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Think Jersey DOT

Tech Brief

Cost of Transporting People in New Jersey Phase 2

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BACKGROUND

- The extensive and highly developed highway infrastructure of New Jersey, carrying heavy traffic of freight and commuters, plays a pivotal role in ensuring mobility in the tri-State area. Yet, given the high-density growth of the region, it will be impossible to meet all current and potential demand even with an expanded highway system.
- To keep pace with economic growth in the State of New Jersey, the highway transportation system must continuously evolve to face the challenge of achieving increased mobility, efficiency and connectivity. For decades this challenge has been a major objective of the federal and state government investments in transportation improvements.
- Central to this objective is the need for new tools for accurate estimation of the full marginal costs (FMC) of highway travel in the State. This information is essential for allocating scarce resources efficiently, for ensuring equity among users of different transportation modes, and for developing effective road user pricing mechanism.
- FMC means the overall costs accrued to society (State of NJ) from servicing an additional unit of user. FMC includes capital costs, maintenance costs, highway accident costs, congestions costs and environmental costs.

WHAT'S THE PROBLEM?

- The "traditional" distance-based approach of FMC calculation cannot accurately estimate the marginal cost of the network, and more importantly it provides marginal cost on the basis of distance rather than trips, which is the most basic way of considering travel behavior of drivers.
- Furthermore, there are no available network-wide FMC calculation tools for

analysts that can estimate trip-based FMC values. Such tool will help transportation planners to estimate the changes in transportation costs due to a particular transportation demand management measure or supply change such as adding new lanes or improving existing lanes.

HERE'S THE SOLUTION

- This project has developed a state-of-the-art GIS-based interactive computer tool for calculating network-wide FMC of highway transportation in New Jersey. The new tool is used to evaluate the short-term impacts of policy implications on the marginal costs of different trips.
- This is a critical component of transportation planning, because demand patterns experience both spatial and temporal variations due to the changes in demand and supply. An accurate cost estimation tool based on the new route flows will help planners to better quantify the effects of these variations and thus to better evaluate current and future transportation investment alternatives.
- Moreover, transportation planners will be able to study the changes in various components of marginal cost functions, namely operation, environmental, accident and others and evaluate various options based on the individual cost component of interest to them and the decision makers.

THESE ARE THE OBJECTIVES...

The four major scopes of our study can be summarized as follows:

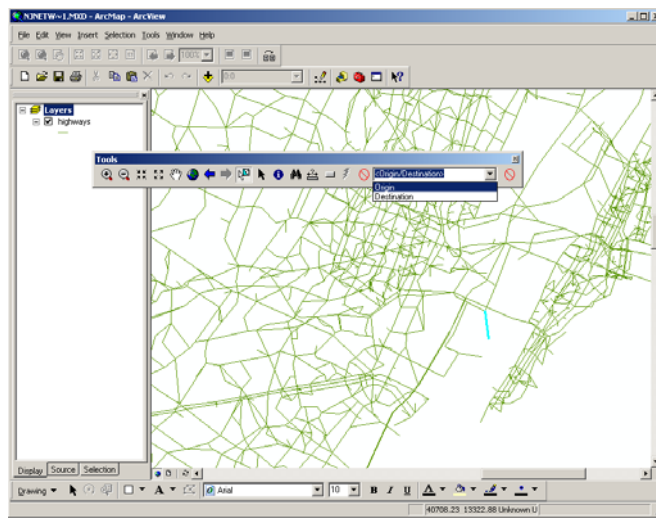
- Improve the trip-based FMC methodology developed in the first phase of the project, and develop a novel methodology to estimate trip-based FMC, which considers not only the shortest “travel time” path but a set of feasible paths between each origin and destination (O-D) pair attractive to the travelers while calculating the FMC of highway transportation in New Jersey.
- Update the various transportation cost functions developed in the first phase of the project.
- Develop a GIS-based interactive computer tool, which implements the proposed methodology, and estimates the FMC between different O-D pairs at several levels of detail, including single O-D pair, and a set of O-D pairs within certain area, county or the entire network.
- Investigate the short-term impacts of policy implications on the FMC of different trips.

Application of marginal cost in transportation network differs from its basic economic definition. This phenomenon creates several interesting research questions that can be summarized as follows:

- While calculating network wide marginal cost, do we have to add an extra trip between every O-D pair?
- Or do we have to pick one O-D pair and introduce the trip between this O-D pair? If the answer is “yes”, then which pair?
- What is the effect of an additional trip to the overall network flow patterns? In reality, does the extra trip affect flows at the equilibrium?
- What is the effect of policy implications on the cost of a additional trip, in the short-run?

HERE IS WHAT WE DID...

- We propose a new methodology to estimate the system marginal cost within a reasonable accuracy range in a highway network. The methodology estimates trip based FMC by considering a set of feasible paths between each O-D pair.
- In order to implement this proposed methodology, we first develop marginal cost functions. Marginal cost functions depend on total cost functions since once total cost functions are developed marginal cost functions can easily be derived with respect to a selected variable.



- The proposed trip-based FMC estimation methodology and marginal cost functions estimated for different cost categories are implemented in GIS using C programming language and Visual Basic for Applications (VBA).
- The proposed trip-based FMC methodology is then illustrated on a simple

network and on Northern New Jersey, and compared with existing methodologies in the literature. The comparison results show that the “traditional” distance-based approach overestimates the marginal cost of the network, and more importantly it provides marginal cost on the basis of distance rather than trip, which is the most basic way of considering travel behavior of drivers.

- Results obtained from the application of the new tool on the North Jersey network demonstrate that FMC between an O-D pair exhibit differences among various paths that connect any single O-D pair. These results also demonstrate the importance of analyzing trips based on a number of factors in addition to travel times such as volume, capacity, road type, and distance.

- We also calculate the short-term impacts of investment choices on the FMC of different trips using the GIS-based tool. The analyses are focused on lane improvements on several route sections, namely NJ Route 18, NJ Route 17, NJ Route 3, and the Garden State Parkway. The changes between before and after scenarios demonstrate that even though capacity investments can reduce the marginal cost of users, the amount of savings mainly depends on the characteristics of that region. More specifically, the amount of capacity investments highly depends on the amount of excessive demand that needs to be satisfied, and the reduced congestion delays. In general, the more congested a road is, the more traffic is generated by increased demand. Increased capacity on highly congested urban roads attracts considerable traffic due to high levels of latent demand. Thus, if a road section to be improved is in a very congested area, capacity investments may result in overall higher usage of this same road section.

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