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Development of a Time-Dependent Hurricane Evacuation Model for the New Orleans Area

INTRODUCTION

When hurricanes threaten coastal cities, the most effective strategy to mitigate mortality is to evacuate the population at risk. However, public officials face several transportation challenges when managing evacuations from a large city like New Orleans. As a result, they seek the help of transportation officials to implement a safe and efficient evacuation. In response, transportation officials evaluate several alternative evacuation policies—for example, phased evacuation, initiation of contraflow, and evacuation of carless people using transit. The evaluation of alternative evacuation policies requires statistical evacuation behavioral models that are responsive to various factors that influence evacuation behavior. The current post-event revealed preference data collection methodology is incapable of collecting detailed time-dependent behavioral data that is required for the development of statistical behavior models capable of evaluating alternative evacuation policies.

The research conducted in this study sought to develop a new data collection methodology that is capable of collecting time-dependent evacuation behavior data that can be used to develop statistical evacuation behavior models. The method developed in this research is innovative and unique in that it is capable of collecting evacuation behavior data using audio-visual stated choice scenarios and, as such, the method can be used to collect data without an event actually occurring.

OBJECTIVE

The goal of the research was to develop and test a new data collection method capable of collecting time-dependent evacuation behavior data. To accomplish this goal, the following objectives were established:

- Design a time-dependent, audio-visually based stated choice questionnaire.
- Design a conventional static revealed preference self-administered questionnaire to be administered jointly with the time-dependent, audio-visually based stated choice questionnaire.
- Monitor the time and cost of each survey separately.
- Enhance the revealed preference data with time-dependent storm data from official sources.
- Estimate two time-dependent sequential logit models (TDSLM) of evacuation demand—one on the enhanced revealed preference data and the other on joint data formed by combining the enhanced revealed preference data and time-dependent stated choice data.
- Apply each model to conditions reflecting Hurricane Georges.

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- Compare each model's prediction of time-dependent evacuation demand with the reported values from the post-Georges survey conducted by the University of New Orleans Survey Research Center in November 1998.
- Specify and derive a time-dependent nested logit model (TDNLM) that relaxes the restrictive assumptions imposed by the TDSLM model.
- Estimate a TDNLM using Hurricane Gustav data and compare the models prediction with the prediction from the TDSLM on the same data.
- Compare the cost and predictive performance of each survey method.

SCOPE

The research is restricted to the development and evaluation of a new method to collect hurricane evacuation behavior. As such, it is a proof-of-concept study to determine the effectiveness and relative cost of collecting data using the new method in contrast to the conventional method of post-event revealed preference data collection. The method was tested using data collected in the New Orleans metropolitan area, and resulted in completed surveys from a relatively small sample of 300 households. The results of the study are not necessarily generalizable and the results of the comparison of revealed preference data with that from stated choice are restricted to evacuation behavior during Hurricane Gustav.

METHODOLOGY

The research conducted in this study involved a literature review, development of a new survey instrument, administration of a mail-out, mail-back survey to test the new survey instrument, comparison of evacuation behavior data collected from the new and old method, estimation of two statistical evacuation behavior models, and finally, cost comparison of the old and new data collection methodology.

To test the new data collection methodology, a survey was conducted in New Orleans and the surrounding nine parishes to collect data from approximately 300 households. Along with the stated choice data, revealed preference data on Hurricane Gustav was also collected. Assessment of the new data collection procedure was limited to comparison of the relative cost of data collection, with each procedure and the performance of the data in producing evacuation demand models that reproduce observed behavior.

Two statistical evacuation behavioral models were developed. One model was estimated using the data collected from revealed preference data and the second model was estimated using the combined data formed by combining the two data sets-data collected using the revealed preference questionnaire and data collected using the stated choice questionnaire.

Finally, the costs and predictive performance of two data collection methodologies were compared.

CONCLUSIONS AND RECOMMENDATIONS

The results showed that the new stated-choice method of data collection developed in this research is easy to use and effective in collecting time-dependent and policy sensitive evacuation behavior data, but costs 25 percent more than the traditional method. A slight improvement in model performance was observed with use of the stated choice data. The major recommendation coming out of this research is to refine the newly developed method using a total immersive virtual environment to make stated choice scenarios look more realistic in nature.