Comparing the Effects of Integrated and Nomadic Navigation Systems on Road Traffic Safety: Methodology.

Lucas Johnston (student number: 10564888)

Information Studies, University of Amsterdam, Instructor: Dr. Frank Nack

Version: 0.1 (draft), Date: 15 April 2023

METHODOLOGY

The data collection and analysis consisted two main phases, first a requirements elicitation and the second an experiment.

Ethical considerations: To minimize risks to the participants, researcher and other traffic, the researcher has explicitly requested compliance with traffic laws at all times during driving sessions, and to always put safety first when making decisions while driving.

3.1 Requirements elicitation

Specific indicators of road safety relevant to the use of navigation systems were identified through a comprehensive requirements elicitation process involving surveys, expert interviews, and field observations. By a triangulated approach data was collected about behavior while navigation assisted driving, as well as variables or contextual factors that may influence the relation between distractions and driving performance.

Survey: An online survey was held among 100 anonymous car navigation system users (minimal 25 nomadic, 25 integrated) to observe the behavior around navigation assisted driving. The study aimed to collect a sample which would come as close as possible to a cross section of all car drivers in the Netherlands, given limited resources and time. Respondents were partly recruited by distribution of flyers via fueling stations across the country, partly by recruitment from within the network of the researcher. The respondents provided basic demographic data, and answered questions concerning: (1) their use or of navigation systems while driving (e.g. how, what for, preferences, frequency), (2) how they may or may not have found they were distracted by navigation systems, (3) how have they found those distractions to impact their driving performance, (4) how distractions may be linked to navigation user interface. The resulting raw qualitative data was the main source of indicators such as events, distractors and their perceived effects on safety.

Expert interviews: To the survey results were added the insights of a traffic safety researcher to provide context to the survey results to add to, weigh and rank indicators identified from the survey results. The interviewee is a scientist linked to the Institute for Road Safety Research (SWOV), experienced in analysing naturalistic driving data, more specifically with regards to distraction in traffic.

The interview was conducted using a semi-structured format with a pre-determined list of topics to guide the discussion. The interview topics concern: (A) what the expert observes in driving behavior and traffic incidents that is linked to information system use while driving, (B) what differences the expert may or may not observe between use of integrated and nomadic information systems regarding driving behavior and incidents, (C) what the experts say should be done in terms of information system design or regulation to improve traffic safety, with regard to navigation systems. After transcription, a summary was made which was sent to the interviewee for review, to mitigate the risk of recall errors.

Observations: A sample of four car drivers was drawn: two persons who prefer a smartphone, two persons who prefer an integrated navigation system. Sessions are held in which the driver and a researcher drive for sixty minutes by navigation over any trajectory that was convenient. The researcher observes the participant's device and the behavior of the driver, while making notes. The purpose is to cross reference the observations with the topics found earlier.

The data collected from the survey, expert interviews, and field observations were analyzed to identify potential indicators of road traffic safety and navigation-assisted driving behavior. After each data collection step, qualitative results were edited and then coded, processed into a code book and content analysis took place. After finishing the three data collection steps, a combined content analysis took place and a narrative form analysis was written. Furthermore, based on a process of exclusion and ranking, the most important road safety indicators were selected for further experimental study.

Exclusion: Several factors restricted the feasibility of testing certain indicators, including availability of resources, ethical concerns related to unacceptable risks in road traffic, and personal aspects that are too subjective and difficult to quantify. Based on such factors, certain indicators were excluded from further experimental study.

Ranking: The importance of each indicator on road safety was assessed using a weighted scoring system that takes into account both the severity and prevalence of the safety risk. The survey data was the most important source for determining the prevalence of safety risks, while severity was mostly determined by the outcome from the expert interviews.

3.2 Experiment

To answer question number four as stated in the introduction, a naturalistic experiment was conducted. 40 participants were recruited by the same method as the previous survey, of which 20 commonly use smartphone navigation, and 20 commonly use integrated navigation. Each participant drove a predetermined route while following navigation instructions. Road safety indicators were measured through methods such as GPS logging. Ideally, to increase reliability of the results, multiple methods were used concurrently. It was hypothesized that the integrated navigation system group will show better road safety indicators compared to the smartphone navigation system group. If the results would confirm the hypothesis, it would provide grounds for future empirical study into how nomadic navigation systems may be improved. The collected data was analyzed using statistical techniques, including descriptive statistics, t-test, and regression analysis, to compare the road safety indicators between the two groups. The statistical significance level will be set at $p < 0.05$.

H0: There is no significant difference in road safety indicators between using a smartphone navigation system and an integrated navigation system in a car.

The independent variable in this study is whether participants use a smartphone navigation system (A) or an integrated navigation system (B). The dependent variable is a specific road safety indicator or set of indicators that were identified through the requirements elicitation process. It is important to note that while distraction is a possible mediating variable in the relationship between navigation system type and road safety, it is outside the scope of this study to measure distraction directly.

The lack of control over variables in this naturalistic study posed risks to both validity and reliability. These risks include bias through confounding variables and the presence of uncontrollable external factors.