MARKET User's Guide

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The purpose of this model is to provide a high level estimate of the benefits to the agricultural sector associated with a US-Mexico border transportation project. The model uses a benefit cost analysis approach to calculate the vehicle operating cost savings, business and personal time and reliability cost savings, safety benefits, logistics/ freight cost savings, environmental benefits, and economic impacts in the form of business output and the positive effect of wage income. The analysis also calculates the total benefits that are accrued solely by the agricultural sector, as well as a project prioritization factor.

INPUTS

Project Parameters	
Construction Cost (M$)	$77.59
Construction Start Year	2022 ▾
Operation Start Year	2027 ▾
Scenario-Baseline	
Truck Percent	28.6
AADT	15,397
Average Speed (Base)	64.8
Scenario-Project	
Average Speed (Project)	65.8
Project Length (Miles)	10
Area Type	Rural ▾
Port of Entry	Pharr ▾
Calculate	

User inputs include the following variables.

- Cost: The total cost of the project in 2018, in millions of dollars
- Construction Start Year: The year in which construction begins
- Operation Start Year: The year in which the project begins operation
- Truck Percent: The percent of vehicles on the project roadway that are commercial freight trucks
- Average Annual Daily Travel (AADT): The average number of vehicle trips on the project roadway each day
- Average Speed Base: The average speed of vehicles on the existing roadway in miles per hour (mph)
- Average Speed Project: The estimated average speed of vehicles on the proposed project roadway

- Project Length: The total distance of the project in miles
- Port of Entry: The border port of entry corresponding to the project
- Project Area Type: Can be Urban, Suburban, or Rural, depending on the project

Appendix A shows the default values used in the analysis. The commodity mix of freight trucks was gathered from the Bureau of Transportation Statistics (BTS) import and export data.[1] These outputs are discussed in further detail in the following sections.

OUTPUTS

Benefits and Costs	Present Value (2018)
Vehicle Operating Cost Savings	$4.71M
Business Time and Reliability Cost Savings	$4.54M
Personal Time and Reliability Cost Savings	$2.27M
Safety Benefits	$3.90M
Logistics/Freight Cost Savings	$4.85M
Business Output	$108.80M
Positive Economic Effect of Wage Income	$48.65M
Total Benefits	$177.78M
Capital Costs	$65.04M
Total Costs	$65.04M
Benefit / Cost Ratio	2.73 : 1
Total Agriculture Benefits	$3.26M
Project Prioritization Factor	5.02

Methodology

MARKET Model

The first step of the MARKET model is the cost calculation. The construction costs are distributed evenly over the construction period and discounted. All costs and benefits assume a 3 percent discount rate. The model then generates travel impact costs for the baseline (no-build) scenario and the project (build) scenario. The difference in costs between the baseline and project scenario is the cost savings or benefit of the project. These costs are calculated separately for passenger and truck travel. In order to calculate these costs, first the number of trips, vehicle miles traveled (VMT), vehicle hours traveled (VHT), were calculated.

- Trips
    - Annual Trips = Average Annual Daily Traffic (AADT) * 365

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[1] Bureau of Transportation Statistics. *Transborder Freight Data.* https://www.bts.gov/transborder

- - Truck Trips = Annual Trips * Percent of Truck Traffic
  - Passenger Trips = Annual Trips – Truck Trips
- VMT = Trips * Project Length
- VHT = VMT / Average Speed[2]

Vehicle Operating Cost Savings

These variables were then used to calculate several annual truck and passenger vehicle costs for the baseline and project scenarios. Vehicle operating cost is the cost per hour of operating a passenger vehicle or truck. This factor includes maintenance, tires, mileage-based depreciation, and insurance. Fuel costs are also calculated and added. An increase in speed in the project scenario will result in less vehicles hours of travel, leading to less operating costs, consequently creating a benefit.

- Vehicle Operating Costs
  - Base Operating Cost (Truck and Passenger) = (VHT * Vehicle Operating Cost per Hour)
  - Fuel Operating Cost (Truck and Passenger) = (VHT * Gallons per Hour) * Fuel Cost per Gallon

Business and Personal Time and Reliability Cost Savings

Value of time is the crew cost for trucks and the personal time costs for passenger vehicles. Time-savings result from multiplying the number of crew or passengers per vehicle by the crew or passenger cost per hour factor for each crew- member/passenger, and then multiplying by the VHT in each scenario. The difference between the two scenario costs is the cost savings.

- Value of Time
  - Truck Business Time Cost = (Number of Crew per Vehicle * Crew Cost per hour per crew member) * Truck VHT
  - Passenger Business Time Cost = (Number of Passengers per Vehicle * Passenger Cost per Hour per Passenger) x (Passenger VHT * Percentage of Business Personal Time)
  - Personal Time Cost = (Passengers per Vehicle * Passenger Cost per Hour per Passenger) * (Passenger VHT * Percentage of Passenger Personal Time)

Environmental and Safety Benefits

Environmental costs are the truck and passenger vehicle emissions cost. Reduced congestion results in lower idle times for all vehicles, which reduces vehicles emissions per trip. Emission costs are calculated using the per hour rate for Volatile Organic Compounds (VOCs), Nitrogen Oxide (NOx), Sulfur Dioxide (Sox), Particulate Matter (PM), and Carbon Dioxide (CO_2). Safety costs are the truck and passenger property damage, injury, and fatality costs. The project scenarios assume a decrease in accident rates, based on the type of project, which reduces safety costs.

- Environmental Costs (Truck and Passenger)
  - VHT x Environmental Cost per Hour
- Safety Costs (Truck and Passenger)
  - ((VMT / 100,000,000) * Fatality Rate per 100m VMT) x $ per Fatality
  - ((VMT / 100,000,000) * Injury Rate per 100m VMT) * $ per Injury

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[2] If the change in average speed is less than 1 mph between the baseline and project scenarios, the baseline speed is rounded down to the nearest mph and the project speed is the baseline speed plus 1 mph.

- ((VMT / 100,000,000) * Property Damage Rate per 100m VMT) * $ per Property Damage

Freight Time Costs

Freight time costs represents the costs to industries that produce or consume the freight goods on the trucks moving through the port of entry (POE). The freight time cost savings consists of commodity time costs, perishability costs, and just in time costs. These factors were calculated using a methodology developed by Fitzroy, et al. with EDR group.[3]

First, the estimated buffer time was calculated. Buffer time in this analysis is defined as the extra time required to ensure that 95 percent of trips are on time. Then commodity time cost for each commodity was calculated by multiplying the tons per vehicle by the commodity percent of freight, then by the commodity cost per hour, and the total buffer time VHT. This calculation repeats for each commodity moving through the POE. The commodity cost per hour for each commodity was calculated through EDR's methodology which assumes an hourly return on capital of 10 percent, divided by 5,400, with 5,400 being the estimated number of productive hours in a year. This was then multiplied by the cost of the good as reported at the POE to give the commodity cost per hour. This represents an hourly opportunity cost of the good not being at its destination.

The perishability cost was also estimated based on the calculated buffer time and using EDR's methodology. Perishability cost is the loss in value from goods spoiling during transport. This applies to goods that need to be fresh at their destination such as fruits and vegetables. A calculation similar to the commodity time cost calculation was used. Buffer time was multiplied by the tons per vehicle, then by the commodity percent of freight. This was then multiplied by the perishability cost factor, then by the perishability commodity factor. A perishability cost factor of $0.001 per buffer hour was used, based on EDR's methodology. Perishability commodity factors were also assigned to goods based on EDR methodology. Just in time cost was calculated in the same way, using a just in time cost factor and a just in time commodity factor in place of the perishability factors. Just in time commodity factors were used based on EDR methodology, with a just in time cost factor of

- Total Freight Time Cost = Commodity Time Cost + Just in Time Cost + Perishability Cost
  - Commodity Time Cost= Truck Buffer VHT * Tons per Vehicle * Commodity Percent of Freight * Commodity Cost per Hour
    - Commodity Cost per Hour = Commodity Price * (0.1/5400)
  - Just in Time Cost = Truck Buffer VHT * Tons per Vehicle * Commodity Percent of Freight * Just In Time Cost Factor * Just in Time Commodity Factor
  - Perishability Cost = Truck Buffer VHT * Tons per Vehicle * Commodity Percent of Freight * Perishability Cost Factor * Perishability Commodity Factor

Transportation cost savings are calculated annually for both the baseline and project scenarios. The project costs are then subtracted from the baseline costs to produce annual project benefits for each

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[3] Fitzroy, Stephen, et al., New Methods for Assessing the Costs of Delay and Reliability on Major Highway Corridors: A Commodity-Focused/Industry Sector Approach for Addressing Freight Planning in MAP-21. ITED Conference 2014. https://www.edrgroup.com/pdf/Fitzroy-ITED-2014.pdf

cost category. These annual benefits are discounted, then summed to provide total discounted project benefits for each cost category.

Economic Effects

The economic effects of the project are also calculated. These include the business output and wage income. Business output is associated with construction spending on the project and is presented as the sum of worker wages and business income. The positive economic effect of wage income is the impact of increased worker income associated with construction spending on the economy.

- Business Output = Discounted Construction Cost * Business Output Multiplier[4]
- Economic Effect of Wage Income = Discounted Construction Cost * Wage Income Multiplier[5]

Project Prioritization Factor

In order to calculate the benefits solely accrued by the agricultural sector, the project and baseline costs were calculated a second time, however only the truck trips attributable to agricultural sector activity were counted as represented by the percentage of freight attributable to agricultural sector commodities. This percentage was then applied to the total number of freight trips, to determine the number of agricultural sector trips. The cost savings were then calculated a second time using this focused number of trips. This resulted in total benefits that are directly accrued to the agricultural sector.

The total benefits and costs are shown in the final results table for each project. Each benefit is summed to calculate the total discounted benefit. The total discounted benefits are then divided by the total discounted costs to calculate the benefit cost ratio of the project. A benefit cost ratio of greater than 1.0 is positive indicating that the benefits of building the project outweigh the cost. The agricultural sector only benefits are also divided by the cost of the project, the multiplied by 100 to calculate the project prioritization factor. The project prioritization factor is not a cost benefit ratio, as it is not possible to allocate a specific portion of the total project cost to the agricultural sector. Rather, the project prioritization factor provides an estimate of the relative benefit to the agricultural sector per dollar spent on the transportation project. A higher project prioritization factor means that the project provides more benefits per dollar to the agricultural sector relative to a project with a lower project prioritization factor. The project prioritization factor should not be used as a sole factor to select projects, but used as a one point of comparison when comparing potential projects.

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[4]Business Output Multiplier changes based on Urban, Suburban, or Rural classification
[5]Wage Income Multiplier changes based on Urban, Suburban, or Rural classification

Assumed Values

The default values used for this analysis were obtained from multiple sources and are displayed in Table 1. All costs have been inflated to 2018 dollars. Additionally, it was assumed that passenger vehicles are used 42.5% of the time for business and 57.5% of the time for personal use.

Table 1. MARKET Default Values

Assumption	Passenger	Truck
Persons per Vehicle (Business)	1.2	1.1
Persons per Vehicle (Personal)	1.6	-
Crew Cost Factor ($/hr per Crew Member)[6]	-	$29.70
Passenger Personal Cost Factor ($/hr per occupant)[6]	$14.74	-
Passenger Business Cost Factor ($/hr per occupant)[6]	-	$27.52
Environmental Cost $/hr	$0.03	$0.62
Vehicle Operating Cost ($/hr)	$5.03[7]	$22.56[8]
Fatality Accidents per 100m VMT	1.08[9]	0.2[10]
Personal Injury Accidents per 100m VMT	77[9]	9.7[10]
Property Damage Accidents per 100m VMT	200[9]	157[10]
$ per Fatalities Accident[6]	$9,967,928	$9,967,928
$ per Personal Injury Accident[6]	$180,700	$180,700
$ per Property Damage Accident[6]	$4,415	$4,415

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[6] https://www.transportation.gov/sites/dot.gov/files/docs/mission/office-policy/transportation-policy/284031/benefit-cost-analysis-guidance-2018_0.pdf
[7] https://exchange.aaa.com/wp-content/uploads/2015/04/Your-Driving-Costs-2015.pdf
[8] http://atri-online.org/wp-content/uploads/2017/10/ATRI-Operational-Costs-of-Trucking-2017-10-2017.pdf
[9] https://www.bts.gov/archive/publications/national_transportation_statistics/table_02_17
[10] https://www.bts.gov/archive/publications/national_transportation_statistics/table_02_23