Dubuque Intermodal Transportation Center

Cost / Benefit Analysis

Input values used in this analysis are taken from the U.S. Department of Transportation (USDOT) guidance on the preparation of Cost Benefit Analyses, including the recently published guidelines for the HSIPR program and TIGER and TIGERII Grant applications. Where USDOT has not provided valuation guidance or a reference to guidance, standard industry practice has been applied.

Estimates used in the monetization of benefits include the cost of operating a vehicle, including maintenance, repair, and depreciation. As part of calculating diversion benefits, the number of vehicles that would be taken off the road due to the improvements is calculated. The expected increase in ridership is used in conjunction with the average vehicle occupancy (1.2 persons/vehicle) to estimate the reduction in the number of vehicles.

Benefits resulting from the reduction in the number of vehicles are based on values for congestion cost, pavement maintenance, noise pollution as well as accident costs, all in dollars per vehicle miles. Internal costs include those for fuel, both for vehicles as well as train miles, in addition to estimates for fare per passenger mile as well vehicle operating cost per car mile.

Meanwhile, emission costs are expressed as dollars per ton and are based on the benefits associated with recently adopted regulations that limit emissions of air pollutants from passenger cars.
The analysis for Dubuque Intermodal Facility Campus is divided into four components.

- Economic Impact
  - Direct Impact
  - Indirect Impact
  - Induced Impact
- Impact of Passenger rail and Intercity bus
  - Transportation Benefits
  - Environmental Benefits
  - Energy Benefits
- Impact of ITS improvements
  - Transportation Benefits
  - Environmental Benefits
  - Energy Benefits
- Energy Savings by replacing old facility
  - Energy savings
  - Emissions

This section of the application summarizes the results of the Benefit Cost Analysis (BCA) for the Dubuque Intermodal Transportation Center (THE CENTER). A much more detailed explanation of the BCA is included as an attachment to this narrative.

The operation cost and revenues generated by passenger rail, intercity bus and local transit are not taken into consideration as they are more related to operations of specific systems rather than the intermodal center. The Intermodal center operations will be funded through revenue generated through parking and funds received by transit system from state, local and Federal Transit Authority.

Economic Impact

A model using input-output multipliers from IMPLAN was used to determine the quantity, industry composition, and compensation of jobs to be created in the short-term during project construction, as well as the level of economic output to be generated by transportation infrastructure investments.

In the case of the THE CENTER, the need for resources to design and build would represent a short-term increase in demand for construction labor and materials. Economic multipliers from IMPLAN were applied to the increase in construction demand to estimate three types of impacts:
Direct impacts represent new spending, hiring, and production by construction companies to accommodate the demand for resources in order to complete the project.

Indirect impacts result from the increase in production of industries supplying intermediate goods and services to the construction industry. Such firms will also experience increased demand for their products and, if necessary, will hire new workers to meet the additional demand. The level of inter-industry trade within Dubuque County will determine the size of the indirect impact.

Induced impacts stem from the re-spending of wages earned by workers and households benefitting from the direct and indirect activity. In other words, if an increase in labor demand leads to earnings in a set of industries, workers in these industries will spend some proportion of their increased earnings at local retail shops, restaurants, and other places of commerce, further stimulating economic activity.

To estimate the short-term economic impacts of the THE CENTER, a construction cost of $13.55 million in real 2012 dollars was assumed, which would represent a direct increase in demand for construction. The project is expected to begin generating jobs in 2013 Q2 and maintain job creation until the project completes in 2014 Q4. As shown in Table 1, the THE CENTER Project is expected to generate $3,405,218 in Indirect and $4,048,790 in induced impact in the area.

Table 1: Economic Impact of the project

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	109.5	$5,117,996	$13,555,535	109.5
Indirect Effect	27.7	$1,265,358	$3,405,218	27.7
Induced Effect	41.4	$1,374,134	$4,048,790	41.4
Total Effect	178.6	$7,757,488	$21,009,544	178.6

Impact of Passenger rail and intercity bus

VMT
The development of THE CENTER will help in accommodating passenger rail from Chicago and Intercity Bus system from Madison and Des Moines. The passenger rail project and Intercity Bus project will result in a significant reduction in annual vehicle miles traveled (VMT) due to mode shifts between Dubuque and Chicago, Madison and De Moines downtowns. It was estimated that the project would result in an annual reduction of 3.9 million and 110.71 Million for the life of the project in VMTs from automobile.

Transportation Benefits
Accommodating new passenger rail services and coordinating the service with intercity bus system and local transit system will help in creating more ridership for rail and bus system in the area. It is estimated that annual ridership by train will be 20,430 and by intercity bus will be 10,950. The revenue generated annually by passenger rail is $919,350 and by intercity bus is $492,750. It is assumed that the fair for passenger rail is $40

per ride and intercity bus is $45 per ride. It was estimated that the passenger rail will generate $27,580,500 and intercity bus will generate $14,782,500 over the life of the project. The project life for passenger rail is estimated as 30 years and the project life for intercity bus is estimated as 15 years. Having passenger rail service and intercity bus service will help highway users $6,642,855 in congesting costs, $3,321,428 in accident costs and $332,143 in pavement maintenance cost during the life of the project.

Environmental benefits

The annual reduction of 3.7 million VMTs resulting from the passenger rail and intercity bus will produce a corresponding decrease in 4.75 tons of NOX, 0.05 tons of PM, 61.07 tons of CO and 2,107.20 tons of CO2. Overall passenger rail and intercity bus system will save $181,291 in emission annually and $5.4 million for life of the project.

Table 1: Input variables used in Cost / Benefit Analysis

Parameters	Units	Values
General		
Period of Study (life cycle)	Years	2012-2046
Vehicle occupancy normal (HSIPR)	Persons / Vehicle	1.2
External Costs –Vehicles		
Congestion cost per vehicle mile	$/Vehicle mil	0.06
Pavement maintenance cost per vehicle mile	$/Vehicle mil	0.003
Noise pollution cost per vehicle mile	$/Vehicle mil	0.001
Accident cost per vehicle mile	$/Vehicle mil	0.03
Gas mileage per vehicle	miles/gallon	30
Internal costs-Bus, Train, Air, Vehicle		
Fare per Intercity rail passenger	$/ride	45
Vehicle operating cost per car mile	$/Vehicle mile	0.37
Air Fare	$/one-way	150
Bus Fare	$/one-way	45
Average Daily Airport Parking	$/day	5

Parameters	Units	Values
Emissions cost per Ton		
NOX	$ / ton	3,938
PM	$ / ton	165,375
VOC	$ / ton	1,673
CO2	$ / ton	34
Cost of Gallon gas	per gallon	$3.59

Results

The benefits of the Intermodal facility and rail service are evaluated in this analysis based on the HSIPR funding evaluation criteria published in CFR Vol. 74 No. 119 Docket No. FRA 2009 0045 and TIGER II

Operational and Ridership Benefits Metrics

It was estimated that opening year ridership from Dubuque would be 14,450 which is 17% of overall ridership in the corridor. The first year of operation is 2015 and the annual growth rate in ridership is assumed to be 2.00%.

Table 2 below shows the estimated average annual level of ridership for the passenger rail service from Dubuque station over the 30year analysis period and Intercity Bus over 15 years period.

Table 2: Incremental ridership by source

	Value
Average Annual Level of Passenger Train Ridership to Chicago	20,430
Average Annual Level of Passenger Bus Ridership to Madison	10,950
Average Annual Trips Diverted from Auto by Intercity bus to Madison	9,125
Average Annual Trips Diverted from Auto by Passenger rail to Chicago	17,025

As a result of the above mentioned diversion of trips from auto to passenger rail, Table 3 below shows the total amount of auto trips diverted throughout the study period and estimated average annual reduction in vehicle miles traveled (VMT). A result of the diversion from auto usage to the passenger rail service and Intercity bus, Table 3 below show the total VMT avoided over thirty years in addition to the pavement maintenance cost savings.

Table 3: VMT Reduction and Pavement Maintenance Savings

	Value
Total VMT avoided for 30 years	117,393,750
Pavement Maintenance Savings	$332,143

In terms of Vehicle Operating Cost (VOC) savings, Table 4 below illustrates the net VOC savings, in addition to the induced demand benefits for new passenger rail users. Induced demand benefits accrue to users who were not making the trip between Chicago and Dubuque using the available modes of transportation prior to the project, and are now using the rail service for the trip.

Table 4: VOC Net Savings to New Users and Induced Demand Benefits

	Value
Net VOC savings	$17,210,038
Induced Demand Benefits	$212,983

Benefits to remaining highway users include average annual VMT reduction, which results in a reduced cost of congestion and reduced accident costs (from fewer accidents). Table 5 below shows these benefits for 30 years of the projects.

Table 5: Benefits to Remaining Highway Users and Safety Benefits

	Value
Total VMT avoided for 30 years	117,393,750
Reduced Cost of Congestion	$6,642,855
Reduced Accident Costs	$3,321,428

Environmental Benefits

Environmental benefits are calculated by: (1) estimating the reduction in vehicle and plane emission from trips being diverted to rail; and, (2) estimating the increase in emission from introducing new passenger rail service. Table 6 indicates the total life cycle emission reduction for the project in 30 years

Table 6: Environmental Reduction

	Value
Reduced Gallons of Fuel	3,713,835
Reduced Nox Emissions (tons)	129
Reduced PM Emissions (tons)	1
Reduced CO Emissions (tons)	1,655
Reduced CO2 Emissions (tons)	57,089

Table 7: Emission Cost Savings

	Value
Energy savings (Gas)	$13,332,668
Nox Cost Savings	$506,759
PM Cost Savings	$222,946
CO Cost Savings	$2,768,001
CO2 Cost Savings	$1,941,028
Noise Emission Savings	$91,935

Findings and Overall Results

The table below summarizes the benefits of passenger rail and intercity bus on Dubuque Intermodal modal over life of the project.

Transportation Benefits	
Benefits to Rail Users	
Total Ridership	612,900
Average Annual Ridership	20,430
Average Annual Reduction in VMT	3,064,500
Benefits to Intercity Bus Users	
Total Ridership	328,500
Average Annual Ridership	10,950
Average Annual Reduction in VMT	848,625
Benefits to Remaining Highway Users	
VOC benefits	$17,423,021
Congestion Cost Savings	$6,642,855
Accident Cost Savings	$3,321,428
Pavement Maintenance Savings	$332,143
Environmental Benefits	
NOx	$536,099
PM	$235,889
CO	$2,930,143
CO2	$1,941,028
Noise Emission	$91,935
Energy Benefits	
Gas savings	$13,332,668
Economic Benefits	
Direct & In direct impact on the community	$36,286,358

Impact of ITS Improvements

The IBM Route Optimization component aims to utilize the systems, algorithms and analytics developed by IBM Researchers in combination with real-time origin, destination data gathered through smartphone and RFID technology. The project is designed to study people movement, analyze transit and transportation systems challenges in Dubuque, and improve and optimize their operations. As part of the project scope, IBM will evaluate transit and transportation use to develop recommended changes, continue to gather data, analyze it, revise and refine the demand estimates, and revise the optimization recommendations based on the long term data gathered before and during the implementation phase of the project.

VMT

The implementation of IBM route optimization will help to reduce headways for transit and increase in ridership and hence reduce the automobile VMT on the road system. It is assumed that the route optimization will help to attract at least 2.2% (5000 household) of the household trips in Dubuque region. The route optimization project will result in a significant reduction in annual vehicle miles traveled (VMT) due to mode shifts in the Dubuque metropolitan area. It was estimated that the project would result in an annual reduction of 5.63 million and 81.69 Million for the life of the project in VMTs from automobile.

Transportation Benefits

Accommodating new transit riders and coordinating the service with intercity bus system and passenger rail system will help in creating more ridership for local transit system area. It is estimated that annual ridership for local transit is 1,314,000. The revenue generated annually by local transit is $1,314,000. It is assumed that the fair for local transit is $1 per ride. It was estimated that the local transit will generate $19,710,000 in 15 years. The project life for local transit is estimated as 15 years. Having improved local transit service will help road users $4,901,580 in congesting costs, $2,450,790 in accident costs and $245,079 in pavement maintenance cost during the life of the project.

Environmental benefits

The annual reduction of 5.63 million VMTs resulting from improved local transit will produce a corresponding decrease in 6.29 tons of NOX, 0.07 tons of PM, 80.88 tons of CO and 2,790.63 tons of CO2. Overall passenger rail and intercity bus system will save $275,849 in emission annually and $4.13 million for life of the project.

Table 7: Input variables used in Cost / Benefit Analysis

Parameters	Units	Values
Number of Targeted households (2.2% of Dubuque Households)		500
Average Trip length (Dubuque MPO travel demand forecast model)	Miles	5
Average number of trips per household (Dubuque MPO travel demand forecast model)	Trips	7.2
Vehicle occupancy by per car	Car	1.2
Average Trip length	Miles	5
Average bus capacity	per Bus	30
Cost of Gallon gas	per gallon	$3.59

External Costs -Vehicles		
Congestion cost per vehicle mile	$/Vehicle mil	0.06
Pavement maintenance cost per vehicle mile	$/Vehicle mil	0.003
Noise pollution cost per vehicle mile	$/Vehicle mil	0.001
Accident cost per vehicle mile	$/Vehicle mil	0.03
Gas mileage per vehicle (in city)	miles/gallon	20.5

0.0465 gallons of gas for every .916 pounds of carbon dioxide (EPA)
Number of Tons of CO2/0.0111 is diesel equivalent in gallons (EPA)

Parameters	Units	Values
Emissions cost per Ton		
NOX*	$ / ton	4,166
PM*	$ / ton	174,976
VOC*	$ / ton	1,771
CO2*	$ / ton	34
Cost of Gallon gas	per gallon	$3.59

* Transportation Economics & Management Systems, Inc. 2004. Midwest Regional Rail Initiative Project Notebook.

Ridership Benefits Metrics

It was estimated that opening year ridership for local transit system would be 1,314,000 which is. The first year of operation is 2014 and the annual growth rate in ridership is assumed to be constant.

Table 8 below shows the estimated average annual level of ridership increase VMT and gas savings by using local transit system in city of Dubuque.

Table 8: Average annual ridership and VMT

Details	Value	
Number of riders	3,600	
Vehicles Miles travelled in a day	18,000	per day
Vehicles Miles travelled in an year	6,570,000	365 days
Number of gallons used	320,488	

A result of the diversion from auto usage to local transit, Table 9 below show the total VMT avoided over fifteen years in addition to the pavement maintenance cost savings.

Table 9: VMT Reduction and Pavement Maintenance Savings

	Value
Total VMT avoided	81,693,000
Pavement Maintenance Savings	$245,079

Benefits to remaining highway users include average annual VMT reduction, which results in a reduced cost of congestion and reduced accident costs (from fewer accidents). Table 10 below shows these benefits for 15 years of the projects.

Table 10: Benefits to Remaining Highway Users and Safety Benefits

	Value
Total VMT avoided for 15 years	81,693,000
Reduced Cost of Congestion	$4,901,580
Reduced Accident Costs	$2,450,790

Environmental Benefits

Environmental benefits are calculated by: (1) estimating the reduction in vehicle emission from trips being diverted to local transit; and, (2) estimating the increase in emission from local transit system. Table 11 indicates the total life cycle emission reduction for the project in 15 years

Table11: Environmental Reduction

	Value
Reduced Gallons of Fuel	953,749
Reduced Nox Emissions (tons)	94.36
Reduced PM Emissions (tons)	0.99
Reduced CO Emissions (tons)	1,213
Reduced CO2 Emissions (tons)	41,859

Table 12: Emission Cost Savings

	Value
Energy savings (Gas)	$3,423,960
Nox Cost Savings	$393,085
PM Cost Savings	$172,961
CO Cost Savings	$2,148,473
CO2 Cost Savings	$1,423,223
Noise Emission Savings	$81,693

Findings and Overall Results

The table below summarizes the benefits over IBM ITS route optimization over 15 years of the project.

Transportation Benefits	
Benefits to Intercity Bus Users	
Total Ridership	19,710,000
Revenues	$19,710,000
External Costs -Vehicles for 15 years	
Congestion cost savings	$4,901,580
Pavement maintenance cost savings	$245,079
Noise pollution cost savings	$81,693
Accident cost savings	$2,450,790
Environmental Benefits	
NOx	$393,085
PM	$172,961

CO	$2,148,473
CO2	$1,423,223
Noise Emission	$81,693
Energy Benefits	
Gas savings	$3,423,960
Economic Benefits	
Direct & In direct impact on the community	$27,353,394

Energy Savings by replacing old facility

Energy savings calculations are done for replacing the existing transit facility with Energy Star design. EPA Energy Star Target Finder was used for these calculations. Project life is estimated to be 30 years.

The Phase II of Intermodal Transportation Campus has two components to it Bus storage facility (37,754 sq ft), transit offices within the bus storage facility (10,246 sq ft).

Table11: Intermodal Facility Campus Phase II details

Gross Floor Area	Weekly operating hours	Workers on Main Shift	Number of PCs	Office Air-Conditioned	Office Heated
Bus Storage Facility 37,754 Sq ft	30	60	0	50% or more	50% or more
Transit Offices 10,246 Sq ft	40	8	5	50% or more	50% or more

The existing transit bus garage is built in 1902 and has been removed in 1980. This building needs lot of retrofits to make the building structurally sound. The table below shows the existing energy usage of the transit facility and its carbon emissions.

Table12: Existing energy usage by transit facility

Energy	Transit facility
Source Energy Use Intensity (kBtu/Sq. Ft./yr)	173
Site Energy Use Intensity (kBtu/Sq. Ft./yr)	51
Total Annual Source Energy (kBtu)	8,345,238
Total Annual Site Energy (kBtu)	2,498,573
Total Annual Energy Cost ($)	49,971
Pollution Emissions	
CO2-eq Emissions (metric tons/year)	575.66

The energy usage for new transit bus facility is done using energy start calculator. It is assumed that the electricity purchased from grid will be at $0.020 /kbtu and natural gas will be $0.008/kbtu based on EPA standards Source: Data adapted from DOE-EIA. See EPA Technical.

Assumptions are 41% Electricity - Grid Purchase and 59% Natural Gas. The Target & Average Building energy use for this facility are calculated based on the typical fuel mix in the zip code specified. The table shows the energy usage by new transit bus facility as part of Intermodal facility campus

Table12: Energy usage by new transit facility using energy star calculator

Target Energy Performance Results (estimated)				
Energy	**Design**	**Target**	**Average Building**	**Existing Bus Facility**
Energy Performance Rating (1-100)	N/A	93	50	
Energy Reduction (%)	N/A	60	0	
Source Energy Use Intensity (kBtu/Sq. Ft./yr)	N/A	47	118	173
Site Energy Use Intensity (kBtu/Sq. Ft./yr)	N/A	14	35	51
Total Annual Source Energy (kBtu)	N/A	2,273,092	5,682,731	8,345,238
Total Annual Site Energy (kBtu)	N/A	680,567	1,701,416	2,498,573
Total Annual Energy Cost ($)	N/A	$13,611	$34,028	$49,971
Pollution Emissions				
CO2-eq Emissions (metric tons/year)	N/A	157	392	576
CO2-eq Emissions Reduction (%)	N/A	60%	0%	

The project will save 532,803 KWH annually with energy star designed new transit facility. The project will save 15,984,095 KWH in new transit system through the life of the project. The project life is assumed to be 30 years. The project will save $879,125 in energy on transit facility over the life of project. Alliant energy cost for industrial building is $0.0682/KWH

Table13: Total Energy savings by Phase II of Intermodal Facility Campus

Description	**Transit Facility (KWH)**
Project's Current Annual Energy Use.	732,257
Project's Estimated Annual Energy Use.	199,454
Project's Estimated Annual Energy Savings	532,803
Project’s Total Estimated Energy Savings Over Its Useful Life.	15,984,095

Table14: Total dollars savings through energy by Phase II of Intermodal Facility Campus

Description	**Transit Facility ($0.0682/KWH)**
Project's Current Annual Energy Use.	$49,940
Project's Estimated Annual Energy Use.	$13,603
Project's Estimated Annual Energy Savings	$36,337
Project’s Total Estimated Energy Savings Over Its Useful Life.	$1,090,115

The project will have 556 tons of CO2 emissions savings annually from new transit facility when compare to existing facility and when compared to existing transit facility that are not designed to energy star standards. The project will save$566,775 in CO2 emissions on transit facility over the life of project. The cost of CO2 is estimated at $34/ton.

Table15: Total emission savings by Intermodal Facility Campus

Description	**Transit Facility (Tons)**
Project's Current Annual Greenhouse Gas Emissions.	576
Project's Estimated Annual Greenhouse Gas Emissions.	157
Project's Estimated Annual Greenhouse Gas Savings.	419
Project's Total Estimated Greenhouse Gas Savings Over the project's useful Life.	12,560

Table16: Total dollars savings through emissions by Intermodal Facility Campus

Description	**Transit Facility ($34/Ton)**
Project's Current Annual Greenhouse Gas Emissions.	$19,573
Project's Estimated Annual Greenhouse Gas Emissions.	$5,338
Project's Estimated Annual Greenhouse Gas Savings.	$14,235
Project's Total Estimated Greenhouse Gas Savings Over the Project's Useful Life.	$427,035

The table below summarizes the CBA findings. Annual costs and benefits are computed over a long run planning horizon and summarized over the life cycle of the project. The project is assumed to have a passenger rail with useful life of 30 years, Intercity Bus with useful life of 15 years, Local transit with useful life of 15 years and Phase II of Intermodal center with useful life of 30 years is used in the analysis. Construction is expected to be completed by end of 2014.

At a 7% discount rate, a $5.6 million investment results in fully $60.4 million of benefits. This yields a benefit to cost ratio of approximately 10.79. At a 3% discount rate, a $8.8 million investment results in fully $82.1 million of benefits. This yields a benefit to cost ratio of approximately 9.27.

Table17: Benefit to Cost analysis

	7% Discount Rate	**3% Discount Rate**
Benefit Cost Analysis Results		
Total Economic Impact during project development and construction	$21,009,544	$21,009,544
Total Discounted Benefits by Passenger rail and Intercity Bus	$34,277,553	$54,142,391
Total Discounted Benefits by ITS improvements	$4,651,878	$6,097,315
Total Discounted Benefits by the building	$540,273	$853,377
Cost of the project (Federal Aid)	$5,607,040	$8,856,483

Benefit Cost Ratio	10.79	9.27
Net Present Value	$60,479,248	$82,102,627

The total cost of the project is $16,260,536 million where $13,555,536 is for construction of Phase II of Intermodal Facility Campus with Street Conversion and $2,705,000 for ITS optimization.

The city is providing $ 4,236,042 in local match and $825,000 in land. IBM and local colleges are providing $336,172 and State of Iowa I providing $1,600,000 in form of CMAQ (Congestion Management Air Quality) funds. The city is requesting $10,056,321 million in TIGER IV funds to complete the project.