ABSTRACT

Sadri, Arif Mohaimin. Ph.D., Purdue University, December 2016. Social Network Influence on Ridesharing, Disaster Communications, and Community Interactions. Major Professor: Satish V. Ukkusuri.

The complex topology of real networks allows its actors to change their functional behavior. Network models provide better understanding of the evolutionary mechanisms being accountable for the growth of such networks by capturing the dynamics in the ways network agents interact and change their behavior. Considerable amount of research efforts is required for developing novel network modeling techniques to understand the structural properties such networks, reproducing similar properties based on empirical evidence, and designing such networks efficiently. Conceptual and methodological developments in network analysis have furthered our understanding of the effects of individuals' interpersonal environment on normative social influence and social engagement. Network data offers better insights related to an individual's abilities, aspirations, attitudes, behaviors, and interpersonal environment. Social influence occurs when an individual's emotions, opinions, or behaviors are affected by others in the social network and takes place in a multitude of varying disciplines such as conformity, socialization, peer pressure, obedience, leadership, persuasion, sales, and marketing.

The overarching goal of this thesis is to provide a holistic understanding of the level of social influence on ridesharing, disaster communications and community interactions by characterizing the impact and propensity of information exchange between network agents. This thesis develops novel techniques to explore how individuals are socially influenced, both on-line and off-line, while making shared-trips, communicating risk during extreme weather, and interacting in respective communities. *Chapter 2* provides a comprehensive summary of the network science literature and synthesizes studies

relevant to ridesharing, social capital, ego-centric network design, behavioral modeling of activity-based travel and evacuation decision-making, social media research in transportation science and disaster management. *Chapter 3* presents a zero-inflated Poisson model to predict the frequency of joint trips, using ego-centric social network data, for regular activity travel decisions. *Chapter 4* presents a multinomial logit model of travel mode choice and carpooling during special events such as game-day.

Chapter 5 presents a mixed-logit model to capture how social networks influence individual-level evacuation decision-making based on data obtained from Hurricane Sandy. *Chapter 6* develops a multilevel model of joint evacuation decision outcome at the dyadic (ego-alter social tie) level by using hierarchical generalized linear modeling approach. *Chapter 7* analyzes large-scale Twitter data (~52 M tweets, ~13 M users, Oct 14 -Nov 12, 2012) to identify subgraphs of Twitter that was active before, during, and after Sandy's landfall at different scales of user activity and important network properties (both local and global) were obtained to examine the relationship between network topology and user activity. It also explores the crisis communication patterns of Hurricane Sandy using advanced machine learning techniques.

Chapter 8 demonstrates how to construct social interaction networks from social media, presents the properties and growth of such networks along with important insights based on the theories of network science literature. *Chapter 9* presents a modeling framework to jointly infer communities and interests in social interaction networks. Several pattern inference models are developed: i) Interest pattern model (IPM) captures population level interaction topics, ii) User interest pattern model (UIPM) captures user specific interaction topics based on only words mentioned in the tweets, and iii) Community interest pattern model (CIPM) captures both community structures and user interests based on both words and users mentioned in the tweets.

The prevalence of social networks in recent times influences people's decision making in so many ways. Ride sharing is getting more popular and people are more likely to carpool with friends as compared to traditional modes of travel. Although ridesharing can yield in

effective matching of trips, it does not necessarily provide desirable end results. The knowledge of a better understanding in terms of how people share rides in a network setting would help policy makers and city planners in modifying existing urban transportation systems by introducing more ridesharing benefits to commuters and building more efficient ridesharing platforms that can result in a more sustainable transportation system.

Disaster communication networks play a salient role during emergencies since people may obtain weather information from traditional media such as radio or television and social media such as Facebook, Twitter, or the internet. Previous sociological studies suggest that social networks serve the purpose of transmitting warning message by disseminating information about an impending threat and individuals having more social connections can be expected to receive more warning information. However, the empirical literature is inconclusive about how warnings received from social connections weigh into evacuation decision making.

Online social media have also become an integral part of our social beings. Effective detection of user communities based on their social interactions and interests would allow traffic managers and emergency officials to efficiently disseminate travel-specific information to travelers/spectators and better conduct special events. The methodologies and findings presented in this thesis will benefit different stakeholders and practitioners to determine and implement targeted policies for various user groups in regular, special, and extreme events based on their social network characteristics, properties, activities, and interactions.