Exhibit D – Research Project Requirement Template

Estimating Point of Interests (POI) Visit Demand using Location-Based Services (LBS) Data and Large-Language Models (LLMs)

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): Lyra Chen, Cynthia Chen

Project Partners: N/A

Research Project Funding: $90,000

Project Start and End Date: 6/1/2025 - 5/31/2026

Project Description:

Estimating demands to points of interests (POI) involves predicting the number of visitors to specific locations, such as restaurants, retail stores, parks, or cultural sites like museums. Unlike traditional travel demand models, which focus on large zones (e.g., Transportation Analysis Zones (TAZ) or census tracts) for long-term planning such as transit network, POI visits estimation targets individual sites that are at a much smaller spatial scale and this granularity is critical for short-term decisions: local Departments of Transportation (DOTs) need to assess how traffic and pedestrian patterns change after reconfiguration of a street segment or a newly constructed pedestrian plaza, while businesses rely on visitor forecasts to optimize staffing, inventory, and site selection. Technology has produced a large quantity of Location-Based Services (LBS) data from GPS traces and mobile app check-ins, allowing us to do precision analysis of POIs across time and space. Even so, we have some challenges to deal with. One is spatial accuracy, which critically limits predictive reliability and the practical value of LBS-driven insights. While some studies acknowledge and quantify positional errors using approaches such as kernel density smoothing or buffering, they are often applied uniformly and may not adequately account for the varied POI spatial contexts and land use patterns in urban settings.

The proposed research will tackle this limitation by developing uncertainty-aware models to estimate demand for POIs. More specifically, the research will incorporate recent advances in Large Language Models (LLMs) into the new estimates. The study will answer these queries:

1) How can spatial uncertainty in LBS data be effectively modeled and mitigated using probabilistic, machine learning, or AI-based methods to improve POI demand estimation?
2) What performance metrics are most appropriate and practically useful for evaluating the accuracy of POI demand estimation models?
3) What factors influence the accuracy and robustness of LLM-based POI demand models, and how do these predictions vary across different land use types, POI categories, and urban contexts?
4) What level of predictive accuracy is required for different transportation planning and policy applications, and to what extent do LLM-enhanced models meet these requirements?

This research aims to develop integrated modeling frameworks that combine LBS data, POI metadata (e.g., from OpenStreetMap or SafeGraph), and contextual information (e.g., land use, weather) to estimate POI visit demand. The research will involve LLMs (like GPT-3 or open-source models) in two main jobs: 1)

Semantic disambiguation of LBS pings in dense or overlapping POI areas, by using reasons to figure out which POI a certain ping is most likely to be about, considering the various dimensions of the situation. 2) Performance evaluation and error analysis of the LLM-based approaches, by trying to understand factors under which these approaches do and don't work. The effectiveness of these models will be validated using ground truth data (manual visit counts, ticket sales, or sensor data) collected in contrasting urban environments, to help test model generalizability across different spatial structures and POI distributions.

US DOT Priorities:

Section left blank until USDOT's new priorities and RD&T strategic goals are available in Spring 2026.

Outputs:

This research project is expected to generate new methods for estimating POI visit demand using spatially uncertain Location-Based Services (LBS) data enhanced by Large Language Models (LLMs). The key outputs include scholarly papers documenting the models, the evaluation metrics and analysis tools for assessing the performance of LLM-based models, and potentially an open-source toolkit to support academic and municipal users interested in applying LLMs to geospatial demand modeling.

Outcomes/Impacts:

These outputs can influence transportation system operations and policy in the following ways:

- Improved demand estimates can help city planners and transit agencies optimize route planning, site selection, and service coverage, and make better investment decisions and reduce necessary costs.
- The project outcome may improve operational safety and emergency preparedness by enhancing crowd forecasting and event management, allowing for safer operations during high-demand times and emergencies.
- The LLM-enhanced model offers fine-grained and dynamic demand modeling methodology, which could be adopted by Transportation departments and MPOs as part of their regular modeling toolkits.

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