

# Opposition report

Title

The effect of ambient lighting combined with Emergency Vehicle Approaching warning on driver reaction.

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## Summary

Emergency vehicles, including police, ambulance, and fire department vehicles, aim to reach accident sites quickly and safely, often exempted from regular traffic rules. However, these exemptions can contribute to stress for both emergency vehicle drivers and other road users, potentially leading to accidents. Despite warning systems like sirens and lights, distractions and unexpected maneuvers can still pose risks, especially in urban areas. To prevent such events/situations a warning message can be sent to the passenger car so they can prepare themselves, which will lead to safer and better reactions.

This thesis aimed to examine the impact of utilizing the Emergency Vehicle Approaching (EVA) warning message, as well as the EVA warning message enhanced with ambient lighting, on the behavior of drivers operating passenger cars. To fulfill the aim of the thesis three questions are presented. Can ambient lighting, combined with EVA warning, help drivers react faster and safer when an emergency vehicle is approaching? Can ambient lighting decrease the response time of emergency vehicles and increase their safety on the road compared to the current situation with no warnings?; How do the drivers feel about augmenting the EVA warning with the LED lights and their subjective reactions?

To investigate/answer the questions, simulator experiments consisting of three scenarios were carried out. The experiment consists of 60 participants from a different group of ages. Each participant filled out two questionnaires. The first questionnaire is about the participant's background and the second questionnaire consisted of the participant's experience after the simulator experiment.

The result showed that the participant's group in the EVA warning or the EVA warning with ambient lighting was better than the group with no warning in place. The result showed however that there are no significant differences between the participant's group in the EVA warning or the EVA warning with ambient lighting. The result from the post-survey showed the participants had a positive attitude toward the EVA warning with the LED lights technology.

## Brief assessment of each chapter.

### Chapter 1: Introduction

Within this chapter, we consider the content to be relevant. With the help of facts/statistics that are addressed in the introduction, the author has formulated a good introduction and problem statement. This makes readers understand why it is interesting to study this topic. The aim and question are also concrete and clear. However, we think it would be clearer if authors could explain under each question, why exactly these questions are relevant to investigate in the thesis.

We also notice that in the sub-chapter 1.2 method, authors only describe what authors have done in the thesis. We think that the thesis would be strengthened if the authors also included some methodological theory. For example, quantitative, qualitative, validity and reliability, etc., depending on what the author considers to be most suitable for this thesis. By doing this, the thesis quality will increase. One suggestion is to treat the method as a separate chapter.

### Chapter 2: Background and Theory

The chapter is well-written, and the tracks are easy to understand. We also think that each part of the chapter is well-chosen and comes in the right order. In addition, there is a good variety of sources, which indicates that the author has put effort and time into completing the thesis.

We also think that it is a plus that authors bring a rubric on the edge of each page. This makes the reader understand that the text belongs to this particular sub-chapter.

The paragraph where the authors talk about the Infotainment System (under Figure 2.5) is far too long. It would increase readability if authors could divide them into reasonable paragraphs.

The chapter takes up many figures. For example, in Figure 2.1. Did the author has been approved by the owner that the figure can be use in the thesis (copyright). Figure 2.3 is it identical to the source the author has taken from or is it inspired by the source? We think that with such a figure, authors can change some details and refer as “ Figure x.x is inspired by (reference)”.

If Johan (examiner) thinks that authors can treat figures as they have already done in the thesis, then it is okay to keep them as they are.

### **Chapter 3: Driving Simulator Experiment**

Well informative chapter. Easy to understand and to follow. It makes it easy to replicate the performed experiments with the information that is given in this chapter. Maybe a little bit too informative. For example, does the reader need to know what the participants receive as thanks for participating in this experiment, is it relevant to the outcome of the study? We like that there are pitchers of the setup and during the experiment, even though it was well explained in the text.

### **Chapter 4: Analysis of data**

The chapters are well-structured and informative. Each figure and table connected very well with the text. However, we think that 4.1 would also fit as part of sub-chapter 2.8 because we think it was brought up very late in the thesis.

We think that the figure in sub-chapter 4.3 (box diagram) is a bit difficult to understand. But then you understand after reading it several times. However, the table is very clear and easy to understand.

In 4.3 pages 42-43, it says that the car should be “moving at least 3 meters from the center of the road”. Is it necessary to move that much from the center of the road? Can you do a “risk analyst” risk analysis on if it's necessary to move that much or if it has to move more?

In 4.4.1 the scenarios are discussed. It would be easier if the result of every scenario was demonstrated with a diagram.

### **Chapter 5: Discussion**

Good start to the chapter where you present the purpose and the questions. There is a lot of repetition from chapter 4 in chapter 5.1 where the result of the driving simulator is presented. There is not a lot of discussion in 5.1, for the most part, is the repetition of facts from chapter 4. If it is conceived as a continuation of a previous study done by Björn Lidestam, why are not both of the studies compared in the discussion? It would be interesting to know what the similarities and differences of the different studies are.

Some details mistake in 5.1.3 Post -survey: common part “ Especially when considering the results from Chapter 4.3.2 and Chapter 4.3.2 ”

It is great that the author also discusses the methodology and a recommendation for the future study of the question.

## **Chapter 6: Conclusion**

Good start to the chapter where the author present the purpose of the thesis and motioned as a continuation of a previous study done by Björn Lidestam. The author has answered all the questions in the conclusion in a concrete way, and we believe that the author fulfilled the aim of this thesis.

### **Overall**

The author has done a very great job. The research topic is very interesting, and it can still be researched deeper in the future. The language is completely easy to read, there are only results and analysis chapters that you have to read several times before you understand. The structure in the thesis came in the right order and the references were handled also in a good way. We would like the author to discuss copyright when with Johan (examiner) regarding the figure taken from the internet, article, book, etc if it is allowed to do as authors have done. I think that authors can even include method theories so that the quality of the thesis increases.

## **Questions**

In Chapter 3

1. In Scenario 0 it said “the drivers were not given any warning and had to assess the situation of the approaching emergency vehicle themselves”,
  - a. Does that mean that the emergency vehicle did not have any warning lights or sirens on or does it mean that the car did not give any warning signs?
2. Can emergency vehicles only use warning lights? And if so,
  - a. why is there on scenario with only AEL (LED lights)?
  - b. If there were a scenario like that, what would be the outcome according to what you concluded from this study?
3. In the scenarios and the rest of the study it only shows them from the perspective of a car driver, with a max speed of 80km/h.
  - a. What might be important differences between the studied environment and an inner-city environment, where the speed limit is around 50 km/h (and more traffic) instead of 80km/h.?
4. The traffic does not only exist with emergency vehicles and experienced car drivers, but there are also buses, cyclists, and pedestrians.
  - a. How do you think that factors affect emergency vehicles?
5. Since this thesis used driving simulator,
  - a. Do you think the result is valid compared to real life scenario, where real driving interaction with emergency vehicles?
  - b. How well do driving in a driving simulator and interaction with EVs with siren and lights replicate real driving?
  - c. Do you there are better method that can potential be used to this study other than simulator?

#### In Chapter 4

6. In Table 4.1 the number of participants in each group varies. As we can see in scenario EVA there are no participants of the group of age 28-40 and the number of participants in each group is uneven.
  - a. Can you reflect or discuss, if and how the uneven age distribution might affect the result of the experiment?
  - b. Do you think that the result will look different if even age distribution in each group?

#### In chapter 5

7. You suggested some factors that need to be considered in future research. Do you think the weather could be one of the factors to include in future research? As the weather can affect vision when driving. For example, in the north during the winter, it is very dark. The snow and icy roads can also occur.
  - a. Do you think that during hectic traffic or heavy traffic will (in the morning and afternoon) effect the reaction time of the participants? Because hectic traffic often led to stress for most of driver?
8. If it is conceived as a continuation of a previous study done by Björn Lidestam, why are not of the studies compared in the discussion?
  - a. Can you explain/describing the differences in the experiment design and the result of both studies/research?

#### General Question

9. If this thesis is not conceived as a continuation of a previous study done by Björn Lidestam.
  - a. Could you have imagined other scenarios now that you have completed the thesis?
  - b. Did the conclusion come as a surprise or was it as you expected?
    - i. Are you happy with the result?
    - ii. Do you think this thesis fulfills the aim?
10. What do you think are the strong and weak parts of the report and why?
  - a. What do you think is most difficult to complete this thesis?