

FRAMEWORK FOR MODELING EMERGENCY EVACUATION

PROBLEM STATEMENT

Emergency situations can require a regional ability to move large numbers of people in a safe and timely manner. A region's evacuation strategy encompasses a variety of areas and needs, many of which are interdependent and interrelated. The evacuation of a region involves a number of inputs, controls, and assumptions. These factors are particularly important when developing a computer simulation program to model evacuation; they affect the initial and the operating conditions of the simulation, which directly affect the model outputs

OBJECTIVES

The main objective of this project is to examine the policies, procedures, and components that affect and are affected by emergency evacuation events. Researchers will study the relationships between a number of identifiable components that make up emergency evacuation and how they can be integrated into a framework for modeling emergency evacuation. The proposed tasks for this study include the following:

1. Perform a literature review.
2. Identify available transportation evacuation models that are in the public domain and proprietary.
3. Formulate a framework for emergency evacuation.
4. Test the proposed framework on a selected site in the Central Florida region.

FINDINGS AND CONCLUSIONS

Researchers investigated the relationships between a number of identifiable components that make up emergency evacuation and how they can be integrated into a framework for modeling hurricane events. Researchers conducted a thorough review of the literature and found that the available evacuation-specific computer simulation models on the market are proprietary and that the developers are reluctant to release these models for investigation. Researchers also found that generic micro-simulation traffic models are designed to simulate current conditions on existing roads and they have no inherent capabilities to estimate network clearance time. Furthermore, all emergency evacuation models adopt a loading curve for the transportation network that resembles an "S" curve. This curve reflects low departure rates at the initiation and conclusion of an evacuation departure window, with the majority of departures occurring in the middle portions of the window. The corresponding cumulative departure curve resembles an "S" in shape. Published studies on human behavior lacked the data to support the assumption that there is an "S" curve, and it appears that there is a need to further study the subject.

A framework for emergency evacuation was developed and tested on a selected site in the Central Florida region (Ormond Beach). The evacuation traffic simulation component of this framework was tested utilizing the INTEGRATION traffic modeling software. The results of simulation runs using three different loading curves confirm the findings of previous research. These loading curves represent different evacuation departure rates, ranging from a steep "S" curve to a linear curve. As expected, the best loading curve is the linear case. For this case, the overall network average clearance time was 14.6 hours. The steep loading curve resulted in overall network average clearance time of

18.2 hours. The standard loading curve has produced clearance times that fell between the linear and steep cases showing an overall network average clearance time of 17.1 hours. This shows that evacuation time is directly related to the assumed underlying loading curve, and provides best- and worst-case clearance time estimates. Each of these loading curve assumptions results in clearance times that extend beyond the 12 hour evacuation window.

INTEGRATION output was used as the baseline for assessing the ARENA model. A comparison of the two model outputs clearly showed that there are statistically significant differences for the tested network. In this project, model implementation for ARENA led to less reliable results than implementation of the INTEGRATION model. These implementation techniques include the logic that ARENA uses in moving entities through the network (constant speed belt movements), the origin-destination coding procedure, the simplified turning movement and signal timing assumptions, and the lack of car following and lane changing interaction logic. It is safe to say that the INTEGRATION model has produced reasonable results and the developed framework can be expanded and applied to larger urban areas.

BENEFITS

This research resulted in the development of a framework for emergency evacuation and demonstrated the value of a tool, INTEGRATION, that will aid analysts to estimate emergency evacuation times for given networks. While it is not a decision support system, the tested model will provide valuable information towards the improvement of managing evacuation efforts.

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