St. Cloud APO Planning Assistance

Return on Investment Performance Measure

Final Technical Report

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Background and Context

Transportation systems provide a public good by supporting commerce and human activity. Economists and transportation professionals acknowledge that a well-functioning transportation system that provides ease of movement for people and goods is critical to facilitating a strong economy. However, the transportation industry has historically done a poor job at valuing or communicating the economic contribution of the transportation system.

A concurrent problem with not capturing the economic value of the transportation system is not implementing value capture mechanisms to fund construction and maintenance of the infrastructure. As a result, our transportation systems are generally underfunded, prompting challenging trade-off decisions between competing investment priorities, both within transportation and with other public goods and services.

Indeed, if the transportation system were treated like a business, it would be required to pay for itself through revenues generated in order to be sustainable. The research presented in this report explores opportunities to better capture the economic contribution of transportation investment. This will help decision makers advance projects that would be expected to provide the greatest return on investment, thus generating more revenues to achieve a more sustainable system.

The steps undertaken in this investigation began with a literature search of Minnesota and national research on this topic. Then a brainstorming exercise is summarized to focus on the most promising revenue mechanisms to capture transportation value. Finally, a performance measure is proposed that is appropriate for the scale of Saint Cloud region, leverages existing tools and resources, and is supported by findings of recent research.

Literature Review

A literature review was conducted that included several Minnesota and national publications pertaining to return on investment analysis for transportation improvements. Each of the documents reviewed is summarized in this section. Key takeaways and a recommendation is also provided, highlighting its applicability to Return-on-Investment (ROI) evaluation in the Saint Cloud planning area.

NCHRP08-36(22) _Positive Impact of Transportation Investment

Title: The Positive Impacts of Transportation Investment

This report is a compilation of four working papers as part of the National Cooperative Highway Research Program (NCHRP) as part of the Transportation Research Board (TRB). The topics covered by each of the papers discuss the various benefits of transportation investment. Specifically, the report calls out four benefits which include:

- Economic Benefits of Transportation Investment
- Environmental Benefits of Transportation Investment
- Community and Social Benefits of Transportation Investment
- The Benefits of Reducing Congestion.

The first paper “Economic Benefits of Transportation Investment” outlines how transportation is intrinsically linked to the function and competitiveness of the U.S. economy. Continued investments in transportation infrastructure help maintain current levels of performance in the system and help accommodate future economic growth. These investments are important for local economies because increases in congestion and declines in the transportation service levels impede economic growth.

The second paper discusses environmental impacts and articulates ways in which transportation investments can benefit the natural environment. The article discusses improvements in air quality, wetlands habitat, clean water, ecological restoration, reduction in noise pollution and light pollution as well as opportunities for reclaiming brownfield sites. This summary of environmental services that can improve from transportation investment concludes by noting that the natural environment benefits from an increasingly multimodal transportation network in which vehicle-miles traveled (VMT) is reduced and access for people and goods is improved.

The third paper highlights ways in which transportation networks increase mobility and access, allow for multimodal transportation, improve social cohesion and safety as well as enhance the visual appearance of communities. Although difficult to quantify, the article highlights ways in which transportation investments improve quality of life for a region, city and neighborhood. Quality of life is improved by implementing context sensitive design that responds to the needs of the built and natural environment as well as seeking ways to reflect community values.

The final paper discusses the various impacts of highway congestion in metropolitan areas including impacts on quality of life, safety and the environment, effects on the economy as well as accessibility and reliability issues. The authors note that congestion issues continue to grow in urban areas, but that reducing congestion is feasible and beneficial. In addition to roadway expansion and bottleneck removal, the authors discuss opportunities to improve traffic signal timing, incident management and traveler information programs as effective strategies for mitigating congestion.

Takeaway: With respect to the St. Cloud Area Planning Organization, the report has several implications for how transportation investments should be viewed and taken into consideration. First, this report shows that roadway maintenance and upkeep promote economic vitality and quality of life for a region. Additionally, the article emphasizes the social, environmental and indirect economic benefits of multimodal transportation networks and the importance of advancing context sensitive design.

Recommendation: This report provides a broad overview of economic, social and environmental impacts that result from transportation infrastructure investment. Important considerations for the APO highlighted in this report included the importance of continued roadway maintenance and improved connectivity which can impact the economic vitality of a region. The report also identifies a variety of indirect benefits that can result from implementing context sensitive design. Continued investments in transportation infrastructure help maintain current levels of performance within a system and as well as help prepare a region for future economic growth.

NCHRP20-24(80) _Value of Transportation Investments

Title: ASSESSING THE ECONOMIC BENEFIT OF TRANSPORTATION INFRASTRUCTURE INVESTMENT IN A MATURE SURFACE TRANSPORTATION SYSTEM

This report seeks to understand how transportation systems interact with economic activity and help contribute to achieving broader economic goals. The authors contend that the United States Interstate highway system is in a preservation and optimization cycle that requires a degree of specialization that is not easily attained. Mature systems and facilities require continuous attention to be effective. The authors came together to identify significant research gaps in understanding linkages between highway networks and the U.S. economy. Additionally, the article conducted a literature review of national, state and industry level analysis to better understand implications of current transportation system uses and demands when considering future system performance. The report identifies a variety of gaps in the literature that would help in identifying the economic benefits of transportation improvements and the methods that are used for estimating the benefits of transportation investment. The authors seek to help support improved transportation decision-making and improved awareness of the economic benefits of transportation investment. This report provides a broad overview and detailed roadmap for understanding the relationship between transportation investments and the United State economy.

Takeaway: The article emphasizes the need for cost-effective improvements and system additions to optimize and improve performance in anticipation and response to market and societal change.

Recommendation: This report does not offer clear evidence that transportation infrastructure investment provides direct revenue streams to a locale. However, the article does highlight the strong connections between the United States economy and a well-maintained transportation network. The authors seek to improve transportation decision-making and increased awareness of the economic benefits of transportation investment within a highway network that has reached a preservation and optimization phase.

SHRP2_PB_C11 Project Brief

Tools for Assessing Wider Economic Benefits of Transportation

Traditional measures of the economic benefits of transportation systems are based on average travel time and travel costs. This article identifies tools for measuring three classes (reliability, connectivity, and accessibility) of transportation system impacts that can directly help businesses gain efficiency and improve operations. The article summarizes spreadsheet tools that "shift the focus of analysis from traditional transportation impact measures to include broader factors that also matter to business operators". These tools can be used to assess specific changes in transportation conditions related to project proposals and their economic consequences. These spreadsheet tools, as well as a database of case studies documenting economic impacts of highway/multimodal investment projects, can be accessed at http://tpics.us.

Takeaway: The spreadsheet tools address three class of effects, including reliability, connectivity, and accessibility, that can help demonstrate the impacts that transportation infrastructure investments have on business operations. "The results produced by the tools can be used directly to generate project impact indicators that can be useful for project evaluation."

Recommendation: This research brief discusses the economic effects of implementing changes to the transportation system and discusses three spreadsheet tools that rely on widely available data sources. These spreadsheet tools could be easily implemented by the APO using already available resources. The results of the spreadsheet tools can be used to generate project impact indicators that are useful for project evaluation and prioritizations as well as running a cost-benefit analysis or economic impact models. Additionally, the research brief references a national database of case studies documenting the actual, post-construction economic impact of highway and multimodal investment projects.

Valuing Mature Highway Networks

Title: Valuing a Mature Highway System: In Search of the Holy Grail

This report emphasizes a growing need for evaluation tools that provide accurate estimates of the value of highway infrastructure. Establishing an estimated value of highways is inherently complex due to the network characteristics of the transportation system and the ways in which return on investment varies based upon geography. From 1980 to 2004, VMT increased 143% on Interstate highways while lane expansion increased only 17%. From 2004 to 2014 however, VMT and lane miles increased at about the same rate of 4%, which the authors note is a sign of a more mature transportation system. Discussing the article "Contribution of Highway Investment to National Economic Growth", the authors note that beginning in 2004 that marginal benefits and marginal costs of highway investment converged which is another indicator of a mature highway system. As the return on investment for highway expansion projects declines, there is a growing need to use the current transportation system more efficiently.

The article addresses several ways in which new technologies can improve transportation efficiency but notes that "many new and forthcoming technologies cannot operate optimally without proper maintenance." The authors also note that there is a growing need for more detailed monitoring of pavement conditions and that deferring roadway maintenance will incur greater opportunity costs in the future. In addition to new technologies, the article notes opportunities to address additional externalities when conducting cost-benefit analysis, including reliability, intermodal connectivity and market access.

Takeaway: The Interstate highway system is maturing, and investment decisions will require clear understanding and effective monitoring of the physical characteristics of the system as well as maintaining a broader perspective regarding the economic and societal benefits of the United States' highway network. The article asserts that no single measure can fully represent the value of transportation infrastructure due to network characteristics. Additionally, roadways are a public good in which the return on investment varies from one part of the system to another.

Recommendation: The article does not provide any direct connections between transportation investment and direct economic benefit, but the study does emphasize the importance of roadway maintenance and notes opportunities to address additional externalities through the implementation of new and emerging technologies.

Zhao_Econ Devel_MnDOT2015-12

Transportation Investment and Economic Development in Minnesota Counties

This study analyzes the link between accumulated transportation capital stocks in Minnesota counties and their annual property tax revenues using longitudinal data from 1995 to 2011 by focusing on return on investment to local governments. The analysis has two distinguishing elements, first it separated capital stocks into load roads and other trunk highways and second it evaluated both internal effects of transportation investments within a county as well as spillover effects that result from transportation investments made by surrounding counties. The study found that local road investments generate property-tax returns for a county but may result in "a zero-sum game due to inter-local competition of property tax bases". The study also found that trunk highway investments have a positive effect on property tax revenues, but that spillover effects can have a larger impact on a county's property tax revenues.

The results of this analysis have implications for policy makers and highlight opportunities for local governments and neighboring counties to work together on trunk highway improvements. Additionally, local road improvements can help counties to improve regional economic competitiveness. The article offers several suggestions for applying this research, such as conducting trend analysis and cross-jurisdictional comparisons, developing a historical overview of transportation investment within a county and the county's growth of its tax bases. Or county engineers may use estimates in this study to project the benefit of future transportation investments. The authors found that an additional dollar of local road investments within a county will lead to more property-tax revenues within the county equivalent to $1.254 in the growth of estimated market values (EMV). Additionally, trunk highway improvements will lead to property-tax benefits equivalent to $0.871 of EMV growth.

Takeaway: The study evaluated local road, trunk highway, and neighboring transportation investments and found that local road and trunk highway improvements have a positive effect on property tax revenues, but that spillover effects can have a larger impact on a county's property tax revenues.

Recommendation: This report provides helpful context and evaluation tools for the St. Cloud APO as it seeks to better understand its return on investment of transportation infrastructure projects. The authors used panel-data regressions to estimate future Minnesota county transportation capital stocks and calculate the return of investment that additional transportation projects could have on property tax bases. The research highlights opportunities for collaboration with neighboring counties on trunk highway projects to leverage the effects of spillover benefits. This article also provides important context for understanding the impacts that transportation investments have on a Minnesota county's property tax revenues. The authors discuss opportunities for policymakers to apply this research by conducting trend analysis and cross-jurisdictional comparisons, developing a historical overview of transportation investment within a county as well as examining the growth of tax bases within a county.

Zhao_Job Creation_MnDOT2018-04

Transportation Investment and Job Creation in Minnesota Counties

This study put together a dataset of business patterns in Minnesota at the county level by compiling the number of businesses, jobs by sector and annual payroll from 1995 to 2010. The study then linked this dataset with transportation expenditures and found that long-term transportation investments contribute to significant but not substantial increases in employment within Minnesota counties. The article references several policy implications that result from the link between long-term transportation investments and employment in Minnesota counties, including an increase in a county's employment rate due to local road improvements as well as trunk highway improvements in a surrounding county.

The authors combined the business pattern dataset for Minnesota counties with data on transportation investment, business patterns and socioeconomic conditions in Minnesota counties from 1995 to 2012. This data was then applied to several research questions including: How does transportation investment affect employment rate, aggregate employment and annual payrolls? Which mode of transportation, trunk highways or local roads, is more effective in job creation? Does the link between transportation investment and job creation differ between urban and rural contexts? The authors note that key findings from this research have policy implications for legislatures and bureaucrats to make better decisions regarding where investment could be most effective.

Takeaway: The authors conclude that rural Minnesota counties see greater increases in employment rates than urban areas as a result of long-term transportation investments on local roads, trunk highways and trunk highway projects in nearby counties.

Recommendation: The authors found that long-term transportation investments contribute to significant but not substantial increases in employment for counties in Minnesota, especially rural counties. The research shows a correlation between local road improvements and increase in a county's employment rate. Additionally, trunk highway improvements in a surrounding county can have spillover effects that raise a county's property tax revenues. The research in this study has content to help policymakers make better decisions regarding where investment could be targets in order to be most effective.

Zhao_TH 610 Eval_MnDOT2014-03

Value Increase and Value Capture: The Case of TH-610 in Maple Grove, Minnesota

This article demonstrates the application of value-capture strategies to supplement transportation funding for highway projects by analyzing 10 square miles of unfinished TH-610 in Maple Grove and modeling property values using five location factors. The study finds "significant evidence of a 'Highway Premium'" and notes that parcels adjacent to the highway have a higher assessed property value that relates more closely to land values than the actual building on the property. The project had three objectives. First, it aimed to model the impacts that the construction of TH-610 and the addition of two new highway exits would have on property values. Second, it looked to predict the increase in property tax base after construction of TH-610. And third, it projected the revenue potential of four value capture scenarios—Tax-increment financing, special assessments, special assessments + joint developments, and special assessments + development impact fees. The organization of the article provided a lit review and overview of value capture strategies, then context about the research area and methods, an analysis of past, present and predicted property values, an estimation of a 'highway premium' and finally projections of the potential revenue associated with the four value-capture strategies that authors analyzed.

The five locational factors that influence property values that the article analyzed include three amenities – water body, open space, and railroad—as well as two accessibility factors—bus stops and highway exits. The estimation of the 'highway premium' projected that improved accessibility as a result of two new highway exits could have $11,928,000 growth in estimated market values for land and approximately $5,390,000 growth in estimated market value for buildings for a total estimated property value growth of $17,318,000. The study uses these estimates to analyze four value-capture scenarios within the Maple Grove impact zone and concludes by estimating the revenue potential of value capture could range between $12 million and $37 million to supplement highway construction.

Takeaway: This article presents a research methodology that can help local governments make informed decisions, and better communicate to the public, about transportation investment projects and there impacts of property values. The authors analyzed 10 square miles of unfinished TH-610 in Maple Grove and present estimate revenue potential from four value-capture scenarios.

Recommendation: This study provides interesting context regarding value-capture strategies that can help to supplement transportation infrastructure funding. The study evaluated the impacts of transportation investment on property values along a trunk highway in Maple Grove and provides important insights about the ways in which transportation projects can provide a return on investment for municipalities. The article discussed a "highway premium" and noted that parcels adjacent to the highway have a higher assessed property value that relates more closely to land values than the physical structure on the property.

Zhao_Value Capture_CTS09-18PS

Harnessing Value for Transportation Investment: A Summary of the Study: Value Capture for Transportation Finance

The article summarizes findings from the Value Capture for Transportation Finance study. The study asserts that large public investment in transportation projects can raise the value of nearby properties and offers strategies and analysis of capturing value changes that result from transportation infrastructure projects. The authors identify eight value capture strategies for local governments that were evaluated using four criteria—economic efficiency, equity, sustainability and feasibility. The eight value capture strategies discussed in the article, and who the strategy impacts, include:

- Land Value Tax (landowner)
- Tax increment financing (landowner)
- Special assessments (landowner)
- Transportation utility fees (landowner)
- Development impact fees (developers)
- Negotiated exactions (developers)
- Joint development (developers)
- Air rights (developers)

The authors note that value capture strategies can be used in conjunction with one another or individually and note that value capture strategies are funding mechanisms that reside somewhere in between user fees (i.e. gas tax or transit fares) and general revenue sources. Value capture strategies "target a restricted set of indirect beneficiaries: landowners and developers who benefit from the increased land value that follows a transportation improvement." After introducing the concept of value capture, the eight value capture strategies and their characteristics, the second half of the article evaluates each strategy using the four criteria of economic efficiency, equity, sustainability and feasibility. The article concludes by noting that strategies "differ in how, when and where they may be applied" and notes that value capture strategies are more commonly used for capital costs as opposed to operations and maintenance.

Takeaway: There are eight value capture strategies available to jurisdictions in Minnesota, that can be used individually or together to harness revenue from property value increases that result in properties adjacent to transportation infrastructure projects. Each value capture strategy has a different outcome when evaluated using the four criteria of economic efficiency, equity, sustainability and feasibility.

Recommendation: This study provides a brief introduction and broad overview of value capture strategies that are available to municipalities. Jurisdictions can apply value capture strategies to properties (via landowners or developers) that benefit from increased land values that result from transportation investment projects. Value capture strategies provide different ways to measure value gains of adjacent properties and harness returns on investment. Additionally, value capture strategies derive revenue from a set of beneficiaries that are linked to transportation investment project rather than general revenue streams that impact a broader set of users.

Initial Inventory and Screening

An initial exercise was undertaken to consider all of the possible revenue streams that may be available to units of government that fund transportation investment in the Saint Cloud Planning Area. The intent of this exercise was to cast a wide net and creatively consider a variety of mechanisms that could be leveraged to or evaluated to capture the return on investment of specific improvements. Then this list was screened against a series of criteria to assess its applicability to a return on investment performance measures to support the APO and its partners. The outcome of this exercise points towards a specific revenue mechanism that is supported by the literature and is tractable to implement with existing resources available in the region.

Idea generation process

An interdisciplinary team of transportation professionals worked together to identify a wide range of revenue mechanisms. These reflect the various streams available to governments, particularly at the city and county level, which could be used to fund transportation as well as may be influenced by transportation investment. The list produced from this exercise is shown in Table 1.

Table 1 List of Potential Transportation Revenue Sources

Revenue Mechanism	Example Project Types	Project Impact
Increased property tax from increased land value	New Roadway Alignment, capacity, congestion reduction, transit, trails, intercity connectivity	Opening new land for development
Increased regional activity via reduced travel impedance	Capacity Expansion	Increase mobility
Increased (re)development and economic activity	Urban Corridor Revitalization	Improve multimodal access and amenities to attract visitors and business
New spending that would have occurred elsewhere (smaller towns)	Intercity mobility (regional hub)	Improved access to/from regional center
Farebox recovery	Transit Expansion	Mobility for transit-dependent populations
Non-personal vehicle mobility population now mobile → increased economic activity	Transit Expansion Trail/Bike/Ped	Mobility for transit-dependent populations
Attractiveness of community, quality of life	Trail/Bike/Ped	Recreational opportunities
[Savings] Upfront spending to reduce longer term maintenance expense	Preservation	Safety, reliability, user cost reduction
[Savings] Reduced costs for emergency services to respond to vehicle crashes	Safety improvements	Reduce frequency and severity of crashes
[Savings] Unproductive spending on vehicle maintenance could be spent elsewhere in region/economy	Preservation	Safety, reliability, user cost reduction

For each revenue mechanism, one or more project examples are provided that would potentially impact the level of revenue generated from such an investment. This is further described by the project impact(s) to link the transportation effects of the investment on the broader economy and, in turn, the revenue path.

To illustrate one example, "Increased regional activity via reduced travel impedance" was identified as a potential mechanism to increase revenue. One project example for reducing travel impedance is by expanding capacity on the system. This would be expected to reduce travel times and delay between activity centers, and this reduced impedance would allow for more economic activity to occur. In the long term, this would be expected to result in overall growth in the regional economy, as affected businesses and households can undertake more productive activities. Various revenue streams, particularly sales tax, would be expected to rise as a result of this growth.

Three mechanisms considered were unique in that rather than increasing revenue, their impact is to reduce other societal costs. Investments in preservation, for example, could reduce longer term government expenses on continual maintenance of deteriorating infrastructure, as well as vehicle-owner expense due to increased wear-and-tear of driving on rough pavements. Safety improvements could likewise decrease the frequency and severity of crashes, resulting in savings on emergency services.

Evaluation Criteria and Screening

In order to screen these potential revenue mechanisms and isolate those that are most applicable to the Saint Cloud planning area, evaluation criteria were applied. These criteria assessed the directness of the revenue impact and the level of confidence in the impact on revenue.

The directness of the impact reflects the number of steps between the transportation impact of the investment and the change in revenue level. In the reduced travel impedance example above, there are a number of steps involved, from increasing mobility to generating economic activity to higher sales tax receipts. Therefore, this was assigned an indirect rating. Conversely, transit farebox recovery was rated direct as passenger fare payments flow directly back to transit agency operations.

The confidence indicates the likelihood that the revenue mechanism is meaningfully impacted by the transportation investment. In some cases, the theoretical relationship makes sense, but is not supported by the literature or current practices. Using the farebox recovery example, this was rated low confidence as higher fares often deter ridership, and can result in decreased revenue.

Table 2 Screening of Potential Transportation Revenue Sources

Revenue Mechanism	Directness	Confidence
Increased property tax from increased land value	Direct	High
Increased regional activity via reduced travel impedance	Indirect	Low
Increased (re)development and economic activity	Indirect	Low
New spending that would have occurred elsewhere (smaller towns, areas)	Indirect	Medium
Farebox recovery	Direct	Low
Non-personal vehicle mobility population now mobile → increased economic activity	Indirect	Medium
Attractiveness of community, quality of life	Indirect	Medium
[Savings] Upfront spending to reduce longer term maintenance expenditure	Indirect	Low
[Savings] Reduced costs for emergency services to respond to vehicle crashes	Indirect	Low
[Savings] Unproductive spending on vehicle maintenance could be spent elsewhere in region/economy (note: vehicle repair/maintenance jobs)	Indirect	Low

To screen these potential revenue sources, the desire was to isolate mechanisms that have both a direct impact on revenues and a high level of confidence. Only one category featured both ratings, namely "Increased property tax from increased land value". The direct rating reflects that increased land values translate directly to higher property taxes, which are revenue sources that flow to local governments. The high confidence was rooted in the understanding that transportation access is needed to support increasing intensity of land use. This is particularly the case for rural agricultural land that must be connected to the transportation network to become viable for commercial or residential development.

Outcomes and Recommendation

The initial inventory and screening of revenue mechanisms explored numerous potential streams that could be applied to a return on investment performance measure. These had varying levels of directness and confidence regarding impacts to government revenues. The resulting recommendation was to focus on impacts to property values from transportation investments, an idea additionally supported from the findings in the literature search.

ROI Performance Measure

Introduction

A return on investment performance measure can be developed for transportation projects in the Saint Cloud planning area using readily available data and tools, guided by evidence from the literature search. Zhao et al demonstrated that increases in accessibility from transportation investments that improve connectivity have a positive correlation to increases in property value. The review of revenue mechanisms for local governments in the planning area concluded that property taxes are the most direct path for funding that can be allocated to the transportation system. Considering this, the recommended performance measure integrates changes in accessibility with increased property values to provide an indication of changes in tax revenue to local governments resulting from transportation investment.

Approach

Developing the measure encompasses two separate steps of analysis, each involving separate data and tools. The first step is development of accessibility measures using the regional travel demand model. This quantifies the availability of desirable activities relative to the transportation cost – typically travel time – to reach them. The second step is to relate the accessibility measure to property values. The theory holds that more accessible land should equate to higher property values, once other factors affecting land values are controlled for.

Accessibility Measure

Measuring accessibility involves quantifying the availability of desirable activity relative to the transportation costs to connect them. Several measures of accessibility are proposed to support the Saint Cloud ROI measure, accounting for the variety of activities and land uses that travelers choose to undertake and can also influence property values. Table 3 outlines these measures and distinguishes which apply to residential or commercial land uses.

Table 3 Summary of Accessibility Measures

Applicable Land Use	Accessibility Measure	Equation
Residential	Job Accessibility	$Acc_{Job,i} = \sum_j \frac{Jobs_j}{TT_{ij}}$
Residential	Shopping Accessibility	$Acc_{Shop,i} = \sum_j \frac{Shopping_j}{TT_{ij}}$
Commercial	Employee Accessibility	$Acc_{Emp,i} = \sum_j \frac{Population_j}{TT_{ij}}$
Retail	Customer Accessibility	$Acc_{Cust,i} = \sum_j \frac{HH_j}{TT_{ij}}$

Where:

- Acc_i: aggregate accessibility measure for each activity for each TAZ "i"
- $Jobs_j$: number of jobs located in each TAZ "j" throughout the region
- TT_{ij}: loaded network travel time between TAZ "i" and each TAZ "j"
- $Shopping_j$: square feet of retail space located in each TAZ "j" throughout the region
- $Population_j$: number of persons residing in each TAZ "j" throughout the region
- HH_j: number of households located in each TAZ "j" throughout the region

The transportation cost factor is captured in the travel time variable. As shown in the equation, it is anticipated to have an inverse relationship to the accessibility measure; as the travel cost increases, it makes the activity less accessible. Simply put, activities that are farther away or harder to reach count less than those closer by. What remains unknown is whether this inverse relationship is linear, or a different formulation. As part of the measure development process, it is recommended that other formulations are tested – such as the square or square root of travel time – to assess which best captures accessibility.

The data needed to supply inputs to these equations can all be obtained from the regional travel demand model. The travel time measure is an output of the trip assignment process and is extracted by saving travel time skims during the network assignment. Other variables are populated from the land use inputs to the model. The Saint Cloud model uses categories covering 13 measures of land use activities.

- Single Family Residential – dwelling unit
- Med/High Density Residential – dwelling unit
- Office – thousands of square feet (KSF)
- Industry – KSF
- Low Industry – KSF
- Medium Retail – KSF
- High Retail – KSF
- Hotel/Motel – rooms
- School – KSF
- Park – KSF
- Hospital – KSF
- College – KSF

The average household size in the planning area is estimated from the land use evaluation performed to support inputs to the regional travel demand model. This ratio was estimated to be between 2.37 and 2.49 persons per household at various time horizons. A representative value of 2.4 persons per household is reasonable for use in the return on investment evaluation. Since this ratio does not vary geographically across the planning area, more detailed specification of household size will not influence the regression results.

Table 4 Average Household Size in the Saint Cloud Planning Area

	2015	2040 Study	2045 Study
Single Family	34,357	47,322	40,528
Multiple Family	21,107	29,101	26,857
TOTAL	55,464	76,423	67,386
PERSONS PER HOUSEHOLD	~2.46	~2.37	~2.49

Conversion factors are also needed to translate the area of commercial land uses to number of jobs available. The conversion factors are provided for retail, industrial, and office land use types.

Table 5 Commercial Land Use Employment Factors

LU Type	EMP per KSF
Retail	0.75
Industrial	1.5
Office	3

The relationship between these categories and the accessibility equations is shown in Table 6.

Table 6 Travel Demand Model Data for Accessibility Measures

Accessibility Variable	Model Input Variable	Comments
Jobs (number)	Office + Industry + Low Industry + Medium Retail + High Retail + Hotel/Motel + School + Hospital + College	Employment factors for these land uses reflect number of jobs rather than customers, patrons, or users of goods or services produced
Shopping (KSF)	Medium Retail + High Retail	Total square footage of shopping opportunities
Population (persons)	Single Family Residential + Med/High Density Residential	Household size applied to approximate number of persons in labor market
Households (number)	Single Family Residential + Med/High Density Residential	Number of households indicates customer market for retail

The results of the accessibility calculations will result in a value for each of the four measures for each TAZ in the planning area. These values will not have meaningful units and their magnitudes will vary greatly between measures. However, they should provide a meaningful distinction between TAZs across the region regarding their relative accessibility. More importantly, they provide the inputs to estimate the land values in the second step of the ROI process.

Property Value Estimation

The second step is to utilize the accessibility measures, along with other variables, to establish a predictive model for property values. These, in turn, will be used to estimate property taxes collected across the planning area. A linear regression will be conducted for each land use type to determine its relationship to accessibility. The independent variables include accessibility, and other descriptors for the desirability or un-desirability, of each TAZ. The dependent variable will be the average property value for each land use type within each TAZ.

Zhao et al identified several exogenous factors to account for localized conditions affecting the desirability and/or non-desirability of a given property. The range of these measures is outlined in Table 7.

Table 7 Land Use Desirability and Non-Desirability Factors

Category	Factors	Description	Data Source(s)
Desirability	Lakeview	Properties (residential in particular) in close proximity to water bodies are understood to be more valuable	Water body shapefile, including locations of lakes, ponds, marshes, creeks, and rivers
	Green Space	Properties (residential in particular) in close proximity to parks, trails, and golf courses are understood to be more valuable	Park facility shapefile including locations of public parks and recreational trails Community zoning shapefile including golf course land uses
Non-Desirability	Transportation	Properties impacted by noise and other pollution from major transportation facilities including highways, railroads, and airports are understood to be less valuable	Highway and railroad alignment shapefiles Land use zoning shapefile showing airport area OR landing/takeoff noise contour shapefile (if available)
	Industrial	Properties impacted by noise and other pollution from industrial facilities including factories, are understood to be less valuable	Land use zoning shapefile identifying industrial properties Other data for industrial site known to be emitters of air, noise, or other pollution

A spatial analysis should be performed on shapefiles containing this information to identify TAZs influenced by the desirability and/or undesirability factors. This is done using a buffer analysis extending outwards from the facilities. Successive buffer areas of 0.25, 0.5, 0.75, and 1.0 mile should be used and assigned a descending index from 4 to 1 for each factor. These indices will be used in the regression analysis to estimate their influence on property values.

Property Tax Data

Property tax data from the counties in the planning area will be obtained to analyze property values by land use category within each TAZ. The categorization of the property types should be kept as disaggregated as possible given the categories available from the tax data. The property "pins" shapefile is then used to establish a correspondence between each property and the TAZ where it is located. A GIS spatial analysis should be performed to identify these "point" features inside the TAZ polygon features using a many-to-one correspondence.

Once this correspondence is known then characteristics of each property type category within each TAZ can be summarized. Recommended summary measures would include number of properties per category, and minimum, maximum, median, mean, and standard deviation of property values.

Linear Regression

The data from the regional model, accessibility measure, desirability/undesirability factors, and property tax information should be organized at the TAZ level to facilitate the regression analysis. A separate regression should be performed by land use categories, based on the degree of consistency between the property tax data and land use inputs to the travel demand model. The regression equation will take the general form:

$$Property\ Value_i = C_0 + C_1 \cdot Acc_i + C_2 \cdot LakeView_i + C_3 \cdot GreenSpace_i + C_4 \cdot Trans_i + C_5 \cdot Ind_i$$

Where:

- $Property\ Value_i$ is the average property value per KSF by land use type in each TAZ "i"
- $C_{0..5}$ are the coefficients of the regression analysis
- Acc_i is the accessibility by activity type for each TAZ "i"
- $LakeView_i$ is the lakeview desirability index for each TAZ "i"
- $GreenSpace_i$ is the green space desirability index for each TAZ "i"
- $Trans_i$ is the transportation non-desirability index for each TAZ "i"
- Ind_i is the industrial non-desirability index for each TAZ "i"

The results of the regression will provide overall goodness-of-fit measures and an estimated coefficient and significance value for each coefficient. The goal of the regression will be to achieve a high goodness-of-fit measure for the regression, along with a positive and statistically significant relationship with the accessibility measure. The hypothesis for this analysis is that accessibility is a key indicator of property values; if other variables are not found to be significant in predicting property values the resulting tool can remain useful.

Technical Details and Troubleshooting

An applicable regression method for the evaluation may be to use k-fold cross validation. In this approach, the data is split randomly into "k" groups, for example five groups, each with 20% of the data. The regression is performed on 80% of the data and then validated against the remaining 20%. This exercise is repeated five times, validating against one of the 20% groups each time. Each regression will result in different regression results, however in a well-fit model they should be close. To assess this, the variation in the goodness of fit parameters and variable coefficients are compared to assess which are consistent and meaningful across all of the control groups. The ultimate model can then be established from the subset that had the best goodness-of-fit, or some combination of results that is representative of the entire sample.

Regression analysis can be challenging to achieve successful results on the first iteration. Adjustments can be made in an attempt to capture the meaningful indicators of the dependent variable. Each of the input variables to the regression analysis was created based on a variety of assumptions reflecting our understanding of the transportation system, accessibility, and behavioral characteristics. There is likely, in fact, wide variability or poorly understood interactions among these variables relative to their influence on property values. If needed to improve the confidence of the accessibility value in predicting property values, these input variables should be adjusted to assess the sensitivity of the regression model. Examples of these adjustments could include:

- Alternative formulations of the accessibility measure, particularly the "cost" coefficient, i.e. travel time. Rather than a linear relationship it could be squared, square root, or even a completely different formulation such as exponential or logarithmic relationship.
- Buffer areas and influence indices for desirability and undesirability factors could also be modified. These adjustments would involve increasing or decreasing the buffer radii or using more or less pronounced index values at each successive buffer.
- Other explanatory variables could be added, such as an area type indicator for inherently unique community types. Examples may include central business district, university, or manufactured home community.

Finally, the regression analysis presented up to this point is envisioned at the TAZ scale. An alternative approach, albeit more data intensive, would be to perform the regression at the individual parcel level, or at some lesser degree of aggregation such as census blocks, etc. The accessibility would still be reflective of the TAZ level, but greater granularity could be incorporated regarding specific land use type, and proximity to buffer areas of desirability/undesirability factors.

Application

The application of the return on investment performance measure is the step that provides the most utility for St. Cloud APO and its planning partners. This will provide an estimate, or prediction, of changes in property values and associated tax revenues likely to result from a transportation investment. The process for applying the ROI measure will involve the following steps:

1) Perform runs with the regional travel demand model for the No Build and Build condition of the improvement(s) under consideration.
2) Use the travel time skims from the No Build and Build model runs, along with the land use data, to compute the accessibility measures for each TAZ and land use activity.
3) Compare the No Build and Build accessibility measures across all TAZs (a choropleth map is an effective tool) to ensure results appear reasonable, specifically that TAZs most likely to be affected by the transportation investment show the greatest change in accessibility.
4) Use the model equations from the regression analysis to predict the property values for each land use by TAZ for the No Build and Build conditions.
5) Calculate the percent change in property values for each land use by TAZ between the predictions produced by the No Build and Build model equations.
6) Multiply existing property values in affected TAZs by the percent changes calculated for each land use type. This provides the estimated change in property values, which can be aggregated to get a total regional change (if desired).
7) Multiply the existing property tax amounts for each property by the percent change in property values above. This provides the net change in property tax revenues. Sum all of these values across the region, or by jurisdiction, to estimate the total change in revenue for the transportation investment.
8) Calculate the final return on investment measure by dividing the net increase in property tax revenue by the cost of the improvement. It may be suitable to amortize this over a period of 20 years, or other appropriate timeframe reflecting the functional life of the investment.

Each of these steps can produce useful performance indicators for predicted impacts of a transportation investment. The analyst performing this work is encouraged to pause after each step and assess the reasonableness of the results, perhaps generating maps, graphs, or summary tables that can be used to better understand the outcomes and communicate them to stakeholders.

In addition to individual projects, this methodology can also be applied to a program of projects or wider scenario of transportation investments. This would be approached starting with step 1 of the application process, defining the Build scenario with several projects, or comparing two alternative investment scenarios in an incremental analysis.

Next Steps and Future Research

A wide range of further research could be conducted to help support the return on investment performance measures for St. Cloud APO. Many of these resources are available within Minnesota and can help to provide a customized approach that is reflective of the localized conditions in the planning area.

Life-Cycle Cost Analysis

An investigation can be undertaken to estimate life-cycle cost analysis of agency commitments to maintenance and operations of roadway. This would include such elements as preservation of increased pavement and bridge areas, safety impacts (including emergency response costs, recovery costs), emissions reductions, and other costs borne by the agency. This would in turn be compared to the revenue implications of the transportation investment and would allow for determination of sustainability.

Model Validation

Validation can be performed to compare changes to the transportation network and property values resulting from recently completed transportation improvements. The regression analysis described in this chapter uses only a single point in time to assess the influence of accessibility and other factors on property values. A more representative approach may be to perform a longitudinal evaluation that would isolate property values that have changed over time and can be found to be attributable to investments that changed accessibility at those locations.

Accessibility Observatory

The Accessibility Observatory is a research-based organization associated with the Center for Transportation Studies (CTS) at the University of Minnesota. Their staff have pioneered groundbreaking methods for computing accessibility at highly granular levels, and across all modes of transportation. If there is a desire to obtain accessibility measures that are more accurate and geographically specific than can be achieved with the regional model, this may be a resource to help achieve that.

Humphrey School of Public Affairs

Professor Jerry Zhao of the Humphrey School of Public Affairs at the University of Minnesota, cited in several of the academic papers reviewed for this report, could also assist the St. Cloud APO in exploring return on investment performance measures. For example, a workshop could be facilitated that would engage the APO's planning partners in identifying important influence factors for their transportation investments, revenue streams, and available data resources.

Findings and Conclusions

An initial return on investment performance measure has been outlined in this report that reflects current literature on this topic, a review of potential methods, and data resources readily available to the APO. The recommended initial implementation and testing of the measure have been outlined in a way that should allow for straightforward execution once data sources have been obtained through coordination with local partners.

The process can be further refined with additional data and/or more granular scale of analysis, should the APO wish to pursue advancements by engaging with additional technical resources. Several recommendations are provided for areas of future research, testing, and technical innovations.

Summary of Data Needs

- Regional travel demand model and all associated input data
- Water body shapefile including all lakes, rivers, streams, and ponds
- Park facility shapefile including all parks and trails
- Highway shapefile including alignment and functional classification
- Railroad shapefile including alignment
- Land use zoning shapefile including land use types, airport locations, golf courses, and industrial uses
- Other data available for industrial sites known to be emitters of air, noise, or other pollution
- Property tax data including property values, tax amount, and use type classification
- Property tax "pins" shapefile showing centroid of individual parcels