Evaluating Complete Streets through Multiresolution Modeling

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Presentation Outline

- Introduction
- Research Background
- Research Objectives
- Literature Review
- Proposed Methodology (WIP)
- Future Steps

Introduction

- Complete streets is a transportation policy and design approach that requires - Streets to be planned, designed, operated, and maintained to enable safe, convenient and comfortable travel and access for users of all ages and abilities regardless of their mode of transportation.
- Allow for safe travel by those walking, cycling, driving cars, riding public transportation, or delivering goods.
- Dozens of relevant studies to address qualitative benefits of Complete Streets but no studies which would quantitatively assess Complete Streets from both operational and planning perspectives.

Research Background

- Implementation of Complete Streets is often driven by qualitative analysis, thus leaving room for speculations on how would Complete Streets operate under a number of future travel demand scenarios and operational strategies.
- This practice does not comply with our long-term planning processes for urban areas, where future (multimodal) transportation demand levels need to be considered through MACROSCOPIC MODELING of relevant scenarios.
- On the other hand, a realistic account of traffic operations, closely reflecting real-world conditions, requires a level of operational details and performance measures which are achievable only on MICROSCOPIC MODELING level.
- A solution to this level-of-abstraction problem is a MULTIRESOLUTION ANALYSIS of Complete Streets where macroscopic modeling is used to develop/analyze long-term travel demand forecasting scenarios whereas the microscopic analysis is utilized to investigate impacts of operational strategies and retrieve a number of high-resolution performance measures (necessary for safety and environmental indicators).

Research Objectives

1. Develop a multiresolution modeling methodology which will take in consideration both long-term planning aspects of the Complete Streets as well as operational strategies which may be implemented to address specific needs of its multimodal users.

2. Investigate multi-criteria costs and benefits of deploying Complete Streets in a number of scenarios with various Complete Street ‘use-cases’ and network topologies.

3. Document lessons learned and disseminate to the professional community.

Literature Review – Approach Taken

- The FAU research team conducted a literature review to describe existing practices in evaluating and analyzing impact, costs and benefits of the Complete Streets.
- Two distinctive areas were specifically addressed in the literature review are: Methodologies for multiresolution analysis, and Evaluations of Complete Street designs.
- A special emphasis is given to the other recent and ongoing efforts supported by FDOT, such as Complete Streets implementation plan, Complete Streets Handbook, Design Manual, etc.

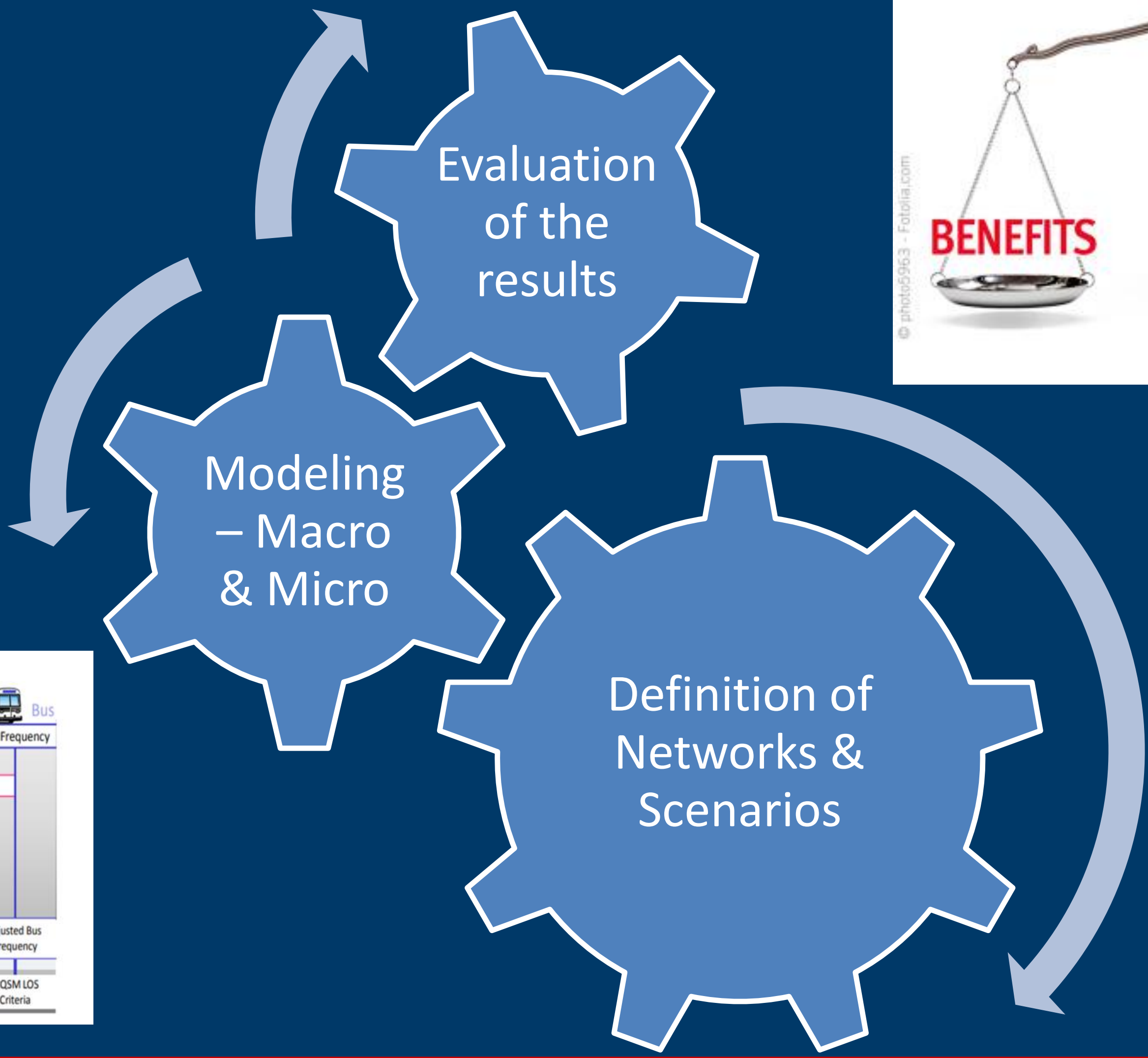
Literature Review – FL Efforts

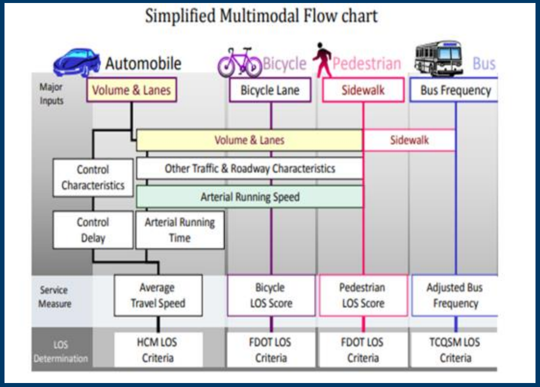
- FDOT (D5) Multi-Modal Corridor Planning Handbook (2013) - help communities tie land use planning and transportation into a "complete street."
- FDOT Complete Streets Implementation Plan (2015) - outlines a five-part implementation framework and process for integrating a Complete Streets approach into FDOT’s practices to ensure that future transportation decisions and investments address the needs of all users of the transportation network and respond to community goals and context.
- FDOT Complete Streets Handbook (2017) – An explanation of FDOT’s Complete Streets approach and principles for state roads along with guidelines for: collaboration with local partners, applying a Complete Streets approach to state projects, and roadway design considerations.
- FDOT Context Classification - the Heart of Complete Streets
- FDOT Design Manual (ongoing effort) - sets forth geometric and other design criteria, as well as procedures, for FDOT projects.
- Miami Dade County Complete Streets Design Guidelines (2016)
- Broward Complete Streets Guidelines (2012)

Literature Review - Summary

- Various researchers utilized different approaches and performance measures to evaluate Complete Streets. In general, most of the studies dealt with qualitative benefits of Complete Streets.
- All sorts of performance measures and perspectives are used to assess impact of the Complete Streets. The perspectives included: economy, environment, place, safety, equity and public health; while the performance measures included: daily automobile traffic volumes, speeding violations, parking utilization, bicycle/pedestrian counts, transit use, mode volumes, rate of traffic accidents, volume of users, and corridor travel times for drivers.
- Few studies also dealt with travel behavior and exposure of the street users to traffic-related air pollutants and relationship between topologies and safety.
- To evaluate the economic vitality of Complete Street, researchers considered measures like number of businesses, property values, employment, retail sales, visitor spending, housing price, and change in property value before and after implementation of Complete Street etc.
- In terms of the utilized methodology most of the studies used before-and-after studies to evaluate the Complete Street projects.
- Many studies also used various types of surveys by utilizing a combination of online tools and in-person engagement to find out the impact of this transformation among stakeholders groups as well as users.

Methodology - Overall





Research Work Flow

- Discuss potential network topologies that can be used to apply proposed Complete Street scenarios.
- Network consideration should be closely tied with development of Complete Street scenarios.
- Define Complete Streets scenarios – Planning and Operational
- Collect the required data sets & prepare models
- Run various Complete Streets scenarios
- Evaluate results
- Perform Cost/Benefit Analysis and LOS Evaluations

Ideas for Complete Street Scenarios - Pedestrians

- Operational Scenario
  - Quantify pedestrian-friendly improvements of a Complete Street design
- Planning Scenario
  - Quantify impact of pedestrian traffic flows at busy urban intersections (requires trajectory analysis of pedestrian and vehicular paths)
  - Will a number of potential conflicts of pedestrians with (permitted) right-turn vehicles decrease with a Complete Street design (when compared to the previous conventional-street design)?

Ideas for Complete Street Scenarios – Freight Traffic

- Operational Scenario
  - How does an increased traffic flow of heavy vehicles (e.g. trucks), on a Complete Street designed mainly to aid freight traffic, impact traffic emissions and energy conservation on this street?
  - What happens with a Complete Street if one out of three lanes of a corridor with freight traffic converts to a dedicated truck lane? How will this affect other transportation modes?
- Planning Scenario
  - What would happen, on the same corridor, 10 years later if a local business area closes (e.g. one of the planning alternatives) and a new residential complex is developed? Is the freight-traffic-driven design of the Complete Street robust enough to sustain such a change in land use?

Ideas for Complete Street Scenarios – Public Transit

- Operational Scenario
  - How near-side bus stops with queue-jumpers, deployed as a part of Complete Street implementation, impact pedestrian walking (e.g. optimal stop from the pedestrian perspective might be on the far-side of the intersection) and extra delays for private cars?
- Planning Scenario
  - Assuming a constant increase in ride-sharing services in the future of Connected and Automated Vehicles, at what point in future does the proposed Complete Street design become obsolete (e.g. demand for bus trips drop to very low levels)?

Ideas for Complete Street Scenarios – Private Traffic

- Operational Scenario
  - How the traffic demand and network performance (in terms of efficiency, safety of all users) will change if a 2+2 arterial / collector road needs to be turned to 1+1 road where the two inner lane will be turned into areas aimed for pedestrians / public transport.
- Planning Scenario
  - What happens with efficiency, safety and environmental indicators of a Complete Street if people change their travel mode due to increased taxes for use of private vehicles?

Data Sources & Types

Data Sources:

- National MPO - Metropolitan Planning Organizations
  https://catalog.data.gov/dataset/metropolitan-planning-organization-mpo-national
- DOT, Counties, Cities
- Open source data, publicly available websites

Data Types:

- Topology data (Shape files, GIS)
- O-D matrices,
- Travel-time matrices,
- Trip attraction/production models,
- AADT and hourly volumes,
- Turning movement counts (TMC),
- Traffic signal data,
- Public transportation data (routes, timetables, etc.),
- Speed limits,
- School zones, etc.

Cost-Benefit Analysis

Possible idea is to consider four primary categories of user benefits for cost-benefit analysis utilizing the output from simulation and available data (According to Caltrans Life-Cycle Benefit/Cost Analysis Model)

1. Travel time savings
2. Vehicle operating cost savings
3. Safety benefits (accident cost savings)
4. Emission reductions

Travel Time Savings

Travel time savings are calculated as a function of the travel speeds and traffic volumes:

- Based on the base and future-year traffic volume projections, future annual average daily traffic (ADT) are estimated, without and with the improvement project, assuming straight-line growth.
- Annual ADTs are multiplied by the length of the area affected by the improvement and divided by the travel speed to find the total travel time, without and with the improvement.
- Annual travel time savings are multiplied by the value of time and average vehicle occupancy for each mode to convert travel time savings into dollar values.
- The dollar value of the travel time savings is discounted to estimate its present value.

Vehicle Operating Costs

Vehicle operating cost (VOC) savings (i.e., changes in fuel use, vehicle wear, etc. due to improved speed) are estimated from travel speeds and traffic volumes as follows:

- Forecasted annual ADTs are multiplied by the affected segment length to find annual vehicle-miles traveled (VMT) with and without the project as well as the difference (VMT savings).
- For each mode, annual VMT savings are multiplied by the fuel consumption (from look-up table based on average speed) and the unit fuel cost to find the dollar value for fuel VOC savings.
- Annual VMT savings are multiplied by unit non-fuel VOC to find the dollar value of non-fuel VOC savings.
- Future annual VOC savings are summed across modes and discounted to obtain their present value.

Safety Benefits

Safety benefits are a function of traffic volumes:

- The aggregated accident cost is calculated by multiplying the accident rate by an average user cost for each type of accident and summing the result.
- Annual VMT is multiplied by aggregate accident cost to estimate the annual cost of accidents without and with the projects.
- The difference (change in accident cost) is discounted to find the present value of future safety benefits.

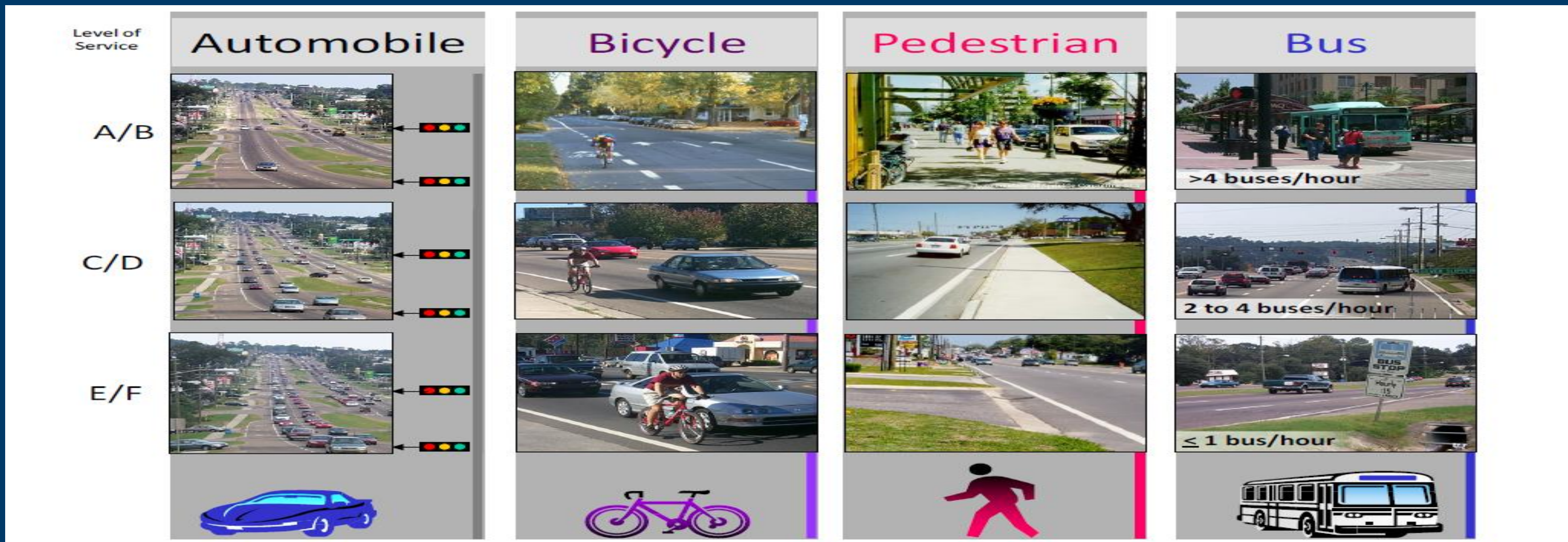
Emissions Reductions

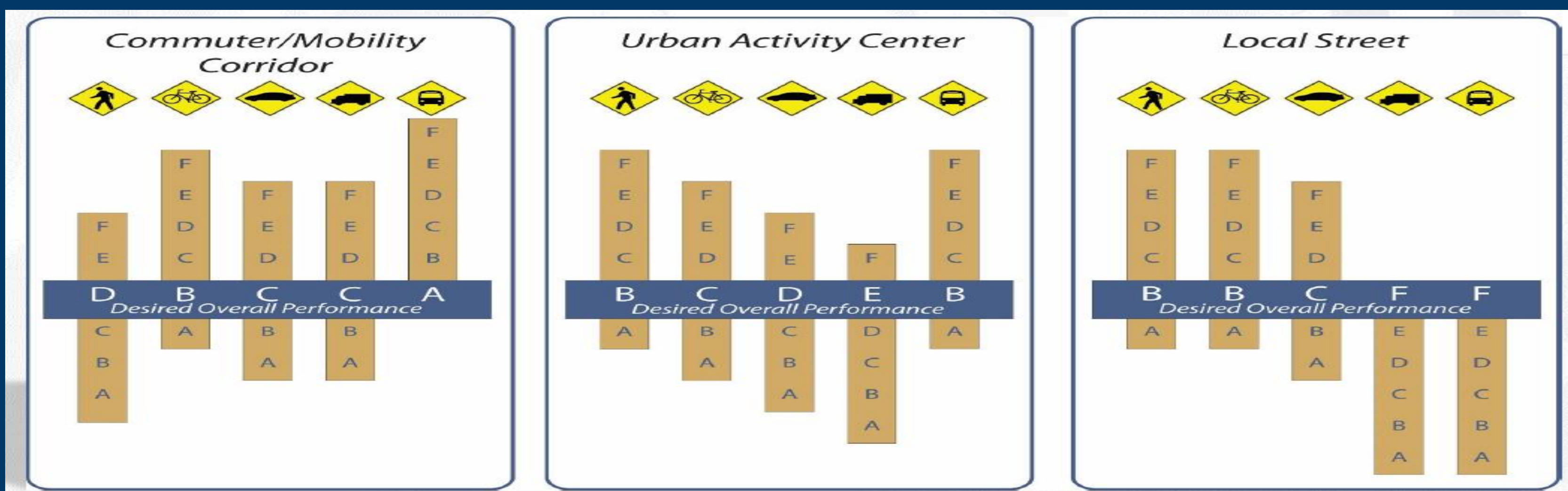
Emissions reductions are calculated from travel speeds and traffic volumes:

– The aggregate emissions cost per mile is calculated by multiplying the emissions rate, which is a function of travel speed, by the emissions cost for each type of emission and summing the results.

– Annual VMT is multiplied by the aggregate emissions cost to find the annual emissions cost with and without the project.

Multimodal LOS on Urban Roadways





FDOT's Variables to Measure Multimodal LOS

Variable having Significant Impact on Calculated Volumes in a Multimodal LOS Analysis		
Area type	Number of thru lanes	Annual average daily traffic (AADT)
Paved shoulder/bicycle lane	Sidewalk	Planning analysis hour factor (K)
Signalized intersection spacing	Left turn lanes	Directional distribution factor (D)
Thru effective green ratio (g/C)	Bus frequency	

Bicycle LOS Variables
Average effective width of the outside thru lane
Motorized vehicle volumes
Motorized vehicle speeds
Heavy vehicle (truck) volumes
Pavement condition

Pedestrian LOS Variables
Existence of a sidewalk
Motorized vehicle volumes
Motorized vehicle speeds
Lateral separation from motorized vehicles

Future Steps

- Define 2-3 Complete Streets case-study networks
- Collect the required data
- Start building models and running scenarios
- Finalize the methodology

Closing Page

Thank you!

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