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A Multi-Objective Optimization Model to Minimize the Gap in Accessibility to Multi-Use Paths While Maximizing the Economic Efficiency of Active Transportation Investments for Fresno, California Project 1913 June 2020

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Researchers in this study examined the accessibility to multi-use paths in Fresno, California and developed an optimization modeling framework with two objectives that can be used to simultaneously maximize total accessibility to the paths and minimize the gap between low- and high-accessibility neighborhoods. The framework demonstrates how to accomplish these two objectives at the same time through optimal allocation of transportation investments in these neighborhoods, which aligns with the SB 1 Objective 4 that "everyone should share the same opportunities for learning, living, labor, and leisure".

Study Methods

1. Researchers calculated the accessibility to multiuse paths for Fresno, California that measured the total length of the paths (via walking and bicycling) a resident could reach within their own neighborhood with a 30-minute cycling ride.

- 2. The study uses a geographically weighted regression (GWR) model to capture the local relationships between accessibility to multi-use paths and previous transportation investments (walkway, bikeway, and primary and secondary roads), while controlling for other socioeconomic factors.
- 3. The marginal-effect analysis for the GWR results categorizes neighborhoods by indicating economically efficient, inefficient, and indifferent locations for further transportation investments.
- 4. Researchers embedded the GWR results into a multi-objective optimization modeling framework to improve accessibility to these multi-use paths all around the city while simultaneously addressing inequality in active-transportation accessibility.

Findings

1. The mapping of the calculated accessibility by cycling shows that North Fresno has better

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accessibility to multi-use paths.

- 2. The marginal-effect analysis for the GWR results indicates economically efficient, inefficient, and indifferent locations for further investments.
- 3. The multi-objective optimization model achieves the planning goal by improving accessibility for Southwest Fresno (low-accessibility neighborhoods) without impairing that in North Fresno (high-accessibility neighborhoods).
- 4. We consider that the proposed analytical approach in this project is an innovation because it is rare to make an active transportation plan from the perspective of science that combines GWR and multi-objective optimization models to achieve economic efficiency and address accessibility inequality.

The methodology of this multi-objective optimization modeling provides decision makers a new insight into the problem of making of an economically-efficient and socially-equal active transportation plan to foster public health.

Policy Recommendations

- 1. This study suggests to include the calculation of accessibility in active transportation planning. The calculated accessibility could point to the physical outcome of previous transportation investments that considers the existing transportation network and also accounts for the effects of connectivity.
- 2.A GWR modeling could be very useful in active transportation planning because the results would reveal efficient (significantly-positive), inefficient (significantly-negative), and indifferent (insignificant) locations for transportation investments.
- 3. It is sensible to allocate more investments in the efficient locations to increase accessibility. More interesting, the results also imply the need of the inefficient locations is not to allocate more walkways and bikeways, but to improve the first-last-mile connectivity to the core cycling network through all transportation means (i.e. sidewalks and on-road bike lanes).

4. A multi-objective optimization model can be used to find out the optimal locations for the future active transportation investments to achieve economically efficiency and reduce accessibility inequality. This is particularly useful when a city is on a tight budget.

About the Author

Chih-Hao Wang is an associate professor of the Department of Geography and City & Regional Planning at California State University, Fresno, where he has taught since 2014. He received his Ph.D. (2013) and Master (2010) degrees in City and Regional Planning from The Ohio State University. Dr. Wang's research focuses on environmental planning from the perspective of natural hazard mitigation. Another of his research interest is to apply spatial statistics to analyze spatial or social interactions in the earthquake process, water management, transportation planning, and community development. His research has been published in journals in areas of environmental planning, transportation, and geography.

To Learn More

For more details about the study, download the full report at transweb.sjsu.edu/research/1913



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