

Exhibit D – Research Project Requirement Template

Measuring the Motivators of Home Delivery Decisions

Recipient/Grant (Contract) Number: The University of Texas at Austin/Grant # 69A3552344815 and 69A3552348320

Center Name: National Center for Understanding Future Travel Behavior and Demand (TBD)

Research Priority: Improving Mobility of People and Goods

Principal Investigator(s): Alison Conway

Project Partners: The City College of New York

Research Project Funding: \$191,516

Project Start and End Date: 6/1/26 - 5/31/27

Project Description: Over the last decade, many shoppers in the U.S. and around the world have quickly become reliant on home-based deliveries of household and retail goods. While growth in e-commerce is easily demonstrated from retail sales records, relevant activity trade-offs and resulting impacts on passenger and freight travel activity remain less well-understood. Some home deliveries are made out of necessity, while others are discretionary. Some deliveries replace in-store shopping, while others are supplementary to in-person shopping activities. Due to the proprietary nature of last-mile freight data and retail sales records, and the use of a wide variety of last-mile delivery strategies using vehicle types ranging from trucks to handcarts, directly measuring home-delivery related transportation activities is extremely challenging.

Household surveys are the only data source available to public agencies to comprehensively characterize household-based delivery demands; however, these typically only include a few questions about delivery frequencies, only sometimes differentiating deliveries by type (e.g. parcels vs. food). Numerous recent research studies have sought to utilize household survey data to study home delivery trends and identify activity trade-offs (e.g. grocery store visits vs. grocery deliveries). These studies typically model delivery choices and frequencies as a function of demographic, household, built-environment, and personal travel-related variables; however, for many of these predictor variables, studies have produced inconsistent results across geographies and delivery types. This inconsistency likely results because these models do not directly account for the underlying motivators of or barriers to the use of home deliveries (Figure 1), relying instead on demographic and household characteristics as proxies. These studies have also produced limited actionable information to directly inform transportation interventions, whether to improve household access to goods or to mitigate the impacts of delivery activity growth. This study aims to address these two limitations.

This study leverages a novel national survey, the second wave of the Transportation Heartbeat of America Survey, that simultaneously captures: 1) motivations for specific types of online purchases and/or reasons for not purchasing goods online; 2) household delivery frequencies

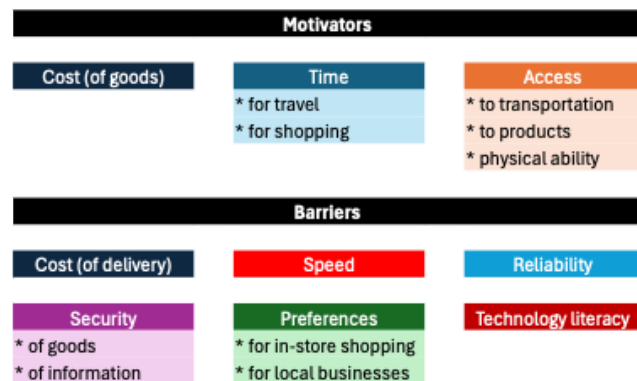


Figure 1. Motivators of/Barriers to Home Delivery

by type (carrier-delivered parcels, crowdsourced packages, prepared food, and groceries); 3) personal travel behaviors; and 4) individual and household characteristics. In this study, we will directly investigate the underlying motivators for home delivery, and the barriers to home delivery, that influence Americans' home delivery choices. First, leveraging location-specific survey responses, we will conduct descriptive and spatial analysis of results to identify relevant trends. Next, we will apply exploratory factor analysis (EFA) to identify latent motivation dimensions (e.g., time constraints, cost sensitivity, accessibility limitations) and latent class analysis (LCA) to identify distinct behavioral segments based on stated delivery motivations. Third, we will estimate and compare delivery frequency models, including ordered probit models, zero-inflated negative binomial models, hybrid choice models, or integrated choice and latent variable models, with model selection guided by Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and likelihood ratio tests. By comparing model performance with and without new motivational variables, this study will test whether controlling for stated motivations improves model fitness and reduces inconsistencies observed in prior work. Based on the finding of this analysis, we will develop recommendations for better capturing relevant predictor variables in future household surveys.

In addition, we will map critical motivator and barrier variables to potential interventions to either improve household access to goods or to manage delivery-related traffic and externality impacts. Examples of interventions might include: educational interventions to overcome technology barriers; delivery service or technology solutions (e.g. autonomous delivery robots, drones) to address transportation access barriers, particularly for seniors, individuals with disabilities, and rural households with limited mobility; alternative delivery solutions (e.g. lockers) to address security barriers; incentive-based delivery consolidation programs to reduce individual delivery trips generated by high-frequency users; and co-location of delivery infrastructure with other types of household activities.

US DOT Priorities: This project is expected to provide breakthrough insights regarding the behavioral drivers of home-delivery activity demands. The project will enable improved measurement of home-delivery activities by local and regional agencies, with aim to better inform relevant system interventions - such as those detailed in the preceding section - to ensure goods access and mitigate delivery externalities. The project contributes to the US DOT priorities of transformation and safety by helping to align transportation system capacities and services with evolving home-delivery demands, reducing the likelihood of traffic and parking conflicts resulting from misalignment, and helping to identify needed system improvements to ensure adequate access to essential household goods.

Outputs: In addition to a *final project report* and related *academic journal publications* and *conference presentations*, this study will produce two key outputs. First, we will produce a *primer* for public agencies on measuring and modeling home-based deliveries. This primer will focus on four topics: 1) who (e.g. seniors, rural residents, household with children) in the U.S. is choosing to use (or not use) home delivery for specific types of goods, and their motivations for doing so; 2) approaches to modeling home delivery frequencies, types of predictor variables, and the relevance of these predictor variables for characterizing and modeling delivery activities; 3) guidance on survey instrument design for capturing delivery-relevant behavioral data; and 4) potential interventions to address specific goods access barriers and mitigate growing home-delivery activity. *Code packages* to execute the final models will also be shared publicly through a GitHub repository.

Outcomes/Impacts: As detailed above, the goals of this project are 1) to provide insights on the motivating factors that drive home delivery decisions, 2) to assist local and regional agencies to collect relevant data to adequately quantify home delivery activity, and 3) to assist agencies in translating results into actionable interventions to address goods access challenges and delivery-related traffic externalities. Result will help inform the design of transportation infrastructure and services that support safe, secure, efficient, and reliable deliveries of goods to varied households in all geographic contexts.

Final Research Report: A URL link to the final report will be provided upon completion of the project.