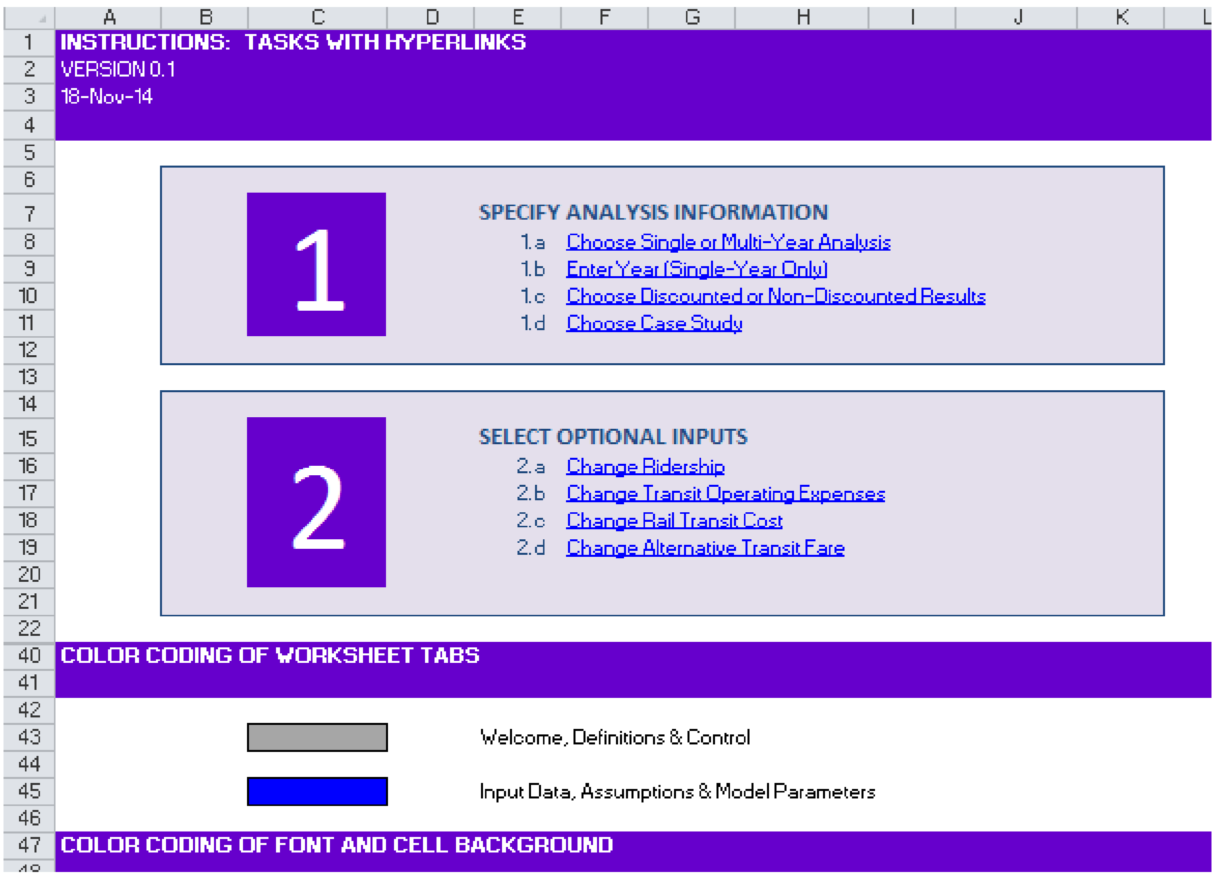
Tool Structure

Upon opening the model, the user must agree to the End User Licensing Agreement (EULA). Read through the agreement and select “Accept” in order to begin using the model. The first sheet, ***Welcome***, provides an introduction to the model. The arrow at the bottom of this page, "Go to Read Me," leads to the ***Read Me*** tab. ***Read Me*** provides an overview of the model structure similar to the previous section of this report. To begin, press the "Start" arrow at the bottom to proceed to the ***Start*** sheet.

Start shows the structure and general organization of the workbook, with information broken into four steps. Each step contains a hyperlink to the relevant sheet (think of this as a shortcut). When pointing to a cell that contains a hyperlink, the pointer becomes a hand, indicating that the cell is something that can be clicked to navigate. ***Start*** also contains information on the color-coding of the worksheet tabs and the color coding of the fonts and cell background that can be used for reference at any time.

A snapshot of the ***Start*** sheet is shown in Figure 12.

Figure 12: START sheet



Project Inputs

The ***ProjectInputs*** sheet is the main model component. At a minimum ***ProjectInputs*** is the only sheet that needs to be used. It contains a few necessary user inputs that are requested to conduct the analysis: the user selects the timing of the analysis, analysis information, and key model inputs. Once these values have been reviewed, the estimation of benefits and economic impacts is completed.

Key results (in tabular and graphical formats) are provided in this sheet to facilitate instant review of "what-if" analysis. The key results presented in the table are high-level results that summarize the total benefits, as well as benefits on a per-trip, per-rider, per-household, and per-dollar spent basis. In addition to selecting the current year, project opening, future years of analysis, and single- or multi-year analysis, the user also has the ability to select several of the model inputs to test various scenarios with inputs differing from those already contained in the model. Values that can be changed to reflect the most current information (and their units of measure) include:

- Ridership (most recent year)
- Ridership Growth (%/year)
- Total Operating Expenses ($/year)
- Rail Transit Fare ($/trip)
- Alternative (bus) transit fare ($/trip)
- Value of time, in-vehicle, personal ($/hour)
- Value of statistical life ($M/life saved)
- Trips for work or work related purposes (%)
- Trips for medical or dental purposes (%)
- Trips for conventions or tourism (%)
- Trips for school or education purposes (%)
- Trips for shopping purposes (%)
- Trips for entertainment purposes (%)
- Residential TOD Premium (%)
- Commercial TOD Premium (%)

To change the value, simply enter a number into the grey "User Input" cell corresponding to the parameter. Note that any user input value entered in the ***ProjectInputs*** sheet will be incorporated into the calculation of benefits **without** modifying the corresponding default value. The default values are provided in the Parameters sheet and do not need to be changed. To revert to the default value, simply delete the value entered in the grey "User Input" cell.

The steps involved in using ***ProjectInputs*** are:

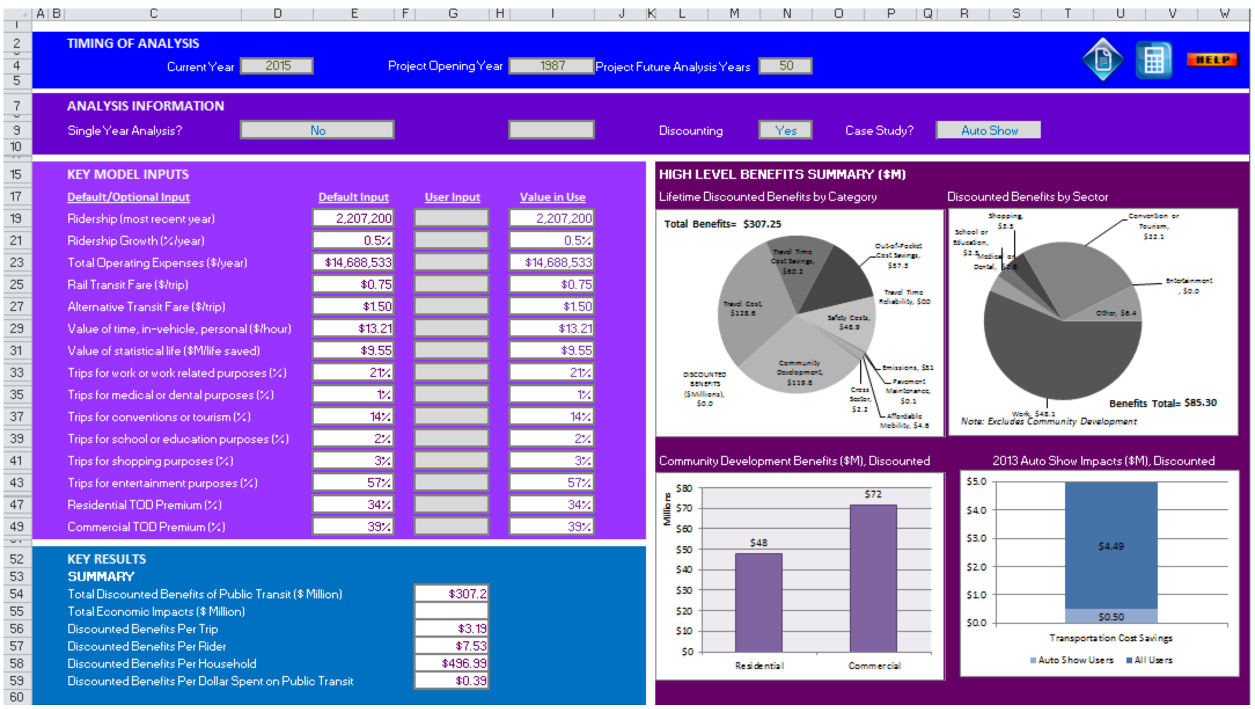
1. Select the Timing of the Analysis:
    a. Enter the Current Year in cell D4
    b. Enter the Project Opening Year in cell I4
    c. Enter the Project Future Years of analysis in cell N4.
2. Choose Single Year or Multi-Year Analysis in cell D9. If Choose "Yes" for Single Year, enter the year in cell I9. .
3. For standardizing the future stream of monetized values of benefits, time discounting is used[19]. To enable discounting of future values, choose "Yes" in cell N9.

[19] The discount rate (in percentage) reflects the market rate of return on current investment in future years. When the rate is applied to future benefits, it converts future benefits back to their present value. So, with a four percent discount rate, a dollar today is equivalent to $1.04 next year while a dollar next year is worth $0.96 today.

4. To show the results of a Case Study, select the desired option in cell R9.
5. Review the default inputs given for your selections made in steps 1-4, shown in column E. Rather than modifying these values in the appropriate model input sheet, these values must be updated in the “User Input” column (Column G). This overrides the Default Input and makes the User Input the Value in Use (in column I). This will allow users to perform “what if” scenario analysis.
6. Review benefits estimated for selections made in the section labeled Key Results, as well as the pie graphs and bar charts on this sheet.

The same instructions are also provided in the ***Start*** sheet. A snapshot of the ***ProjectInputs*** sheet is shown in Figure 13.

Figure 13: Project Inputs Sheet



Model Inputs

Model data and assumptions are stored in the ***I-O Results*** and ***Parameters*** sheets.

Economic multipliers to estimate the impacts of out-of-pocket cost savings and transit operation and maintenance expenses (excluding depreciation) are available in ***I-O Results***. These multipliers are generated by HDR through the input-output analysis conducted in REMI. The user does not need to update these multipliers, and the sheet is protected to ensure that the results are not inadvertently modified.

All data related to transit operations and economic valuation can currently be found in the ***Parameters*** sheet. This sheet provides the variable, the value, and the source for each input used in the model. *Note that depending on the outcomes of the data collection and survey in*

Phase 2, this may change. Additional detail will be provided as it is confirmed. A screenshot of the ***Parameters*** sheet can be seen in Figure 14.

Figure 14: Parameters Sheet

	A	B	C	D	E	
1		HELP				
2						
3	Variable	Unit	Variable Description	Year	Active Value	
4	TOD & Livability					
5	Number of residential parcels	Each	The total number of residential parcels (single-family, multifamily, group homes, and condominiums) within one mile of DPM route.	2013	2,145	http://www.detroit encies/Information ps.aspx
6	Number of commercial parcels	Each	The total number of commercial parcels (office, retail, bank, store, restaurant, etc.) within one mile of DPM route.	2013	496	http://www.detroit encies/Information ps.aspx
7	Number of households	Each	The total number of households in the 19 Census block groups (2010) within 1 mile of DTC stations	2012	11,475	
8						
9	Median residential sale value (in year 2000$)	$	The values (land and improvement) of residential parcel estimated by tax assessor, averaged over all parcels within one-mile of DPM station and route.	2000	$65,294	Hedonic analysis
10	Median commercial sale value (in year 2000$)	$	The values (land and improvement) of commercial parcel estimated by tax assessor, averaged over all parcels within one-mile of DPM station and route.	2000	$374,671	Hedonic analysis
11	Residential TOD Premium	%	Property value increase associated with DPM for residential properties	2000	34%	Hedonic analysis
12	Commercial TOD Premium	%	Property value increase associated with DPB for commercial properties	2000	39%	Hedonic analysis
13	State of Good Repair					
14	Pavement maintenance cost, auto	$/mile	Average cost per mile to maintain pavement state-of-good-repair as a result of automobile use	2014	$0.0014	
15	Pavement Maintenance cost, bus	$/mile	Average cost per mile to maintain pavement state-of-good-repair as a result of bus use			
16	Ridership					
17	Unlinked passenger trips	trips	Number of passengers that board DPM. Each boarding is counted as the passenger boards a vehicle, even when multiple boardings are recorded under one trip from origin to destination.	2013	2,207,200	
18	Average annual ridership growth	%	Projected average increase in ridership based on trend from 1996 to 2012		0.44%	
19	Accident					

Calculations

The calculations for each benefit-type estimated are performed in their respective sheets: ***Benefits, Transportation, CongestionMgmt_Calc, Reliability_Calc, Emission_Calc, Safety_Calc, TOD_Calc, AFFMobility_Calc, PvmtMaint_Calc,*** and ***EI_Calc***. Transportation benefits are broken down by user socioeconomic sector (work, medical or dental, school or education, shopping, convention or tourism, entertainment, and other) and by user benefit category (Congestion Management including out of pocket costs and travel time costs, Reliability, Emissions, Safety, Pavement Maintenance, and Affordable Mobility). Economic impacts are broken down by impact metric (output, value added, employment and tax revenue) and by type of effect (direct, indirect and induced). The ***Transportation*** sheet details the calculations for ridership by socioeconomic sector, as well as the generation of passenger miles and vehicle miles that drive the individual benefit category calculations. The calculations for each user benefit category are contained on the individual calculations sheets. The ***Benefits*** sheet is an aggregation of all of the individual category calculation sheets that provides details of the summary calculations presented in the ***Executive Summary*** tab.

As introduced earlier, the calculations are protected to ensure the integrity of the formulas and the methodology. The contents cannot be modified unless the protection is deactivated. These sheets contain detailed information that is provided for the user's reference. Examples of these sheets are displayed below.

Figure 15: Benefits Sheet

	A	B	C	D
1	BENEFITS ANALYSIS			
2		Year	1987	1988
3		Total		
4	Historic		1	1
5	Future		0	0
6	Discount Factor		6.21	5.81
7				
8	BENEFITS IN CONSTANT DOLLARS BEFORE DISCOUNTING - BY BENEFIT CATEGORY			
9				
10	TOTAL UNDISCOUNTED BENEFITS	$273,797,113	$4,401,392	$4,411,315
11	GENERALIZED TRAVEL COST SAVINGS	$146,800,312	$2,755,762	$2,765,684
12	Travel Time Cost Savings	$45,506,217	$620,140	$630,062
13	Out-of-Pocket Cost Savings	$101,294,095	$2,135,622	$2,135,622
14	TRAVEL TIME RELIABILITY	$0	$0	$0
15	NON-CARBON EMISSION COST SAVINGS	$527,628	$12,948	$12,948
16	Auto	$527,628	$12,948	$12,948
17	Transit	$0	$0	$0
18	CARBON EMISSION COST SAVINGS	$1,255,516	$23,392	$23,392
19	Auto	$1,255,516	$23,392	$23,392
20	Transit	$0	$0	$0
21	SAFETY COST SAVINGS	$12,554,703	$264,696	$264,696
22	PAVEMENT MAINTENANCE SAVINGS	$8,396,915	$177,035	$177,035
23	AFFORDABLE MOBILITY	$3,917,483	$82,594	$82,594
24	CROSS SECTOR	$51,460,689	$1,084,965	$1,084,965
25	COMMUNITY DEVELOPMENT	$48,883,867	$0	$0

Figure 16: Transportation Sheet

	A	B	C	D
1	TRANSPORTATION AND TRAVEL CHARACTERISTICS			
2		Year	1987	1988
3		Total		
4				
5	RIDERSHIP AND PASSENGER MILES			
6				
7	Unlinked Passenger Trips, Excluding Transfers		2,388,280	2,388,280
8	Work		812,015	812,015
9	Healthcare		214,945	214,945
10	Retail		310,476	310,476
11	Education		716,484	716,484
12	Special Events		238,828	238,828
13	Other		95,531	95,531
14				
15	Linked Passenger Trips, Including Transfers		2,388,280	2,388,280
16	Work		812,015	812,015
17	Healthcare		214,945	214,945
18	Retail		310,476	310,476
19	Education		716,484	716,484
20	Special Events		238,828	238,828
21	Other		95,531	95,531
22				

Figure 17: CongestionMgmt_Calc Sheet

	A	B	C	D	E	F
1	GENERALIZED TRAVEL COST SAVINGS					
2		Year	1987	1988	1989	1990
3		Total				
4	Discount Factor					
5						
6	General Variables					
7	Out of Pocket Costs					
8						
9	Average Transit Fare ($/trip)		$0.75	$0.75	$0.75	$0.75
10	Average Cost of Vehicle Ownership ($/mile)		$0.17	$0.17	$0.17	$0.17
11	Average Cost of Taxi ($/trip)		$4.90	$4.90	$4.90	$4.90
12	Average Bike/Walk Cost ($/trip)		$0.00	$0.00	$0.00	$0.00
13	Average Parking Costs ($/trip)		$2.00	$2.00	$2.00	$2.00
14						
15	Average Trip Length (miles)		1.5	1.5	1.5	1.5
16						
17	**Average Vehicle Occupancy (private vehicle)**					
18	Work		1.15	1.15	1.15	1.15
19	Healthcare		1.61	1.61	1.61	1.61
20	Retail		1.98	1.98	1.98	1.98
21	Education		1.83	1.83	1.83	1.83
22	Special Events		1.98	1.98	1.98	1.98
23	Other		1.84	1.84	1.84	1.84
24	**Average Vehicle Occupancy (taxi)**					
25	**Average Vehicle Occupancy (ambulance)**					
26						

Figure 18: Reliability_Calc Sheet

	A	B	C	D	E	F
1	RELIABILITY					
2		Year	1987	1988	1989	1990
3		Historic	1	1	1	1
4		Future	0	0	0	0
5		Discount Factor	1.00	1.00	1.00	1.00
6						
7	General Variables					
8	Travel Time Reliability from Recurring Congestion					
9	Modeled Traffic Volume Growth		0.00%	0.00%	0.00%	0.00%
10	Traffic Volume Growth		-0.31%	-0.31%	-0.31%	-0.31%
11	Hourly Volume with DPM, Peak Hour		21,026	20,961	20,897	20,832
12	V/C Without Diversion		1.14	1.14	1.13	1.13
13	Standard Deviation of Travel Time of Roadway users, minutes		0.87	0.87	0.87	0.87
14	Hourly Volume without DPM, Peak Hour		21,958	21,894	21,829	21,765
15	V/C With Diversion		1.30	1.29	1.28	1.28
16	Standard Deviation of Travel Time of Roadway users, minutes		0.87	0.87	0.87	0.87
17	Change in Standard Deviation of Travel Time, minutes		0.00	0.00	0.00	0.00
18	Monetized Variability of Time (Corridor Model), $/hr		$0.00	$0.00	$0.00	$0.00
19	Monetized Variability of Time (Corridor Model), peak hours		$0.00	$0.00	$0.00	$0.00
20	Monetized Variability of Time (Corridor Model), year		$0.00	$0.00	$0.00	$0.00
21						
22	Travel Time Reliability from Diversion					
23	Standard Deviation of Travel Time of DPM, minutes		0.00	0.00	0.00	0.00
24	Change in Standard Deviation of Travel Time, minutes		0.87	0.87	0.87	0.87

Figure 19: EI_Calc Sheet

	A	B	C	D	E	F
1	Go to START					
2	VEHICLE OWNERSHIP & OPERATING COST SAVINGS			Year:	2014	
3						
4	OUTPUT IMPACT					
5	NAICS Code	Industry	Direct	Indirect	Induced	Total
6	11	Agriculture, forestry, fishing and hunting	$87,370	$144,694	$43,942	$276,006
7	21	Mining	$14,976	$117,288	$25,615	$157,879
8	22	Utilities	$617,652	$259,526	$168,795	$1,045,973
9	23	Construction	$13,048	$237,948	$53,365	$304,361
10	31-33	Manufacturing	$13,105,777	$5,889,062	$3,840,757	$22,835,596
11	42	Wholesale trade	$37,513	$40,830	$15,334	$93,678
12	48-49	Transportation and warehousing	$4,519,195	$76,573	$992,539	$5,588,307
13	44-45	Retail trade	$549,072	$68,397	$152,475	$769,943
14	51	Information	$2,274,536	$280,512	$527,901	$3,082,949
15	52	Finance and insurance	$232,522	$157,914	$89,133	$479,569
16	53	Real estate and rental	$176,547	$42,001	$44,285	$262,833
17	54	Professional - Scientific and technical services	$0	$0	$0	$0
18	3001	Institutions	$819,313	$0	$0	$819,313
19		TOTAL	$22,447,523	$7,314,745	$5,954,139	$35,716,407
20						
21	VALUE ADDED IMPACT					
22	NAICS Code	Industry	Direct	Indirect	Induced	Total
23	11	Agriculture, forestry, fishing and hunting	$45,025	$54,867	$19,389	$119,281
24	21	Mining	$7,717	$60,586	$13,230	$81,533
25	22	Utilities	$388,560	$169,539	$106,850	$664,949
26	23	Construction	$5,623	$112,742	$25,288	$143,653
27	31-33	Manufacturing	$7,620,561	$3,308,852	$2,209,279	$13,138,692

Results

The summary results of the analysis are presented in tabular and graphical format in the ***ProjectInputs*** and ***ExecutiveSummary*** tabs. These results are linked to the calculation sheets and automatically update when inputs are changed.

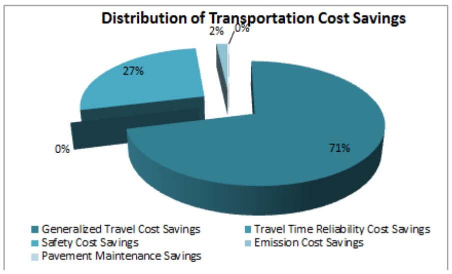
The key results presented in the tables of ***ProjectInputs*** are high-level results that summarize the total benefits, as well as benefits on a per-trip, per-rider, per-household, and per-dollar-spent basis. The graphical results in ***ProjectInputs*** show the lifetime benefits by category (travel cost, emissions, reliability, accident costs, pavement maintenance, community development, and affordable mobility) as well as benefits by sector (retail, education, healthcare, work, special events and other). A third chart shows the community development benefits allocated to retail and commercial properties.

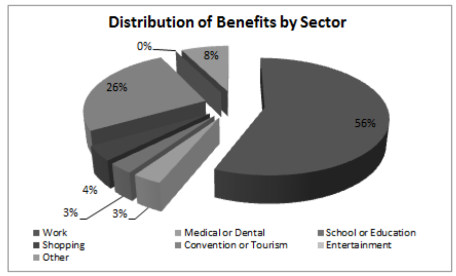
The ***ExecutiveSummary*** provides a detailed table of benefits by type, as well as graphs of the distribution of transportation cost savings, the distribution of benefits by sector, and the benefits by category and trip sector. The benefits are shown by category: transportation, low-income mobility, and transit-oriented development for both historical and future benefits. Column I also presents the implications of these categories to beneficiaries, with an explanation found in Column J. For instance, the implication of generalized travel cost savings is an average of $1.29 per trip for each user.

Figure 20: Executive Summary Sheet

Discounted Benefits

Benefit Type	Historic Benefits (2014 $ Million)		Future Benefits (2014 $ Million)		Lifetime Benefits (2014 $ Million)		Implication to Beneficiary
	Benefits to Date	Average Annual	Forecast of Benefits	Average Annual	Total	Average Annual	
TOTAL BENEFITS	$230.6	$8.2	$76.6	$1.5	$900.3	$3.9	
TRANSPORTATION COST SAVINGS	$106.5	$3.8	$74.3	$1.5	$514.4	$2.3	
Generalized Travel Cost Savings	$76.5	$2.7	$52.1	$1.0	$128.6	$1.6	$0.79
Travel Time Cost Savings	*$37.3*	*$1.3*	*$22.9*	*$0.5*	*$128.6*	*$0.8*	
Out-of-Pocket Cost Savings	*$39.3*	*$1.4*	*$18.1*	*$0.4*	*$128.6*	*$0.7*	
Travel Time Reliability Cost Savings	$0.0	$0.0	$0.0	$0.0	$128.6	$0.0	$0.00
Safety Cost Savings	$27.5	$1.0	$21.4	$0.4	$128.6	$0.6	24.9
Emission Cost Savings	$2.4	$0.1	$0.7	$0.0	$128.6	$0.0	649.5
Pavement Maintenance Savings	$0.1	$0.0	$0.0	$0.0	$128.6	$0.0	$0.00
LOW-INCOME MOBILITY BENEFITS	$4.4	$0.2	$2.4	$0.0	$257.2	$0.1	
Affordable Mobility	$2.9	$0.1	$1.7	$0.0	$128.6	$0.1	27
Cross-Sector	$1.5	$0.1	$0.7	$0.0	$128.6	$0.0	1,089
TRANSIT ORIENTED DEVELOPMENT BENEFITS	$119.8	$4.3	$0.0	$0.0	$128.6	$1.5	
Community Development	$119.8	$4.3	$0.0	$0.0	$128.6	$1.5	$4.27





The ***ExecutiveSummary*** sheet also provides the ability to "what if" test two policy changes – a change in transit service impacting ridership and a change in employment impacting ridership. To test these changes, users enter a positive or negative percent change in cell C36 or D36 of the ***ExecutiveSummary*** sheet. The table will populate with the updated values. An example is presented in Figure 21 below.

Figure 21: Policy Change Table

	B	C	D
49	**Economic Impacts**	**Direct**	**Indirect**
50	DMP Capital Cost Spending		
51	DMP O&M Spending		
52	Generalized Travel Cost Savings		
53			
54		(% Change)	(% Change)
55	**Policy Change**	**2%**	
56	Annual Benefit & Impact Sensivity (Percentage Change in Baseline Benefits	Change in Transit Service (Impacting Ridership)	Employment (Impacting Ridership)
57	**TOTAL BENEFITS**	$78.2	
58	Generalized Travel Cost Savings	$53.1	
59	Travel Time Reliability Cost Savings	$0.0	
60	Safety Cost Savings	$21.9	
61	Emission Cost Savings	$0.7	
62	Pavement Maintenance Savings	$0.0	
63	Affordable Mobility	$1.7	
64	Cross-Sector	$0.7	
65	Community Development	$0.0	
66	Economic Impact		
67			
68			

Appendix A. Survey Instrument

PASSENGER SURVEY

Serial Number: | **Origin Station:** | **Destination Station:**

The objective of the survey is to collect information on riders' trip purpose and mobility on the Detroit People Mover. Please follow the instructions below. There are three questions (left to right); OR fill out this survey online at https://dpm.questionpro.com. This form can be completed every time you make a trip.

1) What is the purpose of your trip? YOU CAN SELECT MULTIPLE ANSWERS. THEN FOLLOW THE ARROW(S). If going home, tell us where you came from.

a. Work / Work-related →

2.a) If the People Mover was not available, you would:
a. Not be able to work
b. Look for another job (closer to home)
c. Adjust your working hours
d. Work at home
e. Use another type of transportation (go to question 3)
f. Other Specify: ___________________________

b. Medical / Dental →

2.b) If the People Mover was not available, you would:
a. Not seek medical assistance
b. Select another physician / care provider
c. Receive home care
d. Use another type of transportation (go to question 3)
e. Other Specify: ___________________________

c. School / Education →

2.c) If the People Mover was not available, you would:
a. Not be able to attend school / college
b. Miss more classes or school activities
c. Choose another school (closer to home)
d. Use another type of transportation (go to question 3)
e. Other Specify: ___________________________

d. Shopping →

2.d) If the People Mover was not available, you would:
a. Make no trip b. Make______% fewer trips (1-99)
c. Go to a different shopping center/attraction
d. Shop online or by catalog
e. Use another type of transportation (go to question 3)
f. Other Specify: ___________________________

e. Conventions / Tourism →

2.e) If the People Mover was not available, you would:
a. Stay home
b. Go to a different venue / attraction
c. Use another type of transportation (go to question 3)
d. Other Specify: ___________________________

f. Entertainment →

2.f) If the People Mover was not available, you would:
a. Stay home
b. Go to a different attraction
c. Use another type of transportation (go to question 3)
d. Other Specify: ___________________________

g. Other Specify: ___________________________ →

2.g) If the People Mover was not available, you would:
a. Make no trip b. Make______% fewer trips (1-99)
c. Use another type of transportation (go to question 3)
d. Other Specify: ___________________________

ANSWER THE NEXT QUESTION ONLY IF YOU RESPONDED "USE ANOTHER TYPE OF TRANSPORTATION" FOR ANY OF THE #2 QUESTIONS. CHOOSE ONE RESPONSE ONLY.

3) If the People Mover was not available, what other type of transportation would you use?

a. Use your personal vehicle
b. Ride with someone else
c. Taxi
d. Other public transit service (for instance, Detroit DOT)
e. Bicycle
f. Walk
g. Other Specify: ___________________________

Your comments and suggestions are very helpful to us. Please use the space below.

____

For more information on the survey, please contact DTC at (313) 224-2160, or HDR, Inc. at 1-800-938-4425. THANK YOU FOR YOUR TIME!

Appendix B. Complete Survey Results

	Count	%
Q2		
Your last trip on the Detroit People Mover was:		
Thursday, March 5, 2015	211	21.7%
Friday, March 6, 2015	402	41.3%
Saturday, March 7, 2015	361	37.1%
TOTAL	**974**	**100.0%**

Q3

On your last trip on the Detroit People Mover, what time of day was your trip?		
Morning (8:00 a.m. - 2:00 p.m.)	452	46.4%
Evening / Night (4:00 p.m. - 9:00 p.m.)	522	53.6%
TOTAL	**974**	**100.0%**

Q4

During your last trip, what station did you get on the People Mover?		
Times Square	68	7.0%
Broadway	47	4.8%
Cadillac Center	44	4.5%
Greektown	262	26.9%
Bricktown	20	2.1%
Renaissance Center	131	13.4%
Millender Center	39	4.0%
Financial District	15	1.5%
Joe Louis Arena	60	6.2%
Cobo Center	214	22.0%
Fort/Cass	27	2.8%
Michigan Ave.	47	4.8%
TOTAL	**974**	**100.0%**

Q5

During your last trip, what station did you get off the People Mover?		
Times Square	30	3.1%
Broadway	28	2.9%
Cadillac	20	2.1%
Greektown	236	24.2%
Bricktown	18	1.8%
Renaissance Center	129	13.2%
Millender Center	18	1.8%
Financial District	23	2.4%
Joe Louis Arena	73	7.5%
Cobo Center	363	37.3%
Fort/Cass	10	1.0%
Michigan Ave.	26	2.7%
TOTAL	**974**	**100.0%**

Q6

What was the purpose of your trip? You can select multiple answers. If going home, tell us where you came from.		
a. Work / Work-related	204	20.8%
b. Medical / Dental	5	0.5%

	Count	%
c. School / Education	18	1.8%
d. Shopping	32	3.3%
e. Conventions / Tourism	135	13.7%
f. Entertainment	560	57.0%
g. Other (i.e. Personal Business)	29	3.0%
TOTAL	**983**	**100.0%**

Q7

If the purpose of your trip was work or work-related, and the People Mover was not available, you would:		
a. Not be able to work	6	2.9%
b. Look for another job (closer to home)	7	3.4%
c. Adjust your working hours	16	7.8%
d. Work at home	6	2.9%
e. Use another type of transportation	169	82.8%
f. Other (Specify)	0	0.0%
TOTAL	**204**	**100.0%**

Q8

If the purpose of your trip was related to medical or dental issues, and the People Mover was not available, you would:		
a. Not seek medical assistance	0	0.0%
b. Select another physician/care provider	2	40.0%
c. Receive home care	0	0.0%
d. Use another type of transportation	3	60.0%
e. Other (Specify)	0	0.0%
TOTAL	**5**	**100.0%**

Q9

If the purpose of your trip was related to your school or to your education, and the People Mover was not available, you would:		
a. Not be able to attend school/college	3	16.7%
b. Miss more classes or school activities	1	5.6%
c. Choose another school (closer to home)	2	11.1%
d. Use another type of transportation	12	66.7%
e. Other (Specify)	0	0.0%
TOTAL	**18**	**100.0%**

Q10

If the purpose of your trip was related to shopping, and the People Mover was not available, you would:		
a. Make no trip	2	6.3%
b. Make fewer trips	0	0.0%
c. Go to a different shopping center / attraction	7	21.9%
d. Shop Online or by catalog	4	12.5%
e. Use another type of transportation	19	59.4%
f. Other (Specify)	0	0.0%
TOTAL	**32**	**100.0%**

Q11

If the purpose of your trip was related to conventions or tourism, and the Detroit People Mover was not available, you would:		
a. Stay home	14	10.4%
b. Go to a different venue / attraction	13	9.6%

	Count	%
c. Use another type of transportation	108	80.0%
d. Other	0	0.0%
TOTAL	**135**	**100.0%**

Q12

If the purpose of your trip was entertainment-related, and the People Mover was not available, you would:		
a. Stay home	56	10.0%
b. Go to a different attraction	41	7.3%
c. Use another type of transportation	463	82.7%
d. Other (Specify)	0	0.0%
TOTAL	**560**	**100.0%**

Q13

If your trip was related to anything other than the reasons listed, and the People Mover was not available, you would:		
a. Make no trip	7	24.1%
b. Make fewer trips	0	0.0%
c. Use another type of transportation	21	72.4%
d. Other (Specify)	1	3.4%
TOTAL	**29**	**100.0%**

Q14

If the People Mover was not available, what other type of transportation would you use?		
a. Use your personal vehicle	331	41.8%
b. Ride with someone else	37	4.7%
c. Taxi	121	15.3%
d. Other public transit service (for instance, Detroit DOT)	38	4.8%
e. Bicycle	10	1.3%
f. Walk	249	31.5%
g. Other (Specify)	5	0.6%
TOTAL	**791**	**100.0%**

Appendix C. Concept of Consumer Surplus

The estimation of social benefits is based on consumer demand theory. Economists refer to the difference between the amount people actually pay for something and the maximum amount they are willing to pay as "consumer surplus". In the demand for transportation, consumer surplus is the monetary quantity that equates to the economic value afforded to people by the availability of an additional mode, such as the DPM.

A graphical representation of trip demand is provided in Figure B-1 on the following page. The level of trip demanded for the DPM and the price difference between public transit and other transportation modes measure the consumer surplus. Formally, consumer surplus can be expressed in the following way:

$$EV = (P_0 - P_1)\, Q_1 + \tfrac{1}{2}\,[(P_0 - P_1)\,(Q_1 - Q_0)]$$

$$= \tfrac{1}{2}\,(Q_0 + Q_1)\,(P_0 - P_1)$$

Where: - *EV* is the economic value of DPM trips;

- P_0 is the fare that people pay when using other transportation modes (personal vehicle, taxi, etc.);

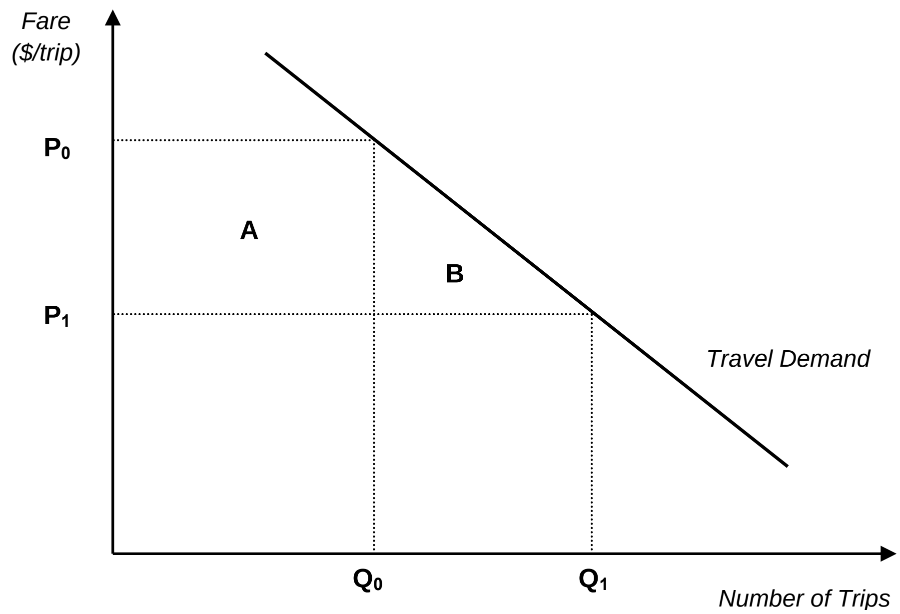
- Q_0 is the number of passenger trips when using other transportation modes;

- P_1 is the average fare paid by DPM riders; and

- Q_1 is the number of passenger trips (ridership).

In the absence of the DPM, trip makers pay P_0 and demand Q_0 number of trips. When public transit is added, riders shift to the DPM as it is more affordable. P_1 is the new cost per trip and Q_1 is the corresponding trip demand. The difference between P_0 and P_1 is the decrease in travel cost, while the difference between Q_0 and Q_1 is the number of new or induced trips. The economic value of the DPM trips is represented by areas *A* and *B*: rectangle area *A* represents the benefits accrued to travelers switching to the DPM (i.e., out-of-pocket cost savings) and **triangle area *B* represents the benefits accrued to new or induced riders**.

Figure B-1: The Concept of Consumer Surplus



Appendix D. Economic Impacts from Capital Expenses on the City of Detroit

Category	Unit	2009	2010	2011	2012	2013	2014	2020	2025	2030	2035
Total Employment	Jobs	160	133	105	83	89	94	61	52	44	38
Private Non-Farm Employment	Jobs	144	120	95	75	81	86	55	47	40	35
Gross Domestic Product	Millions of Fixed (2005) Dollars	$10.1	$8.5	$6.8	$5.3	$5.6	$6.1	$4.0	$3.4	$3.0	$2.7
Output	Millions of Fixed (2005) Dollars	$18.3	$15.5	$12.3	$9.6	$10.2	$11.0	$7.0	$6.1	$5.3	$4.7
Value Added	Millions of Fixed (2005) Dollars	$10.1	$8.5	$6.8	$5.3	$5.6	$6.1	$4.0	$3.4	$3.0	$2.7
Personal Income	Millions of Current Dollars	$5.0	$4.7	$4.2	$3.7	$4.0	$4.4	$4.1	$4.3	$4.6	$5.1
Disposable Personal Income	Millions of Current Dollars	$4.4	$4.1	$3.7	$3.2	$3.5	$3.8	$3.5	$3.7	$4.0	$4.5
Real Disposable Personal Income	Millions of Fixed (2005) Dollars	$4.2	$3.7	$3.1	$2.6	$2.7	$2.9	$2.1	$1.9	$1.8	$1.7

Source: Michigan Department of Transportation

Appendix E. List of Acronyms

APTA	American Public Transportation Association
CBD	Central Business District
CPPI	Commercial property price index
D3	Data Driven Detroit
DOT	Department of Transportation
DPM	Detroit People Mover
DTC	Detroit Transportation Corporation
EPA	Environmental Protection Agency
EULA	End User Licensing Agreement
GeoID	Geographic identification number
GIS	Geographical Information System
HPI	Home price index
I-O	Input-Output
MOVES	Motor Vehicle Emission Simulator
NTD	National Transit Database
O&M	Operation and Maintenance
PDO	Property Damage Only
PIN	Parcel identification number
PPI	Producer price index
PTMS	Public Transportation Management System
REMI	Regional Economic Models, Inc.
TOD	Transit Oriented Development
VMT	Vehicle Miles Traveled
VOT	Value of Time