ABSTRACT

FREIGHT AND WEATHER DECISION SUPPORT SYSTEM

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During inclement weather, studies show that financial loss to the trucking industry associated with delay is over $9 billion dollars annually (FHWA, 2012). There is additional loss due to crashes associated with inclement weather including nearly 4000 fatalities and 104,000 injuries in 2012 (NHTSA, 2012). Inclement weather can include snow, rain/thunderstorms, wind, ice, visibility issues and many others. With the advancement of automated vehicles, if several trucks are connected in travel (i.e. convoyed) and one makes a particular decision during inclement weather of whether to stop or continue on through the weather event, this impacts all of the vehicles that are connected.

Decisions during inclement weather are typically made by the individual driver. There are many aspects of bias that go into a naturalistic decision including length of time driving trucks and past experiences. There is not currently a method to assist truck drivers with that decision. Decision support systems (DSS) have been used in many areas such as winter maintenance and for IFF (Identify Friend or Foe) by the Department of Defense. There are many types of DSS in use today. A Bayesian Belief Network (BBN) can be used as a DSS and can assign a probability of delay or crash based on empirical data. The BBN uses a graphical representation of a probability dependency model. By using existing data of delay and crash the BBN assigns a probability of delay or crash for a given trip that can then be compared to the naturalistic decision for that trip. Because the DSS is evidence based, it provides more robust decision making and may thus increase safety and decrease delays, potentially saving billions.

This research explores the difficulties associated with inclement weather for vehicles, in particular tractor trailer trucks. By using a Bayesian Belief Network (BBN), weather data (snow,

ice, wind, rain/thunderstorms and visibility) and probability for specific aspects of the weather event are input into the network based on previous studies and empirical data. Truck scenario delivery routes are used to assign dependent probabilities or so called risk of delay or crashes. These risks are assigned a decision using an index that incorporates the geometric mean of the probabilities. A survey of trucking firms was done to determine if assumptions within the model were accurate, by examining the decision of the truck driver in storm scenarios. The survey also examined how drivers would react if they were given the level of risk associated with inclement weather, and in particular sought to determine how much risk it would take for them to stop.

The results show that the BBN is successful at predicting risk of delay and crash. From that, an index was created to assign a decision based on those outputs from the model. The survey confirms the assumptions made in the model and that if truck drivers are provided a level of risk, their decisions are more conservative than using their own experiences. Quantifying the collective risk associated with inclement weather and providing an optimized decision has not been done in the past. The research does this and provides a more robust decision using a data driven process.

With the advancement of connected vehicle technology and automated vehicles, this freight and weather decision support system (FWDSS) becomes a critical tool in trip decision making of freight vehicles. In the example of a convoy of trucks, the decision of one truck then affects the rest in the convoy. Using FWDSS can apply a value added decision to all the trucks and reduce delay and crash during inclement weather events increasing safety and mobility as we move to automated vehicles.