DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Planning/Policy/ Programming

Analysis of Comprehensive Multi-modal Shared Travel Systems with Transit, Rideshare, Carshare and Bikeshare Options

A comprehensive study that develops analysis and modeling methodologies as well as prototype mobile apps, for multi-modal shared travel systems in an urban area.

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Project Title:
Analysis of Comprehensive Multi-modal Shared Travel Systems with Transit, Rideshare, Carshare and Bikeshare Options

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WHAT IS THE NEED?

Rise in demand for transportation followed by limited capacities on the street networks has led to growing congestion in large cities like Los Angeles. In such cities, public transportation plays a significant role in alleviating congestion on the street network. However, the problem of transporting people to and from public transport stations, also known as the last-mile problem, remains an issue. Commuters who would have otherwise used public transportation choose to drive their vehicles due to the difficulty of access to public transportation stations. Introducing sustainable transportation alternatives to provide access to public transportation allows the reduction of the negative side-effects of congestion. The private sector that now plays an increasing role as a component of urban transportation via Transportation Network Companies (TNCs) and Mobility Service Providers (MSPs) can augment public transportation options with solutions that include shared use of transportation capacity.

WHAT WAS OUR GOAL?

A primary goal of the study is to develop insights on efficiencies to be gained through the use of various shared mode travels. Further goals are to develop a mobile application that can provide trip plans across multiple modes that include several options such as shared cars, rides, bikes, and bus/rail transit, and to understand user response through limited field surveys.

WHAT DID WE DO?

This research extends the previous project by integrating multiple shared mobility alternatives. In this study, bike sharing will also be integrated into the transit feeder system, along with P2P ridesharing, in an attempt to increase accessibility to transit stations and improve transit ridership. Biking has several advantages compared to normal vehicle usage: (i) it is not affected by the street traffic conditions, and (ii) while drivers' pre-specified schedules combined with the transit system's fixed routes and schedules constrain the potential for matches, the route and schedule of bikes are flexible, as long as bikes are available at stations. By guiding riders to walk some distances to the nearby bike stations and P2P ridesharing go-points and hence aggregating the demand (Stig et. al. 2015), the ride matching rate could increase.

WHAT WAS THE OUTCOME?

This project introduces schemes to study sustainable transportation alternatives that provide access to public transportation. We design a transit feeder system by matching a ride to P2P ridesharing, bike-sharing, walk, and transit. Green transportation modes in the system can be mutually beneficial in terms of improving ridership, saving cost and increasing mobility. Following our earlier study (Phase 1 research in 2015-16), we further proposed schemes to integrate multiple transportation modes and methods to increase ride-matching rates. The proposed system is tested in LA County. Target modes are metro red line subway rail in the Metro bike-sharing program in Downtown LA, walk, and P2P ridesharing. Geographical analysis for accessibility indicates that both P2P ridesharing and bike-sharing enlarge the catchment area of the red line stations. In the morning peak, bikes are more effective in Downtown LA because bikes are generally not affected by downtown street congestion.

The parametric study indicates that our system generally improves matching rates when we compare it to our earlier results on only the rideshare system being a feeder to transit (from Phase 1). The insights gained from our parametric study include the following: First, the matching rate is determined by the riders-to-drivers ratio. The rate increases sharply at first and then remains relatively stable when the number of drivers is more than two times that of riders. Besides, both P2P ridesharing and shared bikes are used as transit feeders by some riders. The usage would increase linearly when the availability of drivers and bikes increases. One limitation, which is also a future research topic, is that this study only included travel demand from vehicle demands. In other words, this study focused on the rideshare matching potential from vehicle demands, and not the total travel demand (vehicle and transit). In future research, transit demand data could be included to study the potential improvements and mode shift. In addition, we propose a heuristic search algorithm to resolve the bike-rebalancing problem. The case study result demonstrates the algorithm's practicality and effectiveness. The core of the algorithm evolved from two key concepts. The first is to view the element of the solution set as bike station pairs rather than individual stations, and the second is the parameter estimation and validation procedure using the concept of unsupervised learning. Dynamic bike rebalancing problem with uncertain demand is challenging using conventional programming based methods because routing, operation cost, dynamic demand, and specific number of bikes to pick up and drop off are highly intertwined. We proposed a ready-to-implement alternative to solve the rebalancing problem with high model interpretability and tractability. The proposed methodology was tested in our research area (Downtown LA). We are interested in extending the study to the upcoming scenarios where additional service vans are dispatched near the Port of Los Angeles, City of the Pasadena, and Venice. Integrating the LA Metro bike redistribution with that in the City of Santa Monica may also be beneficial for both cities and worth examining. Finally, a large component of the existing transit system , namely the bus system, needs to be incorporated into or studies to fully determine the full breadth of possibilities offered by the new shared-mobility alternatives in achieving green and sustainable transportation. This is expected to be a focus in our further research during the subsequent phase-III of the sequence of projects, in 2017-18.

WHAT IS THE BENEFIT?

The main components of such a comprehensive system are metro rail and bus lines, peer-to-peer ridesharing, bikesharing and carsharing. The multi-modal trip scheduling software developed in the past research will be utilized for this research, with enhancement to incorporate bus lines, and carshare systems. The framework is expected to be of critical importance for planning comprehensive future field implementation projects with multi-modal shared travel options.

As TNCs and MSPs are becoming a significant player in urban transportation and shared travel options are an important component of TNC/MSP operations, the algorithms and apps developed in this project will pave the way for larger field tests of comprehensive systems with public-private cooperation. The research may also help in developing modern schemes for transportation in the future when autonomous vehicles may provide further dimensions in shared travel options. The project will also help position the researchers and public and private transportation operators to consider developing comprehensive plans to utilize capacity-sharing to tide over significant changes in urban travel that may be caused by large events such as disasters or a possible Olympics in LA.