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Project Title

Multimodal, Multistate Corridor Modeling for Long-Distance Movements of Food and Containerized Goods

University

North Dakota State University

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Research Needs

Many transportation planning problems span large areas, encompassing many cities and, in some cases, several states. Optimal solutions for lengthy corridors cannot be derived by focusing on isolated segments in a particular state or metropolitan region. The interconnectivity of the corridors must be considered, especially within the context of national and regional freight planning. The traffic in one segment of a multistate corridor may be influenced by traffic levels in other segments. Similarly, the capacity and speed of a primary highway or railway segment may affect the performance of segments upstream and downstream of it. Because of the interrelationships among flows, capacities, and investment patterns, the facilities and traffic in a multistate corridor must be analyzed comprehensively.

Many advances in practice have occurred in this field. Procedures have been recommended for analyzing corridors within the same state or metropolitan region [1]. Guidance has been issued

for creating jurisdictional partnerships and working arrangements [2] and implementing integrated corridor management practices [3]. Capacity analysis tools have been recommended for multimodal corridor planning [4]. In addition to these guidebooks, the U.S. Department of Transportation's Freight Analysis Framework (FAF) provides traffic flow forecasts for corridors and segments of the national transportation network [5]. While FAF offers traffic forecasts, it does not provide the modeling or analytical tools necessary for planning and investment analysis.

Despite many advances in corridor management, additional tools are needed to leverage the capabilities of Geographic Information Systems and simulate multimodal freight movements at the level of detail necessary for corridor performance and investment analysis. In addition to prediction and simulation, optimization, risk, and investment modeling procedures are essential. Moreover, a common modeling framework is needed, one that supports the integration of data from many states and jurisdictions into a comprehensive systems model. Such models require the fusion of data from numerous sources, as well as the consideration of differing constraints and operational practices in various states.

Research Objectives

The purpose of this project is to develop an archetypal model for a lengthy freight corridor (comprised of many jurisdictions) that can be used for capacity, performance, and investment analysis. Uses of the model will be illustrated, along with its limitations and desired data improvements. The potential for transference to other corridors and settings will be discussed, as well as suggestions for future model development. While the same modeling approach can be used for many commodities and types of flows, this project will focus on food, energy-related, and container traffic. These primary flows are critical to global trade, economic development, and food security.

1. Develop an archetypal multimodal GIS network for the GNC in TransCAD
2. Develop grain, food, and container logistics modeling procedures and integrate them into the GNC systems model
3. Develop a risk assessment model (integrated with the GNC network) to assess the risks of hazmat movements and at-grade crossings
4. Design simulation, optimization, and benefit-cost procedures and integrate them into the GNC model
5. Conduct case studies of food and container logistics movements, leading to the formulation of prototypical performance measures and optimization strategies for multistate, multimodal corridors

Research Methods

Building the model requires a wide range of methods and the development of synthetic techniques, including: (1) the use of spatial procedures to join disparate data elements with the degree of locational accuracy necessary for modeling; (2) the development of spatial modeling procedures (e.g., spatial interaction, distribution, and multicommodity flow models), (3) the development of mathematical (optimization) algorithms, (4) graphical and visualization tools, and (5) and the conceptualization and implementation of cost and environmental impact procedures. Highway, railway, grade crossing, and commodity flow data will be assembled or collected for each state in the corridor. All data and modeling techniques will be integrated into TransCAD.

Expected Outcomes

1. An archetypal multistate, multimodal corridor planning and simulation tool that advances the state of modeling and practice
2. Advanced spatial analysis techniques necessary to build detailed multimodal corridor models
3. Food and logistics model with widespread uses beyond corridor analysis
4. Recommendations for replication of the GNC model in corridors other than the Great Northern
5. Inferences gained from applying the model to the Great Northern Corridor including the identification of optimal sets of investments, corridor performance measures, and efficiency gains in food and container logistics.

Relevance to Strategic Goals

- **Safety**. The GNC model will incorporate highway-railroad grade crossings and hazardous material flows. Risk models will be developed for these two safety concerns and included in the model.
- **Economic Competitiveness.** The GNC model will allow simulation of highway and railroad capacity restrictions on the cost and reliability of freight flows, trip times, trip time reliability, and other performance metrics germane to economic competitiveness

Educational Benefits

Several graduate and undergraduate students will be involved in the project. The students will gain experience in GIS model development, including the programming and use of TransCAD and TransModeler, as well as experience in writing algorithms, scripts, and technical documents. In the future, the models could potentially be used as examples or cases studies in transportation classes.

Technology Transfer

Some of the planned activities include

1. Presentations of results and illustrations of the model to the Great Northern Corridor Coalition (GNCC), which includes the transportation departments of the eight states in the corridor, the BNSF Railway, Amtrak, and other rail users
2. Presentations at conferences including the Transportation Research Board, the American Railway Engineering and Maintenance Way Association, and the Institute of Transportation Engineers (provided our requests to present are accepted)
3. Articles in journals focused on freight and transportation planning (provided the submitted articles are accepted)
4. Webinars and recorded sessions via the Transportation Learning Network and other hosts

Note the GNCC and FRA will be involved in the project from beginning to end, providing input and feedback.

Work Plan

The overall work plan for this proposal comprises a 24-month research period. Initial data collection and model construction will occur over a 12-month period with the specific applications of the tool developments occurring months 14-18. Summary documents and documentation including journal articles and presentations are to be complete by month 24.

1. Describe the importance of the Great Northern Corridor (GNC)—which extends from Chicago IL to Seattle WA —in supplying food and facilitating global trade (month 2)
2. Develop an integrated highway and railroad GIS network for the GNC in TransCADIntegrate seaports, facilities, major terminals, highway-railroad grade crossings, and other facilities into the GNC network (month 4)
3. Collect and integrate historical hazard material operational and safety performance data for major facilities such as highway-railroad grade crossings for risk analysis. (month 6)
4. Develop grain and food logistics modeling procedures and build them into the GNC systems model (month 12)
5. Develop container logistics modeling procedures and incorporate them into the GNC systems model (month 12)
6. Develop a risk assessment model (integrated with the GNC network) to assess the risks of hazmat movements passing through at-grade crossings in the corridor (month 14)
7. Design simulation, optimization, and benefit-cost procedures and integrate them into the GNC model (month 14)
8. Develop graphic and visualization tools to illustrate the model and allow users to perform scenario and sensitivity analysis (month 16)
9. Conduct case studies of food and container logistics movements, leading to the formulation of prototypical performance measures and optimization strategies (month 18)
10. Include shared-use analysis procedures for simultaneous consideration of long-distance intercity passenger rail and freight services using the same facilities in a corridor (month 18)
11. Document implications for multistate corridor planning and recommendations for state-of-the-art techniques (month 20)
12. Develop a data management plan for making non-confidential elements available, with strategies for archiving and updating data in the future (month 20)
13. Describe the model and its capabilities through outreach efforts including webinars, workshops, presentations at conferences, and other means (month 22)
14. Author MPC report and journal articles (month 24)

Project Cost

Total Project Costs:	$915,456
MPC Funds Requested:	$457,728
Matching Funds:	$457,728
Source of Matching Funds:	North Dakota State University

References

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[2] McDowell, B. D. *Multistate Institutions for Implementing Improved Freight Movement in the U.S.*, prepared for the Federal Highway Administration Office of Freight, U.S. Department of Transportation, in Partnership with the I-95 Corridor Coalition, December 2009

[3] National Academies of Sciences, Engineering, and Medicine 2020. *Planning and Implementing Multimodal, Integrated Corridor Management: Guidebook*, NCHRP Web-only Document 287, Washington, DC: The National Academies Press. https://doi.org/10.17226/25906.

[4] National Academies of Sciences, Engineering, and Medicine 1998. *Multimodal Corridor and Capacity Manual*, Washington, DC: The National Academies Press.

[4] Hwang, H. L., et al. *The Freight Analysis Framework: Building the FAF4 Regional Database, Data Sources and Estimation Methodologies*, prepared for the Bureau of Transportation Statistics and Federal Highway Administration by the Oak Ridge National Laboratories, ORNL/TM-2016/489, April, 2017