MPC-465
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Project Title:
Development of Performance Matrices for Evaluating Innovative Intersections and Interchanges

University:
University of Utah

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Research Needs:
Innovative (alternative, unconventional) intersections and interchanges are generally defined as design concepts that are able to reduce the number of signal phases and conflicts at the main intersection/interchange, thereby increasing the efficiency, capacity and safety of the signalized intersection. In most cases, this is accomplished by rerouting left turns at a point well ahead of the main intersection/interchange, or accomplishing left turns through a combination of through, right and U-turn movements. These designs are regarded to be "unconventional" because they incorporate geometric features or movement restrictions that would be permissible at standard intersections/interchanges. Such elements include the elimination and/or relocation of various through and turning maneuvers, the use of indirect turning movements, and the inclusion of roundabout designs.

Innovative intersections and interchanges, primarily Continuous Flow Intersection (CFI) and Diverging Diamond Interchange (DDI), have seen an increase in numbers in the United States over the past several years, especially in Utah, making Utah a leader in the country in implementation of these designs. Although on the surface these designs seem to improve traffic performance, their complete impacts and benefits are hard to assess. There are still no clearly defined guidelines and methodologies for monitoring and measuring performance of these designs from state DOTs manuals, AASHTO, HCM, NEMA and HSM. Innovative designs have impacts on safety, accessibility, transit, pedestrian and non-motorized traffic, land use, economic development, and environment, making them an excellent candidate for an in-depth analysis of different benefit-impact combinations. There is not a defined straightforward way for this analysis. Researchers and practitioners have recognized that there are gaps when it comes to innovative solutions, so it can be expected that research in this area will increase in the next several years.

Research Objectives:
The primary objective of this research project is to develop a set of performance matrices for evaluation of innovative intersection designs, from operational, safety, accessibility, transit, pedestrian, non-motorized traffic, land use, economic development, and environmental

standpoints. The methodology will be based on a set of algorithms implemented in an underlying computational engine (i.e. Excel-based program), which will generate performance matrices based on the given geometric, traffic, transit and land use data.

Secondary objectives of this research project are to provide in-depth insights into the innovative designs, guidelines and methodologies for their evaluation. In addition to the visual representation in the performance matrices, the algorithms will provide quantitative values for each performance measure. These indicators can be used for engineering evaluations, and for communicating the results to the public.

The anticipated results of this study would help DOTs make better and more informed decisions about the implementation, and performance and safety evaluations of innovative solutions. Each implementation is unique, and there are a lot of parameters that have to be considered before, during and after the implementation. This research is expected to deliver a set of straightforward methodologies and performance matrices for these evaluations.

Research Methods:
The above objectives will be accomplished through a phased approach. The following methodology, combined into several major tasks, will be implemented in this research:

1. Literature review of implementations, designs and evaluations of innovative intersections and interchanges
2. Review of existing methodologies for performance and safety evaluation of these designs
3. Review of existing standards and guidelines (including, but not limited to AASHTO, HCM, MUTCD, NEMA, HSM, state DOTs design manuals) for guidelines and methodologies that could be implemented with innovative intersections and interchanges
4. Identifying gaps in the existing guidelines and methodologies
5. Identifying potential methodologies that could fill in gaps from 4.
6. Development and recommendations of performance matrices and evaluation methodologies for innovative intersections and interchanges that could be implemented in current and future DOT's projects

Expected Outcomes:
The phased approach of this research should yield the following outcomes:

1. Literature review of implementations, designs and evaluations of innovative intersections and interchanges, as well as existing standards, guidelines and methodologies
2. Evaluation algorithms
3. A set of performance matrices for evaluation of innovative intersections and interchanges
4. Additional evaluation methodologies and performance matrices
5. Final report with all analyses, methodologies and recommendations

Relevance to Strategic Goals:
This project is closely related to the majority of strategic goals. Innovative intersection/interchange designs have already shown the potential in improving safety, although the methodologies for safety assessment and quantification are still needed. By improving traffic operations, these designs have the potential to reduce negative effects on environment and

improve the quality of life in nearby communities. This will also have effects on local economy, through impacts on traffic mobility and land use in the vicinity.

Educational Benefits:
Students will be involved in all aspects of this study, and it will provide a good course material for classes in geometric design, traffic operations, traffic safety, public transit and transportation planning. The students will perform main tasks in literature review, field data collection, methodology and algorithm development, which will provide them with a lot of theoretical and practical experience for their future career. The analysis will include a lot of analytical modeling, operations research and statistical tests, giving the students an opportunity to expand their knowledge in these fields.

Work Plan:
The work plan is divided in three phases, with each phase consisting of one or more tasks. The total duration of the project will be one year. The phases and tasks are as follows:

Phase I: Review of existing performance evaluation methodologies

Phase I will focus on reviewing exiting methodologies used by agencies to monitor and measure the performance of innovative designs, including all the aforementioned measures. The expected duration of Phase I is four months. It will consist of the following major tasks:

1. Literature review of implementations, designs and evaluations of innovative intersections and interchanges
2. Review of existing methodologies for performance and safety evaluation of these designs
3. Review of existing standards and guidelines (including, but not limited to AASHTO, HCM, MUTCD, NEMA, HSM, state DOTs design manuals) for guidelines and methodologies that could be implemented with innovative intersections and interchanges

Phase II: Development of evaluation methodologies and performance matrices

In Phase II the identified methodologies will be evaluated and improved for use by DOTs. Phase II will identify missing gaps in existing methodologies, and look into additional tools to fulfill these gaps. A set of algorithms for operational, safety, accessibility, transit, pedestrian, non-motorized traffic, land use, economic development, and environmental assessments of these designs will be developed. The expected duration of Phase II is four months. The major tasks of Phase II will be as follows:

1. Identify gaps in the existing guidelines and methodologies for evaluation of innovative designs
2. Identify potential methodologies that could fill in these gaps
3. Development of algorithms for operational, safety, accessibility, transit, pedestrian, non-motorized traffic, land use, economic development, and environmental assessments of these designs

4. Development and recommendations of performance matrices and additional evaluation methodologies for innovative intersections and interchanges that could be implemented in current and future DOT's projects

Phase III: Verification of methodologies, additional reviews and analysis and final report

Phase III efforts will focus on verifying the recommended methodologies on the selected implementations of innovative designs. Any needed reviews and additional analysis will be performed in this phase. All efforts from previous phases will be documented in a final report. The expected duration of Phase III is four months.

Project Cost:
Total Project Costs: $70,000
MPC Funds Requested: $35,000
Matching Funds: $35,000 Source of Matching Funds: Utah Department of Transportation

TRB Keywords:
Innovative/Alternative intersections, Continuous Flow Intersection (CFI), Diverging Diamond Interchange (DDI), Performance Matrices

References:

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2. *Innovative Intersections: Overview and Implementation Guidelines*. Wilbur Smiths Associates and HDR Thompson. Prepared for Community Planning Association of Southwest Idaho (COMPASS), April 2008.
3. *Innovative Intersection Safety Improvement Strategies and Management Practices: A Domestic Scan*. Federal Highway Administration, Report No. FHWA-SA-06-016, September 2006.