MOBILITY AND ECONOMIC IMPACTS DUE TO BRIDGE CONSTRUCTION

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Transportation Research Center
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Introduction

- There are approximately 600,000 bridges in the United States; however, about 25% of them are structurally deficient or functionally obsolete. Hence, they require rehabilitation, repair or total replacement (FHWA 2017).
- Accelerated bridge construction (ABC) methods are implemented over conventional construction (CC) to reduce mobility impact time.
- Time metrics for ABC based on mobility impact time (FHWA 2017):

Tier	Mobility Impact Time
1	1 – 24 hours
2	1 – 3 days
3	3 days – 2 weeks
4	2 weeks – 3 months
5	More than 3 months

Introduction






Mobility impact time of PBES is in **months**

Mobility impact time of SPMT is in **weeks**

Mobility impact time of SIBC is in **days**

Mobility impact time decreases

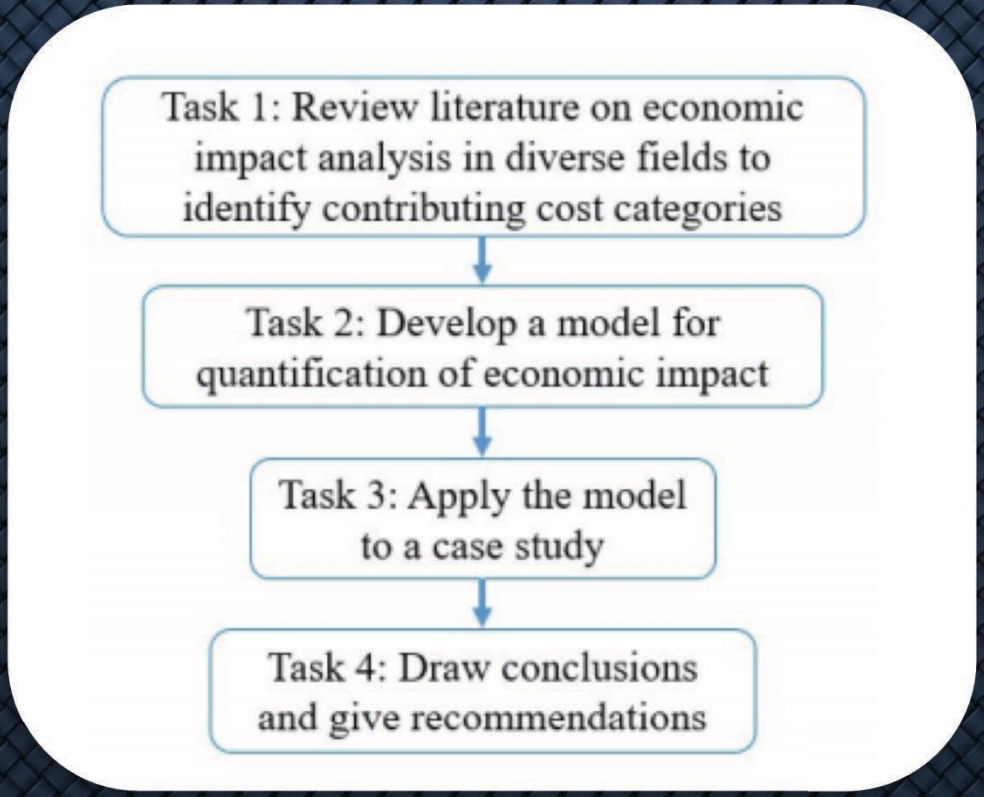
Initial project cost increases
(The ABC costs are 6% to 21% higher than CC due to site complexities, time constraints, and perceived risks.)

- Traditionally, user cost from reduced mobility impact time (T_M) is used to justify additional cost of ABC. However, there are other inconveniences on neighboring communities and businesses which can be quantified as economical impacts.

Objective and Methodology

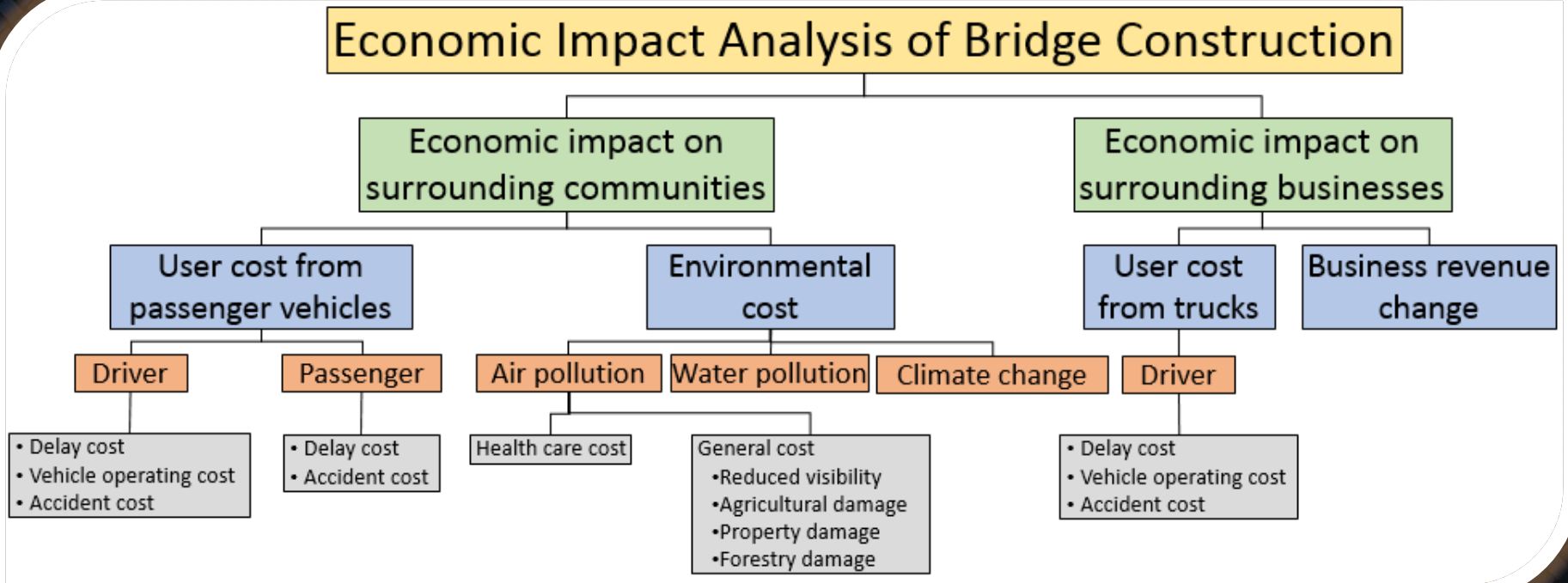
Objective: To develop and implement a model to quantify economic impact on surrounding communities and businesses from a bridge construction project.

Methodology:



Cost Categories

- The project impacts are grouped under three major cost categories (a) user cost, (b) environmental costs, and (c) business revenue change (Aktan and Attanayake 2015; Metthews et al. 2014; Islam et al. 2014; Ferguson 2012; the Swiss Federal Office for Spatial Development 2010; Allouche and Gilchrist 2004; Delucci 2000; the Federal Highway Administration 1997).



Economic Impact on Surrounding Communities

User Cost

- User cost from passenger vehicles within work zone:
  - Driver delay cost: $DDC=[L/S\downarrow a \ -L/S\downarrow n \ ]\cdot ADT\downarrow pv \cdot N\cdot w\downarrow pvd$
  - Vehicle operating cost: $VOC=[L/S\downarrow a \ -L/S\downarrow n \ ]\cdot ADT\downarrow pv \cdot N\cdot r\downarrow pv$
  - Accident cost: $AC=L\cdot ADT\downarrow pv \cdot N\cdot (A\downarrow apv -A\downarrow npv \ )\cdot C\downarrow a$

L= length of the affected roadway due to bridge construction (i.e., work zone length)
S_a = work zone speed limit
S_n = normal speed limit of the roadway
ADT_{pv} = average daily passenger vehicle traffic
N = duration of construction in days affecting the work zone
w_{pvd} = hourly rate for passenger vehicle drivers
r_{pv} = average hourly vehicle operating cost for passenger vehicles
A_{apv} = accident rate per vehicle-mile due to work zone
A_{npv} = normal accident rate
C_a = average cost per accident

Economic Impact on Surrounding Communities

User Cost

- User cost from passenger vehicles within work zone:
  - Passenger delay cost: $PDC=[L/S\downarrow a \ -L/S\downarrow n \ ]\cdot ADT\downarrow pv \cdot N\cdot w\downarrow p \cdot(AVO-1)$
  - Passenger accident cost:

$$PAC=L\cdot ADT\downarrow pv \cdot N\cdot (A\downarrow apv -A\downarrow npv)\cdot C\downarrow ap \cdot (AVO-1)$$

AVO = average vehicle occupancy

w_p = hourly rate for passenger

C_{ap} = average medical cost per accident per person (accident cost excluding cost of damages to the vehicle)

Economic Impact on Surrounding Communities

User Cost

- User cost from passenger vehicles due to detour:
  - Driver delay cost: $DDC=(T\downarrow Dpv-T\downarrow WZpv)\cdot V\downarrow pv\cdot T\downarrow M\cdot w\downarrow pv$
  - Vehicle operating cost: $VOC=(T\downarrow Dpv-T\downarrow WZpv)\cdot V\downarrow pv\cdot T\downarrow M\cdot r\downarrow pv$
  - Accident cost: $AC=(L\downarrow Dpv-L\downarrow WZpv)\cdot V\downarrow pv\cdot T\downarrow M\cdot A\downarrow npv\cdot C\downarrow a$
  - Passenger delay cost: $PDC=(T\downarrow Dpv-T\downarrow WZpv)\cdot V\downarrow pv\cdot T\downarrow M\cdot w\downarrow p\cdot(AVO-1)$
  - Passenger accident cost: $PAC=(L\downarrow Dpv-L\downarrow WZpv)\cdot V\downarrow pv\cdot T\downarrow M\cdot A\downarrow npv\cdot C\downarrow a\cdot(AVO-1)$

T_{Dpv} = time to travel via detour for passenger vehicles

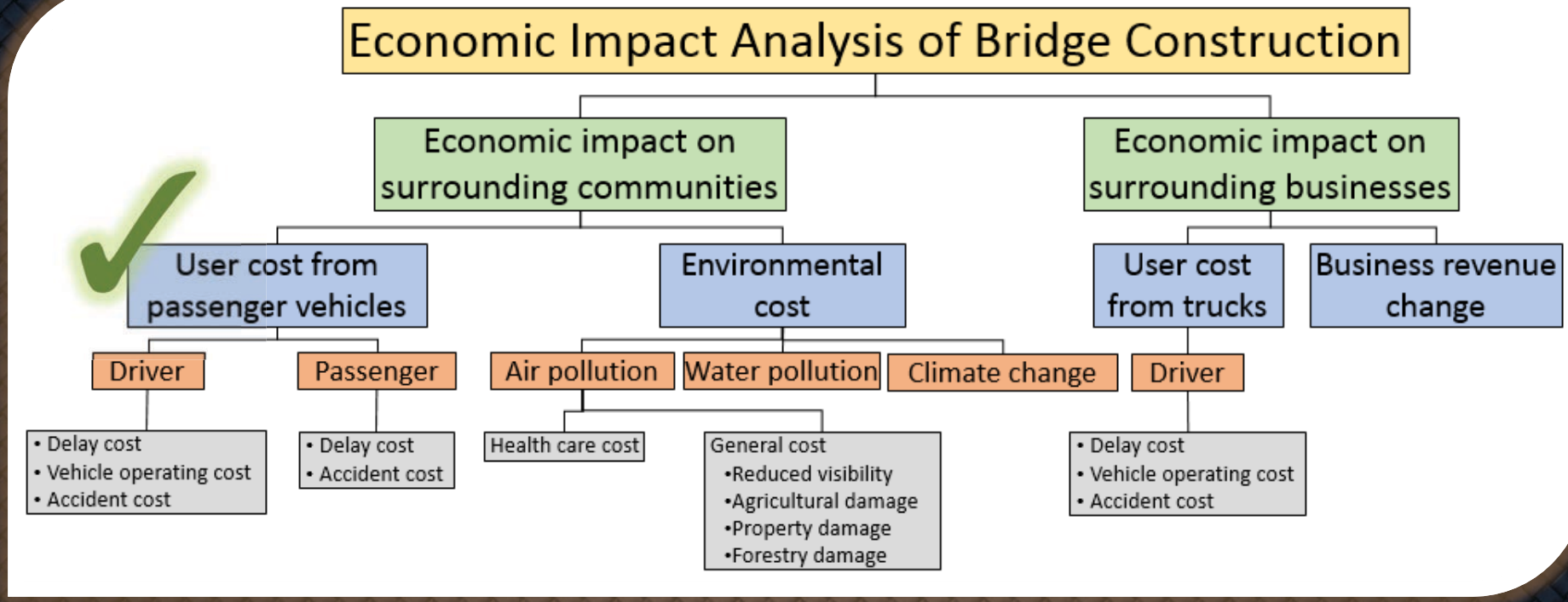
T_{WZpv} = time to travel at the normal posted speed along a distance equal to the road segment that is closed due to construction

T_M = mobility impact time

V_{pv} = volume of passenger vehicle traffic on the roadway to be closed during construction

L_{Dpv} = the length of detour for passenger vehicles

L_{WZpv} = length of the road segment closed to passenger vehicles during construction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Economic Impact on Surrounding Communities

Environmental Cost

- **Environmental cost from air pollution**
  - Health care cost is calculated based on treatment cost since air pollution caused by the following pollutants affects human health:
    - Carbon monoxide (CO)
    - Nitrogen dioxide (NO_2)
    - Volatile organic compound (VOC)
    - Particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$)
    - Particulate matter between 2.5 microns and 10 microns (PM_{10})

Economic Impact on Surrounding Communities

Environmental Cost

- Health care cost from a pollutant within work zone:
  - For passenger vehicles: $CP = UC_p \cdot E_{pv} \cdot ADT_{pv} \cdot N \cdot L \cdot (SCF_{NSpv} - SCF_{WZpv})$
  - For trucks: $CP = UC_p \cdot E_t \cdot ADTT \cdot N \cdot L \cdot (SCF_{NSt} - SCF_{WZt})$
- Health care cost from a pollutant due to detour:
  - For passenger vehicles: $CP = UC_p \cdot E_{pv} \cdot V_{pv} \cdot T_M \cdot (L_{Dpv} \cdot SCF_{Dpv} - L_{WZpv} \cdot SCF_{NSpv})$
  - For trucks: $CP = UC_p \cdot E_t \cdot V_t \cdot T_M \cdot (L_{Dt} \cdot SCF_{Dt} - L_{WZt} \cdot SCF_{NSt})$

CP = health care cost from pollutant

UC_p = unit cost of health treatment when exposed to a pollutant

E_{pv} = emission amount of a pollutant from a passenger vehicle

E_t = emission amount of a pollutant from a truck

ADTT = average daily truck traffic

SCF_{NSpv} and SCF_{NSt} = the speed correction factors for normal speed limit within the road segment with no construction for passenger vehicles and trucks, respectively

SCF_{WZpv} and SCF_{WZt} = the work zone speed correction factors for passenger vehicles and trucks, respectively

SCF_{Dpv} and SCF_{Dt} = the detour speed correction factors for passenger vehicles and trucks, respectively

Economic Impact on Surrounding Communities

Environmental Cost

- Health care cost from passenger vehicles:

$$HC\downarrow pv = CP\downarrow CO + CP\downarrow NO2 + CP\downarrow VOC + CP\downarrow PM2.5 + CP\downarrow PM10$$

- Health care cost from trucks:

$$HC\downarrow t = CP\downarrow CO + CP\downarrow NO2 + CP\downarrow VOC + CP\downarrow PM2.5 + CP\downarrow PM10$$

- Total health care cost:

$$HC = HC\downarrow pv + HC\downarrow t$$

Economic Impact on Surrounding Communities

Environmental Cost

- **Environmental cost from air pollution**
  - General cost categories are:
    - Reduced visibility: established by the decline in the asset value of homes
    - Agricultural damage: established by crop shortfalls
    - Property damage: established by discoloration and building façade damage
    - Forestry damage: established by the decline in timber growth
  - General cost categories are defined as a percentage of total health care cost;

General Cost Category	General Cost (% of Health Care Cost)
Reduced visibility	14.5
Agricultural damage	8.5
Property damage	4.0
Forestry damage	1.0

Economic Impact on Surrounding Communities

Environmental Cost

- **Environmental cost from water pollution**
  - Fuel and chemical spill contaminate the watershed and impact human health and wild life.
  - Water pollution damage from passenger vehicles due to detour:

$$WP\downarrow pv = UC\downarrow wpv \cdot V\downarrow pv \cdot T\downarrow M \cdot (L\downarrow Dpv - L\downarrow WZpv)$$

  - Water pollution damage from trucks due to detour:

$$WP\downarrow t = UC\downarrow wt \cdot V\downarrow t \cdot T\downarrow M \cdot (L\downarrow Dt - L\downarrow WZt)$$

  - Total water pollution damage

$$WP = WP\downarrow pv + WP\downarrow t$$

UC_{wpv} = unit cost of water pollution from per mile travel of passenger vehicle

UC_{wt} = unit cost of water pollution from per ton-mile travel of passenger vehicle

Economic Impact on Surrounding Communities

Environmental Cost

- **Environmental cost from climate change**
  - Transportation activities contribute to climate change with emissions of green house gases (GHG):
    - Carbon dioxide (CO_2) from tailpipe
    - Methane (CH_4) from tailpipe
    - Nitrogen oxide (N_2O) from tailpipe
    - Chlorofluorocarbons (CFCs) from leaking air conditioners
  - To express the global warming contributions of different GHGs, global warming potential (GWP) concept is used.

Greenhouse Gases (GHGs)	Global Warming Potential (GWP)
Carbon Dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous Oxide (N_2O)	298
Chlorofluorocarbon (CFCs)	1,430

Economic Impact on Surrounding Communities

- **Environmental cost from climate change**
  - Impact to climate change within work zone:
    - For passenger vehicles:

$$CC\downarrow pv = SC\downarrow CO2 \cdot E\downarrow pv \cdot ADT\downarrow pv \cdot N \cdot L \cdot (SCF\downarrow NSpv - SCF\downarrow WZpv)$$

    - For trucks: $CC\downarrow t = SC\downarrow CO2 \cdot E\downarrow t \cdot ADTT \cdot N \cdot L \cdot (SCF\downarrow NSt - SCF\downarrow WZt)$
  - Impact to climate change due to detour:
    - For passenger vehicles:

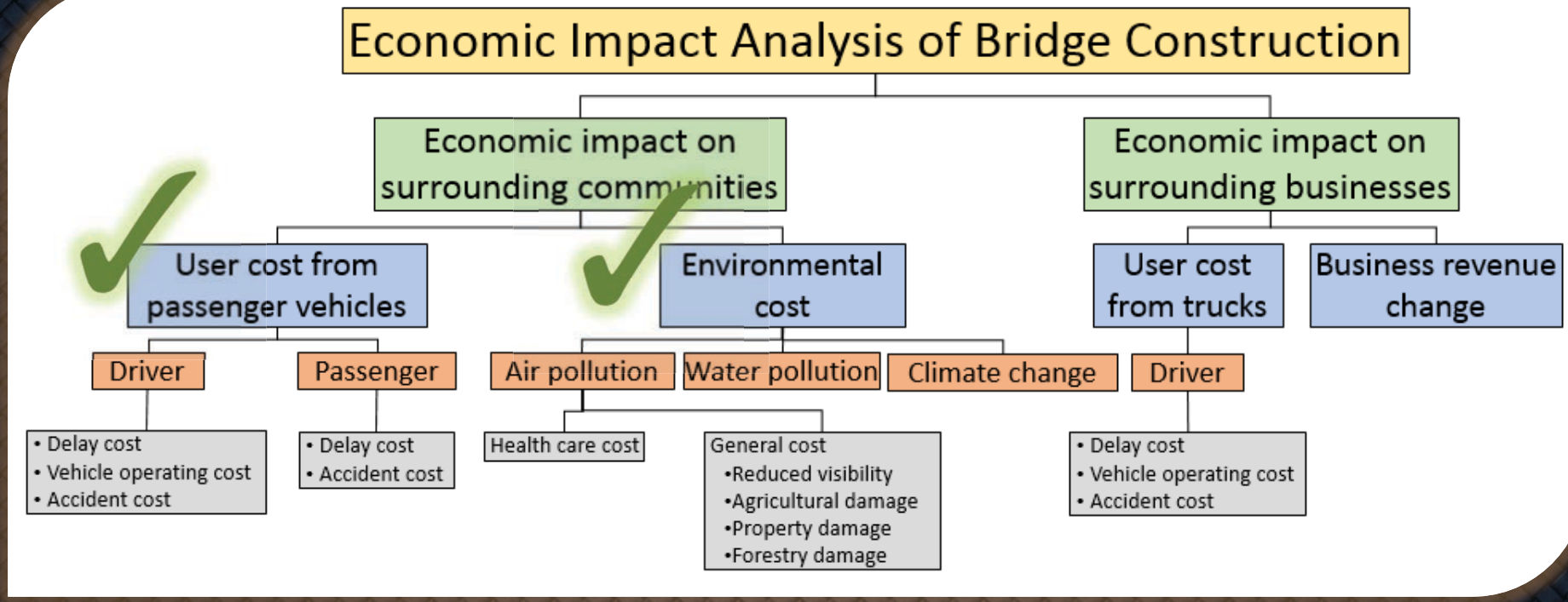
$$CC\downarrow pv = SC\downarrow CO2 \cdot E\downarrow pv \cdot V\downarrow pv \cdot T\downarrow M \cdot (L\downarrow Dpv \cdot SCF\downarrow Dpv - L\downarrow WZpv \cdot SCF\downarrow NSpv)$$

    - For trucks: $CC\downarrow t = SC\downarrow CO2 \cdot E\downarrow t \cdot V\downarrow t \cdot T\downarrow M \cdot (L\downarrow Dt \cdot SCF\downarrow Dt - L\downarrow WZt \cdot SCF\downarrow NSt)$
  - Total impact to climate change:

SC_{CO2} = unit social cost of CO_2

E_{pv} = equivalent amount of total CO_2 emission from passenger vehicles

E_t = equivalent amount of total CO_2 emission from trucks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Economic Impact on Surrounding Businesses

User Cost

- User cost from trucks within work zone:
  - Driver delay cost: $DDC=[L/S\downarrow a - L/S\downarrow n]\cdot ADTT\cdot N\cdot w\downarrow t$
  - Vehicle operating cost: $VOC=[L/S\downarrow a - L/S\downarrow n]\cdot ADTT\cdot N\cdot r\downarrow t$
  - Accident cost: $AC=L\cdot ADTT\cdot N\cdot (A\downarrow at - A\downarrow nt)\cdot C\downarrow a$

w_t = hourly rate for truck drivers
r_t = average hourly vehicle operating cost for trucks
A_{at} = accident rate per truck-mile due to work zone
A_{nt} = normal accident rate for trucks

Economic Impact on Surrounding Businesses

User Cost

- User cost from trucks due to detour:
  - Driver delay cost: $DDC=(T\downarrow Dt-T\downarrow WZt)\cdot V\downarrow t\cdot T\downarrow M\cdot w\downarrow t$
  - Vehicle operating cost: $VOC=(T\downarrow Dt-T\downarrow WZt)\cdot V\downarrow t\cdot T\downarrow M\cdot r\downarrow t$
  - Accident cost: $AC=(L\downarrow Dt-L\downarrow WZt)\cdot V\downarrow t\cdot T\downarrow M\cdot A\downarrow nt\cdot C\downarrow a$

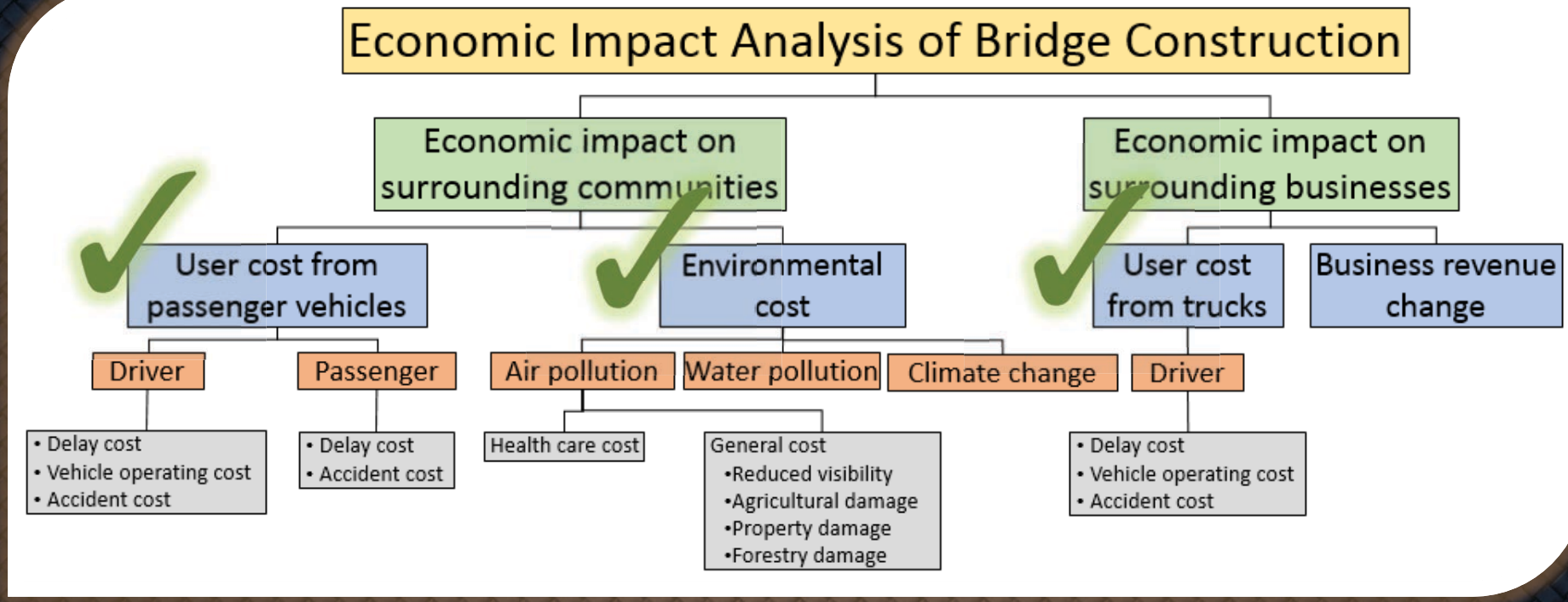
T_{Dt} = time to travel via detour for trucks

T_{WZt} = time to travel at the normal posted speed along a distance equal to the road segment that is closed due to construction

V_t = volume of truck traffic on the roadway to be closed during construction

L_{Dt} = length of detour for trucks

L_{WZt} = length of road segment closed to trucks during construction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Economic Impact on Surrounding Businesses

Business Revenue Change

- Bridge construction disrupts traffic and customer flow to surrounding businesses
- The change in regular flow of customers could result in either and increase or a loss in business revenue.
- Business revenue change (ΔR) is a function of change in number of customers (ΔC), average expenditure per household (AE), and mobility impact time (T_M):

$$\Delta R = AE \cdot \Delta C \cdot T \downarrow M$$

- ΔC is a function of number of households without direct access (HWA) to surrounding businesses during mobility impact time:

$$\Delta C = HWA \cdot P \cdot F$$

P = % influence area with access limitations

F = customer frequency of patronizing a specific business

Economic Impact on Surrounding Businesses

Business Revenue Change

- Households without direct access: area where the access to the influence area is limited during bridge construction
- Influence area: commercial area with access limitations due to bridge construction project
  - Traffic demand models (large urban areas)
  - Analysis of road network (rural areas)

Economic Impact on Surrounding Businesses

Business Revenue Change

- Rational quantification of business revenue loss requires determining site specific P and F. Hence a community survey can provide data to determine site specific P and F. Also, survey can be a tool to crate user awareness on the ABC project:

- If the bridge is closed to traffic for _____ days, would you still travel to the area influenced by the construction for your routine shopping, eating, etc.?
- If your answer to the above question is NO, what type of business/store (gas station, party store, grocery store, pharmacy, auto repair, etc.) located within the influenced area would you still make an effort to access?
- Before the construction, how often do you go to the following businesses/stores?

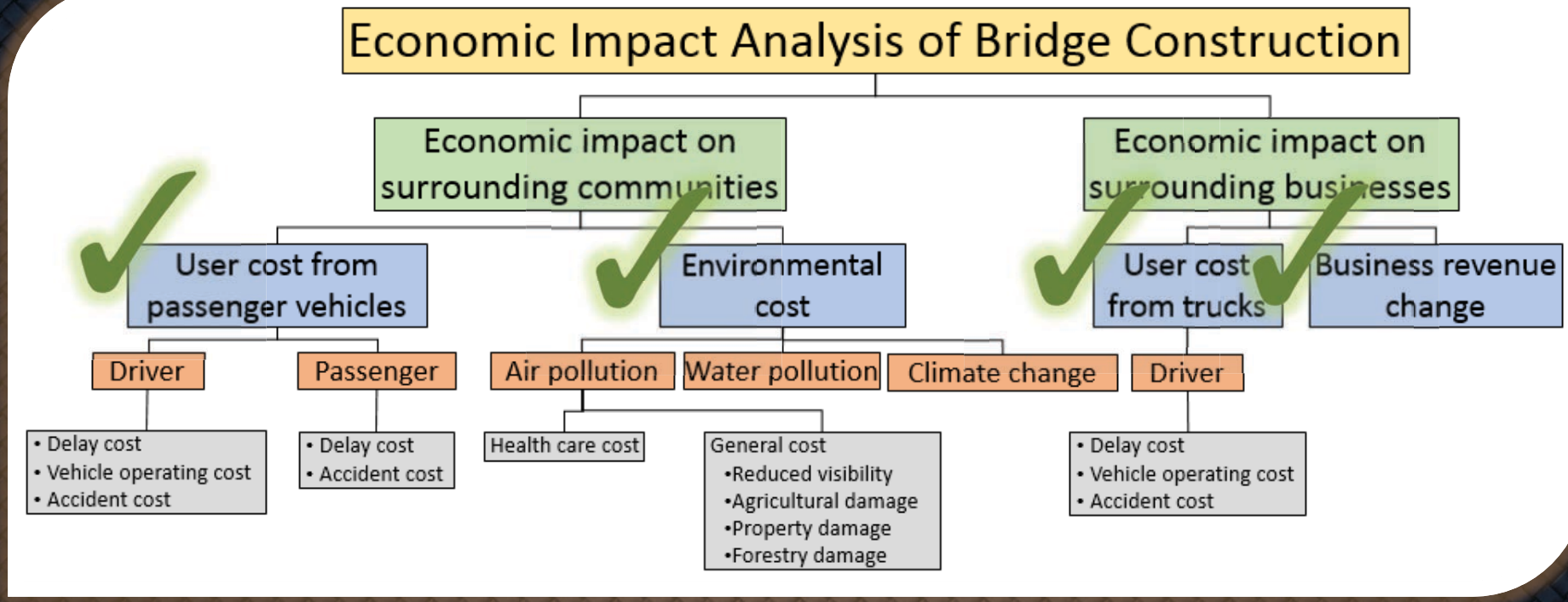
Restaurants: per week

Party/liquor Store: per week

Gas Stations: per month

Pharmacy: per quarter

Auto Repair: per quarter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Case Study – Potterville, MI

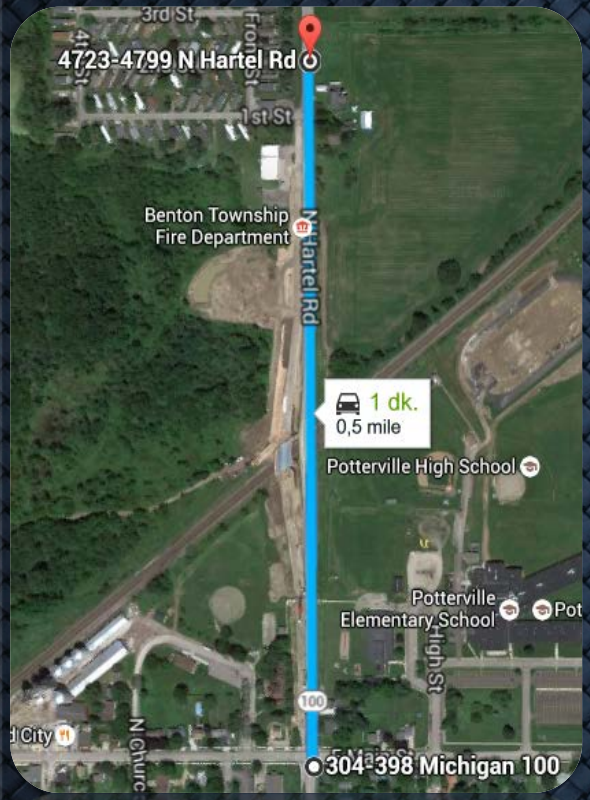
Source: Google map

Case Study – Potterville, MI

Parameters	SIBC	CC
T_M	2 days	180 days
N	237 days	-
L	0.5 mile	-
ADT_{pv}	5045 vehicles/day	5045 vehicles/day
ADTT	190 vehicles/day	190 vehicles/day
S_a	25 mph	-
S_n	55 mph	-
L_{WZpv}	1.6 mile	1.6 mile
V_{WZpv}	55 mph	55 mph
T_{WZpv}	0.029 hr	0.029 hr
L_{Dpv}	4.5 mile	4.5 mile
V_{Dpv}	35 mph	35 mph
T_{Dpv}	0.129 hr	0.129 hr
L_{WZt}	8.5 mile	8.5 mile
V_{WZt}	55 mph	55 mph
T_{WZt}	0.141 hr	0.141 hr
L_{Dt1}	9.8 mile	9.8 mile
L_{Dt2}	3.6 mile	3.6 mile
V_{Dt1}	60 mph	60 mph
V_{Dt2}	55 mph	55 mph
T_{Dt}	0.229 hr	0.229 hr

Case Study – Potterville, MI

Work zone length



Source: Google map

Detour route for passenger vehicles

Source: Google map and TMP

Detour route for trucks

Source: Google map and TMP

Case Study – Potterville, MI

Economic Impact on Surrounding Communities – User Cost

- Cost parameter databases and user cost parameters are:

Databases	Parameters	SIBC	CC
USDOT 2014	w_{pv}	$12.67/vehicle/hr	$12.67/vehicle/hr
USDOT 2014; Litman 2013	w_p	$8.87/vehicle/hr	$8.87/vehicle/hr
AAA 2015	r_{pv}	$31.90/vehicle/hr	$31.90/vehicle/hr
OHSP 2014; MDOT 2016	A_{npv}	4.21 accidents/10 million veh-mile	4.21 accidents/10 million veh-mile
FHWA 2014	CMF	1.77	-
OHSP 2014; MDOT 2016; FHWA 2014	A_{apv}	7.45 accidents/ 10 million veh-mile	-
Kostniuk et al. 2011	C_a	$43,501/accident	$43,501/accident
Kostniuk et al. 2011	C_{ap}	$38,579/accident	$38,679/accident
NHTS 2009	AVO	1.67	1.67
Project data	V_{pv}	5,235 vehicles/day	5,235 vehicles/day

Case Study – Potterville, MI

Economic Impact on Surrounding Communities – User Cost

Cost category	Travelling thorough	SIBC	CC
DDC	Work zone	$165,263	-
VOC	Work zone	$416,091	-
AC	Work zone	$8,426	-
PDC	Work zone	$77,517	-
PAC	Work zone	$5,007	-
DDC	Detour	$12,718	$1,144,586
VOC	Detour	$32,020	$2,881,790
AC	Detour	$536	$48,230
PDC	Detour	$5,965	$536,871
PAC	Detour	$318	$28,658
	Total	**$723,861**	**$4,640,135**

- The most significant criterion are : N while travelling through work zone; L_{Dpv} and T_M while travelling through detour.

Case Study – Potterville, MI

Economic Impact on Surrounding Communities – Environmental Cost

- Cost parameter databases and environmental cost parameters are:

Databases	Parameters	SIBC	CC
EPA 2008	E_{pv} (VOC)	2.2708×10^{-3}lbs/mile	2.2708×10^{-3}lbs/mile
EPA 2008	E_{pv} (CO)	20.7235×10^{-3}lbs/mile	20.7235×10^{-3}lbs/mile
EPA 2008	E_{pv} (NO_2)	1.5278×10^{-3}lbs/mile	1.5278×10^{-3} lbs/mile
EPA 2008	E_{pv} ($PM_{2.5}$)	0.0090×10^{-3} lbs/mile	0.0090×10^{-3} lbs/mile
EPA 2008	E_{pv} (PM_{10})	0.0097×10^{-3} lbs/mile	0.0097×10^{-3} lbs/mile
EPA 2015; Highway Statistics 2013	E_{pv} (CO_2)	0.736 lbs/mile	0.736 lbs/mile
EPA 2008	E_t (VOC)	0.9855×10^{-3} lbs/mile	0.9855×10^{-3} lbs/mile
EPA 2008	E_t (CO)	5.0949×10^{-3} lbs/mile	5.0949×10^{-3} lbs/mile
EPA 2008	E_t (NO_2)	18.9884×10^{-3} lbs/mile	18.9884×10^{-3} lbs/mile
EPA 2008	E_t ($PM_{2.5}$)	0.4453×10^{-3} lbs/mile	0.4453×10^{-3} lbs/mile
EPA 2008	E_t (PM_{10})	0.4828×10^{-3} lbs/mile	0.4828×10^{-3} lbs/mile
EPA 2015; Highway Statistics 2013	E_t (CO_2)	7.65 lbs/mile	7.65lbs/mile
McCubbin and Delucci 1999	UC_p (VOC)	$0.4935 per pound	$0.4935 per pound
McCubbin and Delucci 1999	UC_p (CO)	$0.0395 per pound	$0.0395 per pound
McCubbin and Delucci 1999	UC_p (NO_2)	$7.2850 per pound	$7.2850 per pound
McCubbin and Delucci 1999	UC_p ($PM_{2.5}$)	$66.9325 per pound	$66.9325 per pound
McCubbin and Delucci 1999	UC_p (PM_{10})	$56.6405 per pound	$56.6405 per pound
EPA 2016	SC_{CO2}	$18.665E-03 per pound	$18.66E-03 per pound
EPA 2001	SCF_{WZpv} (CO)	1.01	-
EPA 2001	SCF_{WZpv} (NO_2)	1.02	-
EPA 2001	SCF_{NSpv} (CO)	1.34	1.34
EPA 2001	SCF_{NSpv} (NO_2)	1.16	1.16
EPA 2001	SCF_{Dpv} (CO)	1.02	1.02
EPA 2001	SCF_{Dpv} (NO_2)	0.96	0.96
Delucci and McCubbin 2010	UC_{wpv}	$0.075 per mile	$0.075 per mile
Delucci and McCubbin 2010	UC_{wt}	$1.499 per mile	$1.499 per mile

Case Study – Potterville, MI

Economic Impact on Surrounding Communities – Environmental Cost

Cost category	SIBC	CC
Air pollution		
Health care cost	$1,163	$67,354
Reduced visibility	$169	$9,766
Agricultural damage	$99	$5,725
Property damage	$47	$2,694
Forestry damage	$12	$674
Water pollution	$4,998	$449,794
Climate change	$736	$66,268
Total	**$7,222**	**$602,276**

- The most significant criterion are : N while travelling through work zone; L_{Dpv} and T_M while travelling through detour for all pollution types.
- SCF can become indicative for air pollution and climate change while truck weight is and indicative for water pollution.

Case Study – Potterville, MI

Economic Impact on Surrounding Businesses – User Cost

- Cost parameter databases and user cost parameters are:

Databases	Parameters	SIBC	CC
USDOT 2014	w_t	$24.82/vehicle/hr	$24.82/vehicle/hr
ATRI 2014	r_t	$59.18/vehicle/hr	$59.18/vehicle/hr
OHSP 2014; MDOT 2016	A_{nt}	1.30 accidents/100 million veh-mile	1.30 accidents/100 million veh-mile
FHWA 2014a	CMF	1.77	-
OHSP 2014; MDOT 2016; FHWA 2014	A_{at}	2.30 accidents/100 million veh-mile	-
Project data	V_t	190 vehicles/day	190 vehicles/day

Case Study – Potterville, MI

Economic Impact on Surrounding Businesses – User Cost

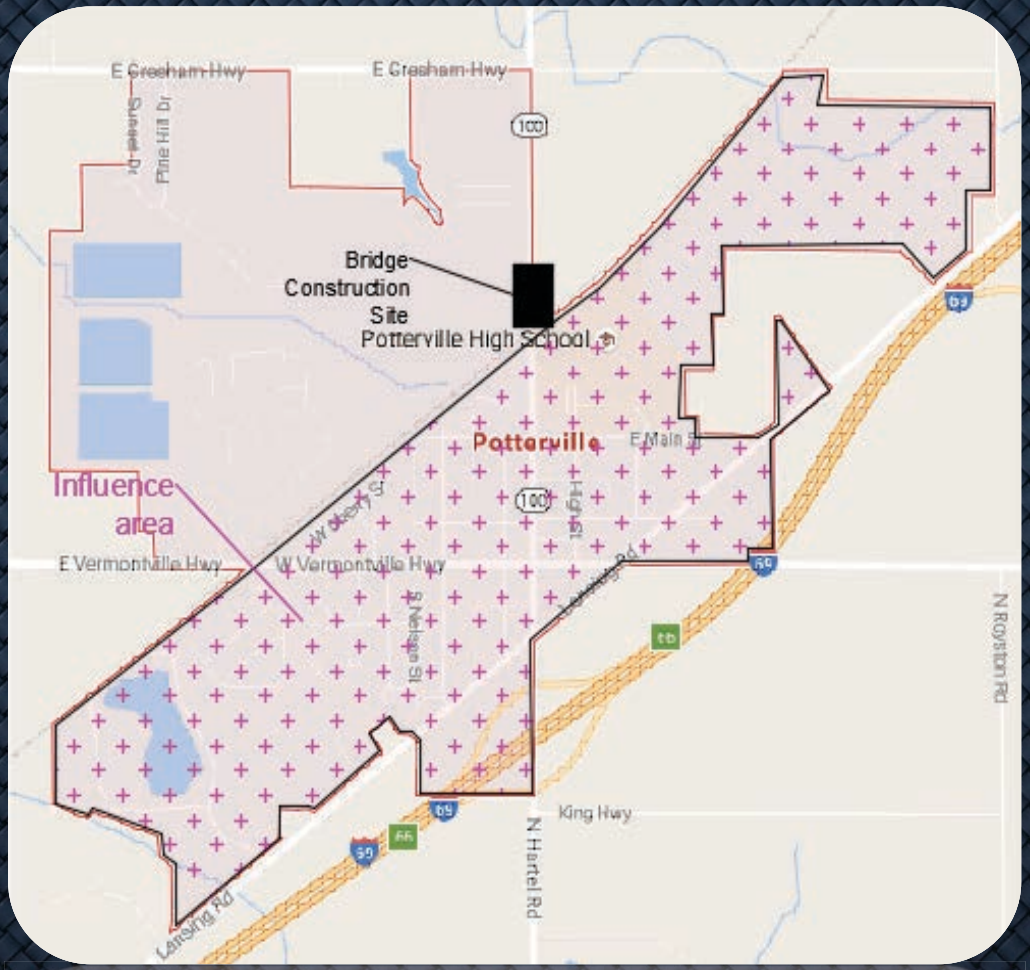
Cost category	Travelling thorough	SIBC	CC
DDC	Work zone	$12,192	-
VOC	Work zone	$29,071	-
AC	Work zone	$10	-
DDC	Detour	$700	$63,020
VOC	Detour	$1,670	$150,263
AC	Detour	$1	$73
	Total	**$43,644**	**$213,356**

- The most significant criterion are : N while travelling through work zone; L_{Dt} and T_M while travelling through detour.

Case Study – Potterville, MI

Economic Impact on Surrounding Businesses – Business Revenue Change

Influence area

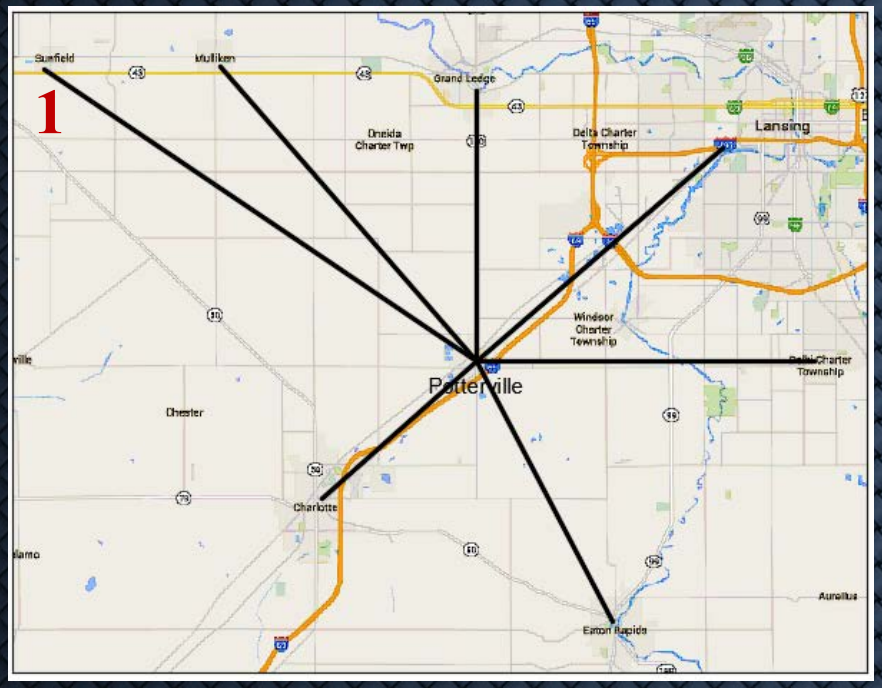


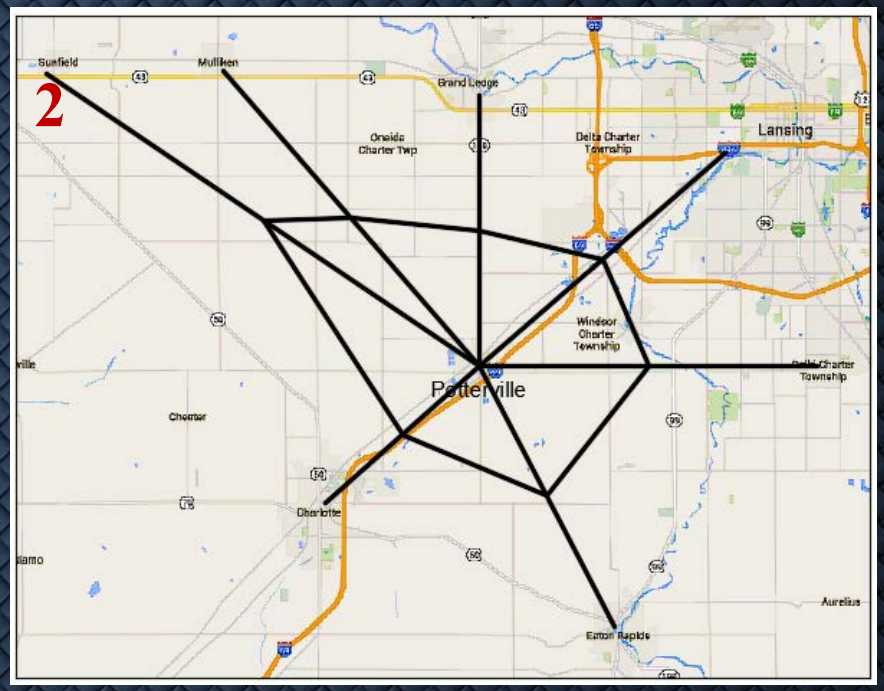
Source: Google map

Case Study – Potterville, MI

Economic Impact on Surrounding Businesses – Business Revenue Change

Households without direct access



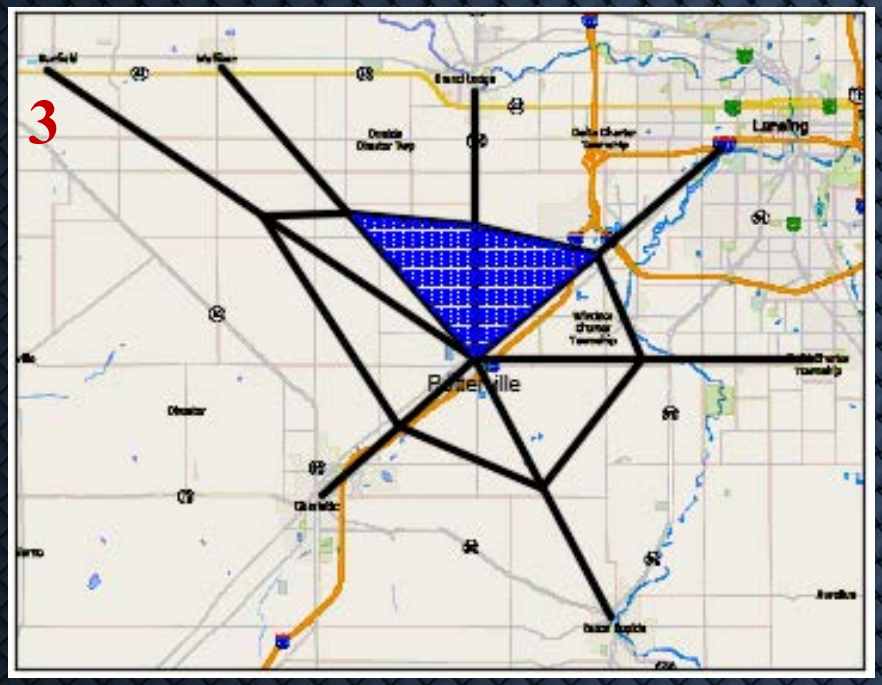


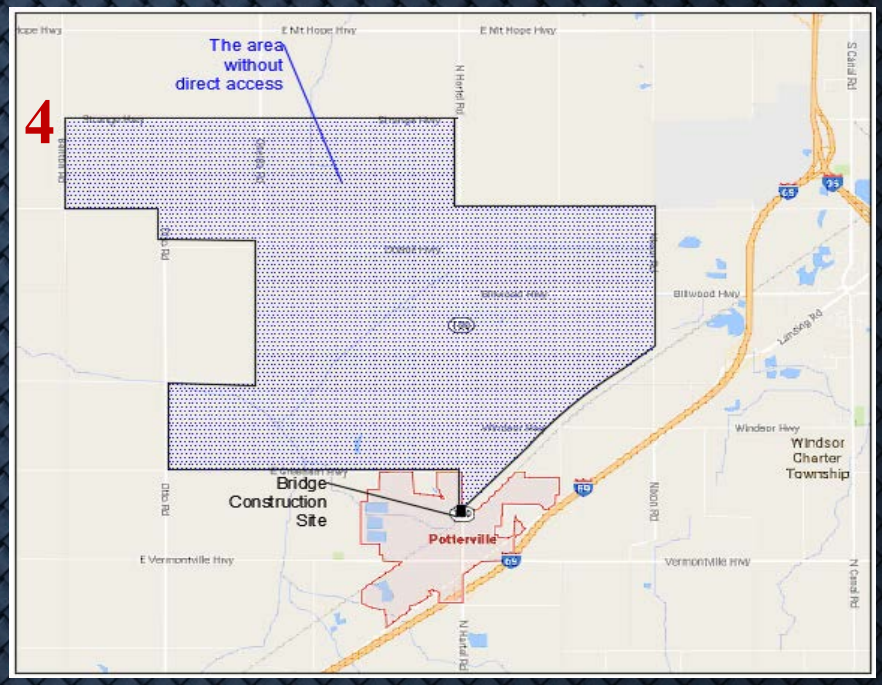
Source: Google map

Case Study – Potterville, MI

Economic Impact on Surrounding Businesses – Business Revenue Change

Households without direct access



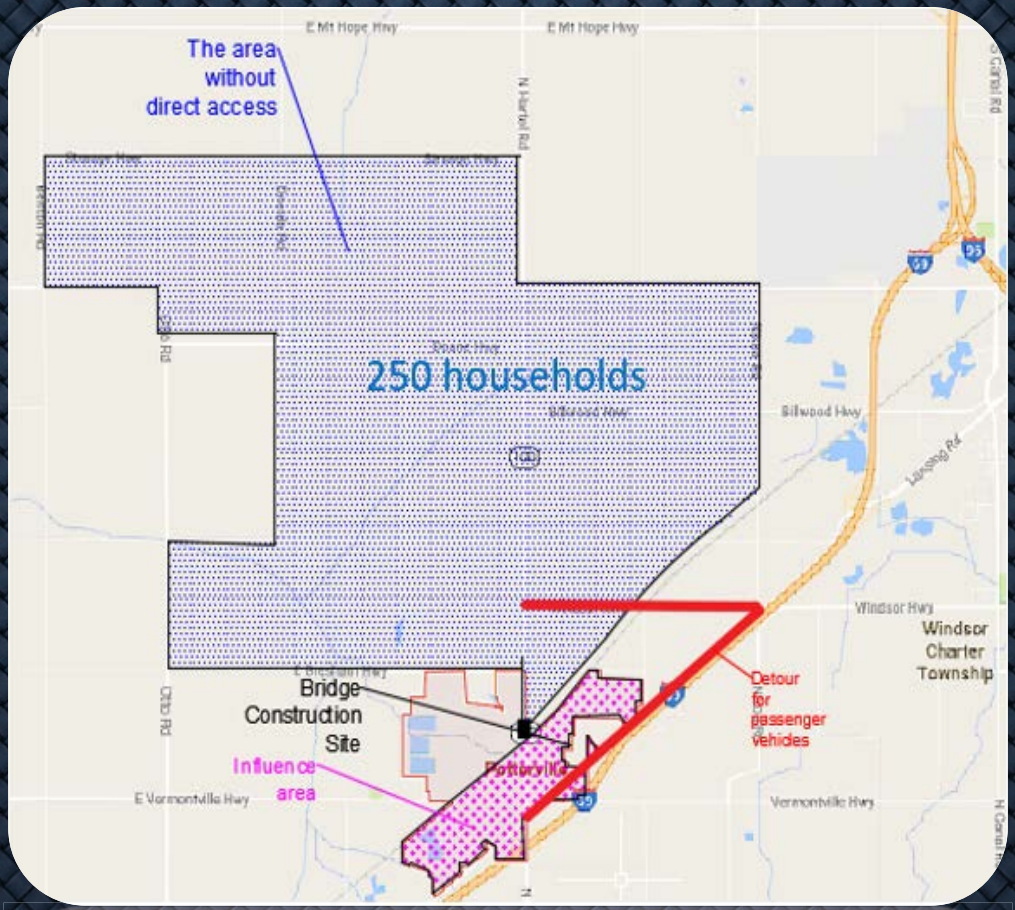


Source: Google map

Case Study – Potterville, MI

Economic Impact on Surrounding Businesses – Business Revenue Change

Area without direct access and Influence area



Source: Google map

Case Study – Potterville, MI

Economic Impact on Surrounding Businesses – Business Revenue Change

- Cost parameter database is published by *DemographicsNow* tool (GALE 2016) which is accessed through WMU Library Services.
- Business revenue change parameters are:

Databases	Parameters	SIBC	CC
Maps	HWA	250 households	250 households
Assumption	F (to auto repair shop)	1visit/90 days	1visit/90 days
Assumption	F (to party/liquor store)	1visit/7 days	1 visit /7 days
Assumption	F (to restaurant)	1 visit /7 days	1 visit /7 days
Assumption	F (to gas station)	1 visit /30 days	1 visit /30 days
Assumption	F (to pharmacy)	1 visit /30 days	1 visit /30 days
DemographicsNow	AE (to auto repair shop)	$42/household/visit	$42/household/visit
DemographicsNow	AE (party/liquor store)	$3/household/visit	$3/household/visit
DemographicsNow	AE (to restaurant)	$23/household/visit	$23/household/visit
DemographicsNow	AE (to gas station)	$235/household/visit	$235/household/visit
DemographicsNow	AE (to pharmacy)	$39/household/visit	$39/household/visit
Assumption	P	100%	100%

Case Study – Potterville, MI

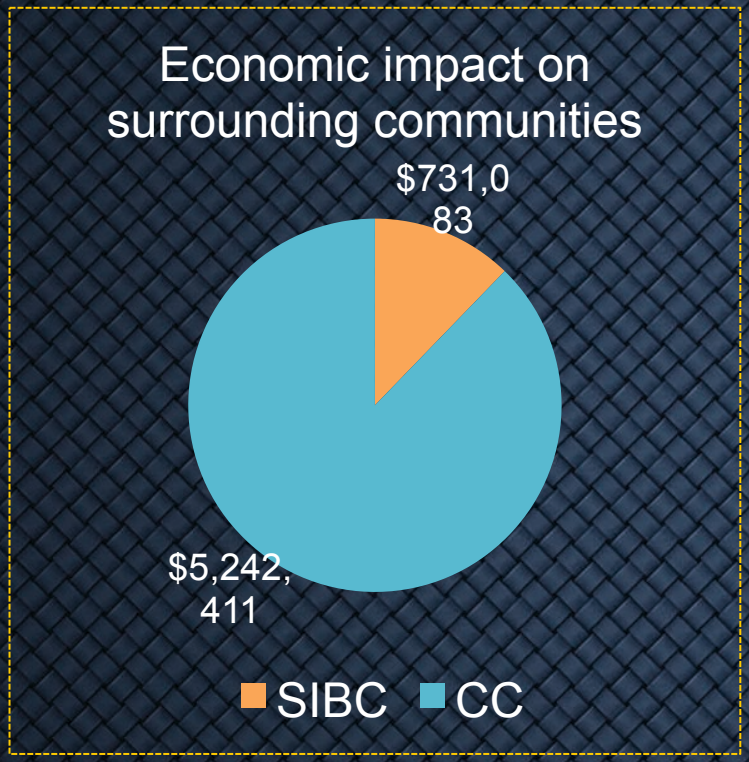
Economic Impact on Surrounding Businesses – Business Revenue Change

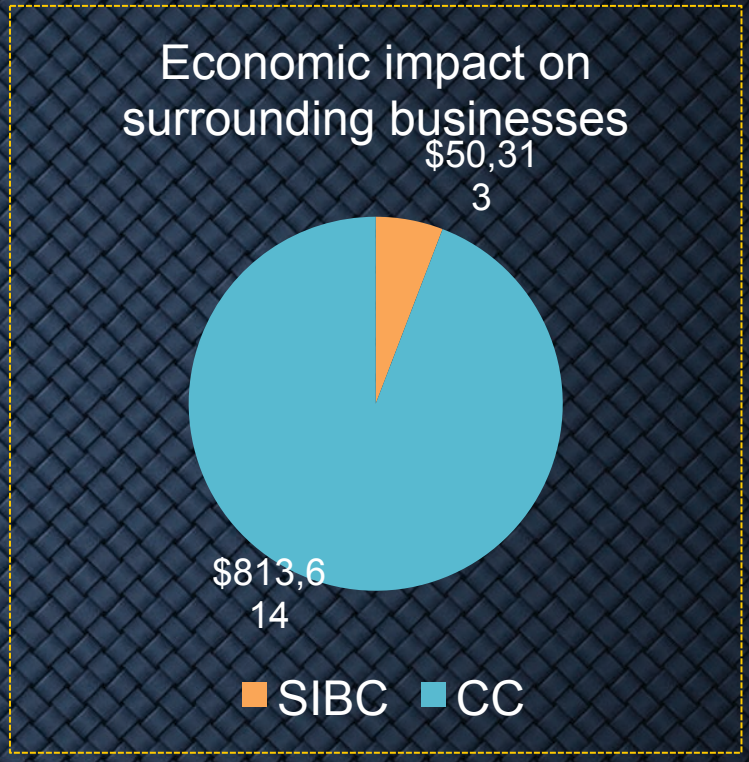
Business category	SIBC	CC
Auto repair shop	$232	$20,875
Party/Liquor Store	$211	$19,038
Restaurant	$1,655	$148,970
Gas Station	$3,925	$353,250
Pharmacy	$646	$58,125
Total	**$6,669**	**$600,258**

- Each parameter contributing to quantification of business revenue change is significant and necessary.

Case Study – Potterville, MI

Economic Impact on Surrounding Communities and Businesses





	SIBC	CC
Economic impact on surrounding communities	$731,083	$5,242,411
Economic impact on surrounding businesses	$50,313	$813,614
Total	**$781,396**	**$6,056,025**

Conclusions

		Contribution percentage	
	Cost category	**SIBC**	**CC**
Economic impact on surrounding communities	User cost	99%	89%
	Environmental cost	1%	11%
Economic impact on surrounding communities	User cost	87%	26%
	Business revenue change	13%	74%

- Environmental cost can be eliminated from economic impact on surrounding communities depending on the road network.
- User cost and business revenue change are two necessary categories to quantify economic impact on surrounding communities.

Future Research

- Several assumptions are incorporated, hence site specific data on those assumptions (V_{pv} and V_t) should be collected through installing traffic count devices.
- Speed measurements can be conducted both within work zone and travelling through detour.
- Travel demand models can be employed to capture network based impact depending on the complexity of the road network.
- More accurate values on % influence area with access limitations (P), and customer frequency of patronizing a specific business (F) can be calculated through surveys.
- Surveys can be upgraded to automated surveys utilizing mobile devices.
- Aggregate unit daily cost for economic impact analysis can be developed if large sample of case studies for statistical accuracy is achieved.

THANK YOU!

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