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Project Title:
Identifying Effective Travel Behavior Change Strategies for Poor Air Quality Events in Northern Utah

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Utah State University

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Research Needs:
Many parts of Utah, particularly areas along the Wasatch Front and in Cache Valley, experience episodes of poor air quality and are classified as nonattainment areas for some criteria pollutants by the Environmental Protection Agency (EPA). In the wintertime, temperature inversions trap pollutants against mountain ranges or within mountain valleys, leading to buildups of fine particulate matter (PM2.5) that exceed the National Ambient Air Quality Standards (NAAQS). For instance, an episode in January 2004 resulted in PM2.5 concentrations among the highest ever recorded in the United States (Malek et al., 2006; Silva et al., 2007). In the summertime, warm temperatures and sunlight combine with other air pollutants to yield high concentrations of ground level ozone. Long-term exposure to particulate matter and ozone has adverse public health impacts, including increased morbidity and mortality from negative effects to respiratory and cardiovascular systems. The large and growing population residing in nonattainment areas of Utah suggests that these poor air quality episodes are a public health issue.

Transportation is a major mobile source of emissions like nitrogen oxides (NOx) and volatile organic compounds (VOC) that contribute to the formation of PM2.5 and ground level ozone. Therefore, a potential technique for mitigating the adverse impact of poor air quality episodes is to reduce levels of driving before and during such events. Current travel behavior change strategies, such as the TravelWise program (UDOT, 2017) organized by the Utah Department of Transportation (UDOT), provide information about options for reduced driving—such as riding

public transit, walking or bicycling, and teleworking—and facilitate carpool matching. These voluntary programs encourage travelers to change their behavior, but the effectiveness of their strategies appears to be limited, based on two prior studies (Teague et al., 2015; Tribby et al., 2013). However, these two studies used aggregate data on traffic volumes and air pollution concentrations, which are unable to examine effects at a disaggregate personal level, where strategies are targeted. In order to design more effective interventions and techniques for improving air quality, more research focused on individual motivators, constraints, and behaviors is needed to examine the reasons behind the transportation impacts (or lack thereof) of such strategies.

Travel demand management (TDM) strategies, which focus on the demand side of transportation, may be a useful source of techniques for reducing driving (Meyer, 2016). Encouragement or "carrot" strategies that provide information about or tools to facilitate walking, bicycling, riding public transit, carpooling, flextime, and telecommuting may be particularly applicable to Utah's poor air quality events. Initiatives that provide a financial incentive or individualized marketing could also be appropriate. On the other hand, "stick"-based strategies, such as variable road pricing or prohibiting car use on certain days, appear to be most effective at reducing driving but are likely politically or practically infeasible (Gärling & Schuitema, 2007). Other longer-term TDM strategies that involve constructing non-auto infrastructure or managing land uses are not relevant for this study.

Health psychology offers alternative perspectives for designing travel behavior change strategies. For example, the Normative Decision-Making Model (Klöckner, & Matthies, 2004) and the Transtheoretical Model (Prochaska & Velicer, 1997) describe behavior change as a process, moving from consideration to preparation to action. Many aspects may be necessary to generate a behavior change, not simply information to create an awareness of the need and potential actions, but also perceived ability and control, social and institutional support, mitigation of behavioral constraints, and mental or monetary rewards. These and other frameworks may be useful guides when creating effective strategies for modifying travel behaviors during adverse air quality episodes in Northern Utah.

Research Objectives:

1. Identify travel demand management and behavior change strategies that may be promising for encouraging reductions in driving during poor air quality events.
2. Assess the effectiveness of these strategies using real-world self-reported travel behavior data.

In summary, this research project intends to first identify various informational, encouragement, enticement, and other travel demand management strategies intended to result in voluntary travel behavior modifications (towards reduced driving) during poor air quality events in Northern Utah. Second, this research project will measure and evaluate the effectiveness of these strategies by statistically analyzing data collected from a series of travel behavior questionnaires. The researchers hypothesize that information-only strategies may not be very effective; instead, techniques that involve social norms, gamification, and/or monetary rewards may be more promising at yielding voluntary reductions in driving on poor air quality days.

Research Methods:

To accomplish these objectives, the following tasks will be undertaken:

1. Review literature on behavior change and travel demand management strategies. Several databases, including TRID and Google Scholar, will be queried using relevant search terms.
2. Based on the literature review, identify a suite of behavior change strategies that may be well-suited for implementation during poor air quality events. Strategies will be assessed according to their applicability to personal transportation, their ability to be deployed rapidly, and their relevance for local and seasonal conditions. Selected strategies may include (but are not limited to) the following:
    a. Providing information about transportation's impacts on air quality;
    b. Suggesting reduced driving options like walking, bicycling, riding transit, carpooling, telecommuting, less idling, and others;
    c. Social encouragement strategies that involve reaching out to or competing with friends and neighbors; and/or
    d. Offering small financial incentives ($1-5) for reducing driving.
3. Design survey instruments (questionnaires) to measure respondent characteristics, attitudes, perceptions, and self-reported travel patterns before, during, and after the deployment of strategies. Both paper and electronic surveys may be designed; surveys may need to be translated into a second language (Spanish). The research protocol (including the questionnaires) will be reviewed by USU's Institutional Review Board (IRB).
4. Recruit participants throughout Northern Utah. Potential participants will be recruited through a paper invitation mailed to a random sample of residential addresses in the study area. The invitation will include information about the study, a consent form, and instructions for how to sign up to participate. A small financial incentive (~$10) will be offered to participants if they complete all rounds of the surveys. Around 500-600 participants are desired.
5. Collect "before" data from participants using a (paper or online) questionnaire survey. This information will include sociodemographic characteristics and information about typical personal travel patterns, among other topics. Once this information is received, participants will be randomly assigned to control or (one or more) treatment groups.
6. Immediately prior to or during a poor air quality event, deploy strategies to treatment group(s). Depending on the strategy, informational materials or incentives may be (e)mailed to applicable participants. Air quality forecasts will be monitored, and strategies will be ready to be deployed within a day or two. This task may be combined with the following task.
7. During or immediately after a poor air quality event, collect "during" data from participants using a questionnaire. This information will include travel patterns during the poor air quality day(s), any travel behavior changes from a normal week, and reasons for making those changes. The intent is to measure short-term travel behavior changes resulting from the treatment strategies.
8. Collect "after" data from participants using a questionnaire, at least one month later. This information will include recent travel patterns as well as attitudes and perceptions. The intent is to measure longer-term travel behavior changes.

9. Process data and analyze travel behavior impacts and potential associated factors using longitudinal statistical analyses. Short-term travel behavior changes will be assessed using the difference between the "before" and "during" surveys, while analysis of long-term changes will also utilize the "after" survey. Using regression analysis, individual and group differences will be explained by the treatment strategies, while controlling for other personal characteristics.
10. Write report and prepare presentation(s) and paper(s) describing the project, its results, and key findings.

The researchers have experience in designing, managing, and analyzing data from travel behavior surveys such as those that will be used in this study.

Expected Outcomes:
This project is expected to generate findings regarding the effectiveness of some strategies for managing travel demand during poor air quality events. It is also intended to serve as a demonstration of the efficacy of measuring short-term travel behavior change through multiple surveys. The survey instruments and research methods developed could be implemented on a larger scale in future research to improve estimates of the effectiveness of various strategies. Finally, the strategies that are developed could be used as a starting point for government agencies to enhance travel demand management programs like TravelWise.

Relevance to Strategic Goals:
- Environmental Sustainability

This project is most directly related to the USDOT's strategic goal of Environmental Sustainability. Reducing the transportation system's contributions to poor air quality is an important component of this goal. The project also indirectly contributes to the goals of Economic Competitiveness and Livable Communities. Healthy communities without significant air pollution are more attractive places to live and do business.

Educational Benefits:
One student will be involved in this project as a graduate research assistant. This student will gain general project management and communication skills, as well as discipline-specific skills such as transportation survey design and transportation data analysis. The design of the survey instruments may be incorporated into transportation planning and other courses taught by the PIs.

Tech Transfer:
The findings of this research project will be disseminated in several ways. In addition to the project report, findings will be presented at local and national conferences such as the Transportation Research Board's Annual Meeting and UDOT's Annual Conference. Furthermore, at least one journal article will be prepared and submitted for publication. Finally, products (like the strategies and surveys) will be shared with relevant and interested local and state government agencies, including Cache MPO and UDOT.

Work Plan:
1. Review literature, identify strategies (2 months)

2. Develop survey instruments, obtain IRB approval (2 months)
3. Recruit participants, collect pre-test data (1 month)
4. Deploy strategies, collect during-test data (1 month)
5. Contact participants, collect post-test data (1 month)
6. Process and analyze data (3 months)
7. Compile report, presentation(s), and paper(s) (2 months)

The research will be carried out over a period of 12 months, according to the schedule included in the above Work Plan. After reviewing literature and identifying potential strategies, a questionnaire will be developed and IRB approval will be obtained (total 4 months). Next, data collection will proceed over the course of 3 months, including recruiting and surveying participants, deploying strategies and another survey, and collecting post-test data. The remaining 5 months will be spend conducting data analyses and preparing project reports, presentations, and papers. For more information on each step in the work plan, see details in the Research Methods section.

Project Cost:

Total Project Costs:	$119,471.50
MPC Funds Requested:	$59,733.75
Matching Funds:	$59,735.75
Source of Matching Funds:	Faculty salary

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