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Final Report

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Community Design and Transportation Safety

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Around the world, 1.2 million people are killed and approximately 50 million people are injured in road crashes. In the United States alone, the economic cost of road crashes and injuries exceeds $230.6 billion annually. Given the impact of road crashes on the economy and quality of life, it is surprising to note that the road fatality rate in terms of the number of fatalities per population and per miles traveled in the United States continues to fall further and further behind that of other comparable industrialized counties.

Less than 40 years ago, there were a dozen major countries with road fatality rates exceeding that of the United States. As of 2004, every single one of the 29 Organization for Economic Cooperation and Development (OECD) countries reporting statistics has a lower road fatality rate per population than the U.S., and ten of those countries have rates less than half the U.S. road fatality rate. One of those countries, the Netherlands, has brought their road fatality rate over the last 40 years from 25 fatalities per 100,000 population per year to under five, which is less than a third of the current U.S. fatality rate per 100,000 population.

There are a many possible reasons as to why the U.S. is lagging behind the rest of the world when it comes to road safety. One possible explanation that this research will focus on is that we often fail to pay enough attention to overall community design when it comes to safety. For instance, various researchers have shown that street widening projects, typically proposed in order to improve safety and relieve congestion, actually result in a reduction in safety. In this case, the focus has been too much on assessing how the changes affect individual street segments rather than how those changes might impact the community as a whole. A second example of failing to regard overall community is in how we often attempt to improve safety on residential streets by minimizing the opportunities for through traffic.

What is missing is the sense that limiting street connectivity in residential neighborhoods can impact safety elsewhere. Hence in this paper, we probe beyond the street, corridor, and neighborhood levels of analyses to determine how aspects of overall community design might affect road safety. More specifically, the goal is to find out more about how characteristics of the street network – in terms of features such as street connectivity, street network density, and street network patterns – are associated with road safety outcomes.

In this research we carry out a spatial analysis of 11 years of crash data in 24 medium-sized California cities. The cities were selected from an initial database of over 150 California cities to best represent a geographically diverse collection of 12 medium-sized cities with good safety records and 12 with poor safety records with respect to the number of road fatalities per capita in the transportation system. Street network measures were combined with street characteristics, socioeconomic data, traffic flow information, and over 230,000 individual crash records geo-coded in a Geographic Information System (GIS) database. The analysis was conducted at the U.S. Census Block Group level of geography for over 1000 distinctly populated Block Groups. Statistical negative binomial regression crash models were estimated for three response variables: total number of total crashes, severe injury crashes, and fatal crashes.

By characterizing the street networks of these cities and the representative street design characteristics, the goal is to capture the safety implications of different street network patterns and to account for the potential implications of the street design features while controlling for variables such as vehicle volumes, income levels, and proximity to limited access highways and the downtown area.

The goal of this study was to assess how street network characteristics affect road safety. Using a spatial GIS analysis together with a novel approach to classifying street network patterns, our research showed that both street network and street characteristics are significantly correlated with road safety outcomes. The basis for this analysis was over 230,000 individual crash records geo-coded in a GIS database in over 1000 census Block Groups in 24 California cities. In conducting this study, we controlled for variables such as street patterns, vehicle volumes, activity levels, income levels, and proximity to limited access highways and to the downtown area.

In general, areas with lower incomes or those that are adjacent to a limited access highway tended to have more crashes; also, being in closer proximity to the downtown area resulted in more total crashes but fewer fatal crashes. We found that street networks with high intersection densities correlate with fewer crashes across all severity levels. The lower crash rates on networks with higher intersection densities might be due to differences in travel patterns in denser, more urban environments. This is supported by the fact that neighborhoods with higher intersection densities also tended to have a lower percentage of people who chose to drive to work.

It is also worth noting that increasing intersection density from the average value to the highest value was associated with an expected 30% decrease in total crashes but with more than a 70% drop in fatal crashes. In other words, the effect of increased intersection density was much more pronounced for fatalities than for less severe injuries. This suggests that one factor at work might be lower vehicle speeds on the street networks with higher intersection densities.

Conversely, we found that increased street connectivity is significantly associated with an increase in crashes of all severities. The negative effect of the link to node ratio may be due to increased traffic conflicts associated with more connectivity. It is also important to keep in mind that highly connected street networks have the capacity to dissipate congestion from arterials, which allows cities to build arterials with fewer travel lanes and less travel on the Citywide street network and be associated with lower crash rates. Also, our previous research showed higher street connectivity (as well as intersection density) to be associated with more walking, biking, and transit use. So in trying to strike the right balance with the varying goals of a transportation system, it will be interesting to eventually determine how different levels of street connectivity for different modes will impact safety.

We found that street network characteristics played a major part in safety outcomes on the streets in our study. More specifically, the statistical crash models gave us two important results concerning the street network: first and foremost, increased street network density in the form of intersection density was correlated with fewer crashes across all severity levels; and secondly to a lesser extent, increased street connectivity in the form of the link to node ratio was associated with more crashes across all severity levels when all other factors are kept constant. However, it is important not to interpret these results in isolation since these two characteristics of the street network are also associated with other factors that impact safety. For instance, increased intersection density, increased street connectivity, as well as the type of street pattern are associated with much higher levels of walking, biking, and transit use. Overall, these results suggest that we must move beyond the narrow focus of just looking at the characteristics of the individual street and start to consider how street network measures interact with street design characteristics in terms of building a safer and more sustainable transportation system.