Journal of the Society of Automotive Engineers Malaysia
Volume 5, Issue 2, pp 244-251, May 2021
e-ISSN 2550-2239 & ISSN 2600-8092

Experimental Setup of Driver Behavior on Road Darkness Level

N. Md Yusof[*1,2], J. Karjanto[1,2], M. Z. Hassan[2,3], S. Sulaiman[4] and N. Mustaffa[4]

[1]Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
[2]Centre for Advanced Research on Energy, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
[3]Faculty of Mechanical and Manufacturing Engineering Technology, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
[4]Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, Hab Pendidikan Tinggi Pagoh, 84600 Panchor, Johor, Malaysia

[*]*Corresponding author: nidzamuddin@utem.edu.my*

REVIEW Open Access

Article History:

Received
25 Aug 2020

Accepted
3 Feb 2021

Available online
1 May 2021

Abstract – *Most of the previous research on the road darkness effect in Malaysia focused on traffic flow characteristics such as traffic speed and its density. Only limited efforts have been made to assess the road darkness effect on driver behaviours. In this paper, an experimental setup is explained to study driver behaviours when approaching parked or slow-moving vehicles during nighttime. A single-carriageway was selected to conduct the study. The road lighting will be controlled to be switched on or switched off during the experiment. Three obstacles in the shape of a motorcycle, car, and lorry will be used to simulate the parked or slow-moving vehicle. The experimental setup is designed to collect driver behaviour data including the reaction time taken for breaking or slowing down when approaching the obstacle, the distance between the car and the obstacle, the speed of the car and its trajectory. This experimental setup is expected to be used in a study that investigates the effect of dark roads on driver behavior.*

Keywords: Experimental setup, road darkness, road lighting, driver behavior, parked vehicle, slow-moving vehicle

Journal homepage: www.jsaem.saemalaysia.org.my

1.0 INTRODUCTION

Investing wisely in road-lighting implementations can only be made if there is a clear understanding of the purposes and benefits of road lighting. In general, good road lighting should provide adequate visual performance and assist the driver in keeping alert. On the expressway, road lighting is used to increase the capacity of the traffic. In the urban or residential area, road lighting helps other road users such as pedestrians and cyclists guiding their path by avoiding the risks of crashing with obstacles (CIE, 2010).

Currently, the roads that are used around the world are operating under daylight road lighting, darkness, and other ambient light. In Malaysia, only 8.4% of the total length of the roads are federal roads, including expressways (JKR, 2018). The rest of the roads are considered state roads including state highways, town roads and village roads. Most of these roads can be seen without any road light, especially in a rural area (Figure 1).

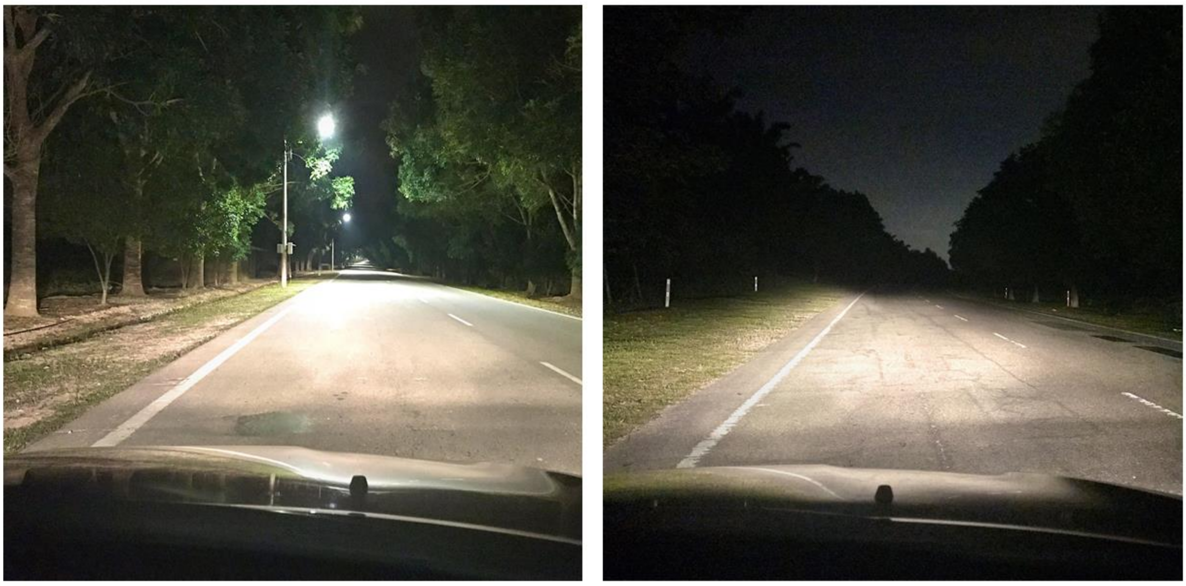

Figure 1: Typical single carriageway: (a) with road lighting, (b) without road lighting

This dark road condition can endanger the lives of road users, especially at night (Kamarudin et al., 2018). For example, a driver who is driving on a dark road will immediately avoid any obstacle on the road without seeing the side view mirror. These obstacles, such as slow vehicles without taillights or no reflector at the back of the cars, could worsen the situation. These conditions cause accidents if other vehicles are too close. Riding in darkness without street lighting also was found related to severe motorcyclist injury crashes, mainly after midnight night riding from 12 am to 7 am are the most severe (Pai & Saleh, 2007). Driving with blocked views on the road such as corners, trees, and uphill and downhill roads exacerbate the situation too. According to CIE (2007), based on available statistics from developing countries, 30% of the accidents happened during night time, as shown in Table 1.

Most road lighting impact studies are focusing on traffic flow characteristics such as traffic speed, travel time, traffic volume and density. Johnnie et al. (2014) studied the effect of road lighting on a dual carriageway road (also known as a divided highway) in Skudai town. They found that the quality of the road does not affect by the road lighting. In another study, Sundara et al. (2013) investigated the effect of darkness on traffic flow characteristics. They evaluated the traffic flow rate, speed, and density during darkness, natural light, and artificial light durations. This study was conducted on an uninterrupted roadway section on a highway road in Johor. They summarized that the highway darkness is not affecting the traffic. Also, Sundara et al. (2015) study the comparison between dry and rainfall weather conditions during darkness time on an expressway in Slim River. Their study including a 24-hours observation of natural light, darkness and artificial light in both weather conditions. They concluded that there is no comparison between darkness dry and darkness rainfall.

Table 1: Percentage comparison of accidents (including fatalities) in several countries during the day and night

Country	Day (%)	Night-lit (%)	Night-unlit (%)
Shanghai 2000 - All accidents	67.2	24.0	3.5
Shanghai 2000 - Fatalities	61.4	22.6	16.0
Bangladesh 1998 - All accidents	70.7	22.2	4.1
Bangladesh 1998 - Fatalities	69.9	21.6	8.5
Zimbabwe 1998 - All accidents	66.6	19.5	13.9
Zimbabwe 1998 - Fatalities	50.3	21.5	28.2
Botswana ‘94-95 - All accidents	62.4	12.3	25.3
Botswana ‘94-95 - Fatalities	57.5	10.6	32.0
Botswana ‘94-95 - All accidents, village and rural only	55.1	8.1	36.9
Fiji 2000 - All accidents	72.1	6.6	21.3

As already mentioned above, most of these studies in Malaysia were done mostly on the expressway. In this paper, the authors explained an experimental setup of an on-road survey to assess darkness road on a single carriageway with two lanes (a two-lane road). The experimental setup aims to study the correlation of the road darkness level with the driver behaviour when suddenly facing an object (other vehicles) either on the road or on the side of the road. This is because 90 % of driver actions on the road are based on visual information. (Carsome, 2018). The behaviour of the driver (as dependent variables) that will be studied including the reaction time (breaking or slowing down), the distance between the driver and the obstacle when the first time the driver seeing the obstacle, and the trajectory of the driver’s vehicle. The darkness level, the location of the obstacle, and the obstacle size are the independent variables.

2.0 EXPERIMENTAL SETUP

2.1 Experimental Design

The test configurations are defined to be simulated as a typical road situation in Malaysia. These configurations are set to include the two-level of road darkness (with light, without light), three sizes of the obstacle (in the shape of motorcycle, car, and lorry), and two locations of the obstacle (on the road, on the side road). A total of 12 different configurations are being set up with an addition of a baseline configuration where there is no obstacle at all scenario.

The configurations of the level of road darkness will be controlled using standalone road lighting. The light intensity during the test will be measured using a light intensity meter. For safety reasons, the obstacles will be made of a 9 mm-thickness particleboard. In case of an accident occur, the particleboard can easily break due to its brittleness in nature. The two locations of the obstacles represent a slow-moving vehicle on the road scenario and a parked vehicle on the side road scenario.

2.2 Instrumented Car

An instrumented car, a customized Perodua Myvi with a manual gearbox, will be used as the test platform of the future study (Figure 2). Initially, this instrumented car is designed to replicate an autonomous vehicle of the future for user behaviour study. For the current experimental setup, a data logger from Freematics (2019) will be used to measure vehicular data for driver behaviour (Figure 3). This data logger is capable of obtaining and recording the onboard diagnostics II (OBD-II) car data such as the speed and the RPM of the car. The OBD-II adapter also contains a triple-axis micro-electro-mechanical systems (MEMS) accelerometer and a gyroscope. Besides, this data logger is connected to a global positioning system (GPS) receiver with an update rate of 5 Hz. The 3.2-inch TFT LCD display shield is used to show a real-time data display (Figure 4).

Figure 2: The instrumented car

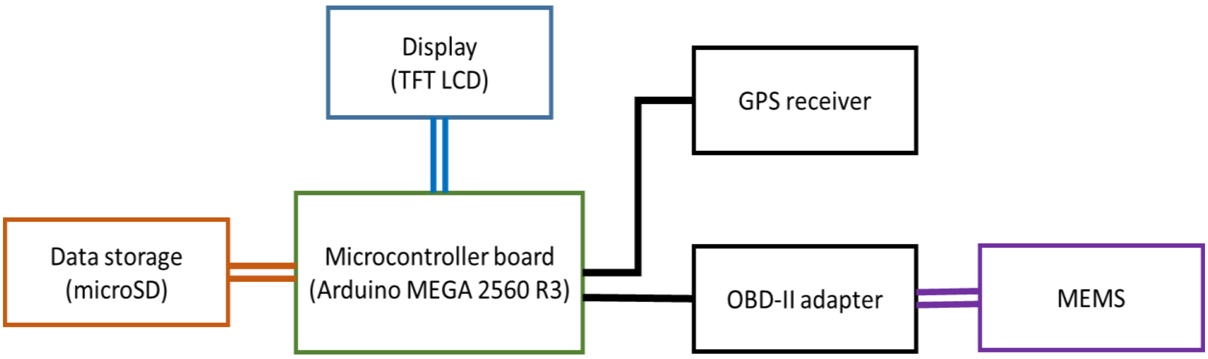

Figure 3: Schematic diagram of the data logger

Figure 4: Example of real-time data display (Source: Freematics, 2019)

2.3 Test Location

A 2.4 km straight dual carriageway in Melaka is selected as the test location (Figure 5). However, for the experimental setup, only one side of the carriageway will be used for the study and converted into a two-lane road. Furthermore, the test location has a road light that needs to be manipulated (switched on and off) during the study. Hence, approval is yet to be required from the Public Works Department (PWD/JKR) Malaysia before any study can be conducted.

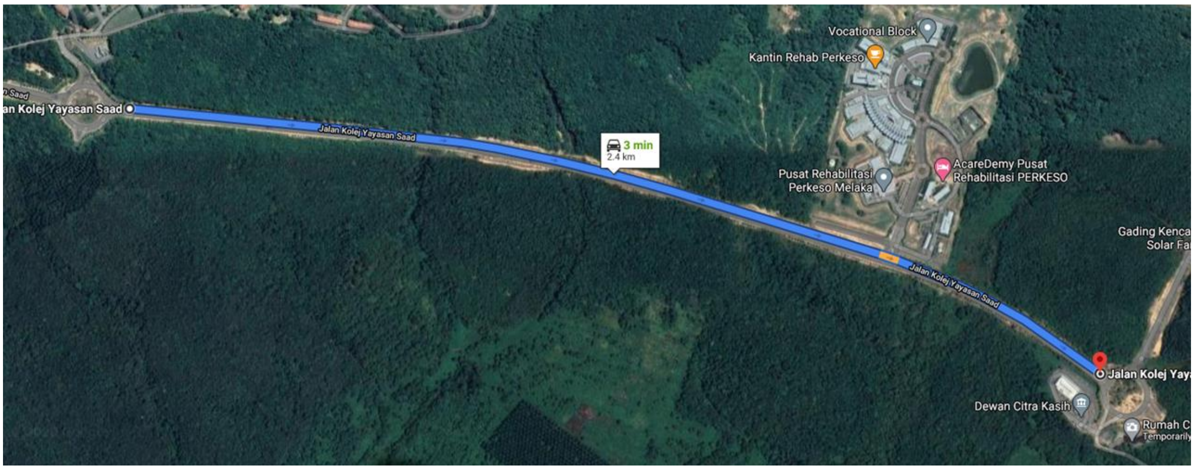

Figure 5: The location of the experiment

2.4 Participants

Potential participants will be recruited through Google form. The link to the Google Form will be distributed through social media as well as through flyers being put up around the Industrial Campus of Universiti Teknikal Malaysia Melaka (UTeM). The selected participants are experienced drivers with a valid driving license and should not have any night vision problems such as night blindness.

2.5 Ethical Approval

All research involving human participants must be conducted ethically. Researchers need to acquire ethical research approval from ethics committees before approaching potential participants and before collecting any research data. For the current experimental setup, ethical research approval is still in the process of applying from the UTeM Research Committee.

2.6 Planned Procedures

Upon arrival at the starting point (Figure 6), the participant will be briefed about the nature of the experiment, including rights to withdraw from the study at any time. Then, the participant will be asked to sign the informed consent form before being directed to the instrumented car. The participant will be reminded to wear a seatbelt and to obey traffic rules at all times, including maintaining the speed of the instrumented car at around 70 km/h. After that, the participant will be given around 10 minutes to drive the instrumented car between location *A* and the *Start/Stop point*. This driving will be done for him/her familiarizing with the driving.

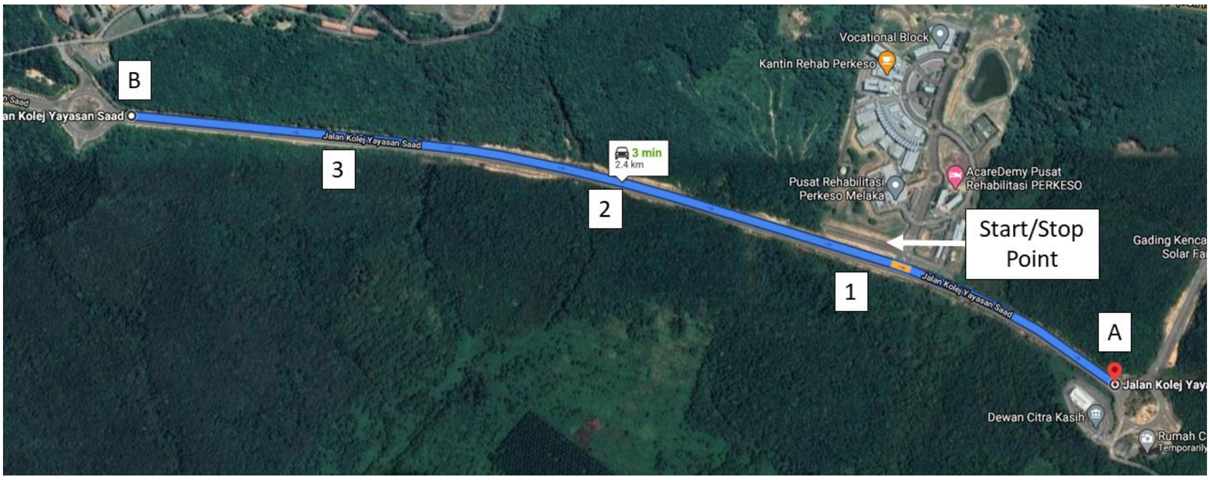

Figure 6: The designated route with test configuration locations at 1, 2 and 3

Afterwards, the participant will drive the instrumented car from location *A* to location *B*. During this time, three test configurations will be randomly presented at locations *1*, *2*, and *3* each (Figure 7). Then, the participant will drive back to location A, and at this time, another three test configurations will be randomly presented. The participant will keep going between locations A and B until all test configurations are covered. Later, the participants will drive back to the *Start/Stop point* and will be brought back to the starting point for a short debriefing. A small voucher as a token of appreciation will be given to the participant at the end of the experiment. During the entire experiment, an experimenter will be seating at the back seat of the instrumented car. This experimenter is the one who interacts with the participant if needed and manages all the data collection inside the instrumented car.

2.7 Data Analysis

The dependent variables of this study will be the driving behaviour of the participant data including the reaction time taken for breaking or slowing down when approaching the obstacle, the distance between the instrumented car and the obstacle when the driver reacts, the speed of the instrumented car and its trajectory. All data will be extracted and analysed using IBM SPSS Statistics Version 23 software. Statistical analysis of independent t-test or z-test (depending on the distribution of the collected data later) and two-way analysis of variance (ANOVA) will be performed. This analysis will determine if there are any statistically significant differences between the independent variables (darkness, obstacle location, obstacle shape) on driver behaviour.

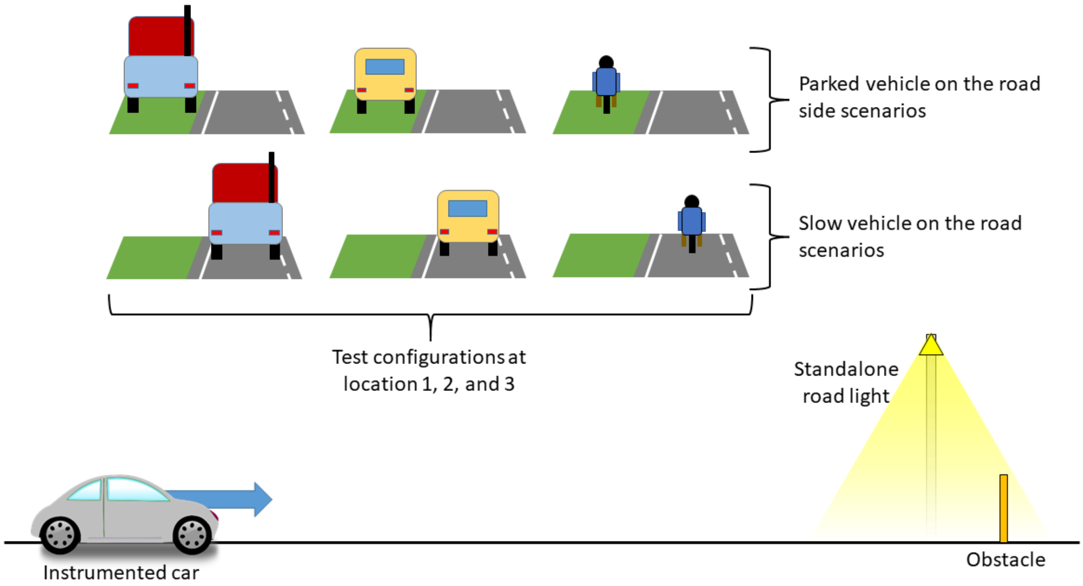

Figure 7: The experimental setup

3.0 CONCLUSION

This experimental setup is a part of a study that investigates the effect of dark roads on driver behavior. The study is currently proceeding on schedule in the first phase of the experiment. It is expected that the study will be completed on time and within the allocated budget.

ACKNOWLEDGEMENTS

The authors fully acknowledged Universiti Teknikal Malaysia Melaka (UTeM; Grant no. ANTARABANGSA-ANCHOR/2020/FKM-CARE/A00031/A00031) and ASEAN NCAP for the approved fund that makes this important research viable and effective. This research is fully supported by an international grant ASEAN NCAP III entitled "Correlation of Darkness Level of the Road with Driver Behaviour" (No. A3-C33).

REFERENCES

Carsome (2018). Driving at night – Visibility, safety & 3M. Retrieved from https://www.carsome.my/news/item/driving-at-night-visibility-safety-3m

CIE (2007). Road transport lighting for developing countries. The International Commission on Illumination. In Commission Internationale de L'Eclairage.

CIE (2010). Lighting of roads for motor and pedestrian traffic. The International Commission on Illumination Vienna (Austria): CIE. Publication No., 115, 2010.

Freematics (2019). Freematics Mega Kit.

JKR (2018). Statistik Jalan Edisi 2018. Retrieved from http://www.kkr.gov.my/public/Buku Statistik Jalan 2018.pdf

Johnnie, B. E., Nordiana, M., & Rahman, R. (2014). Effect of road lighting on the quality of dual carriageway road service. Research Journal of Applied Sciences, Engineering and Technology, 7(5), 950–956.

Kamarudin, M. K. A., Abd Wahab, N., Umar, R., Mohd Saudi, A. S., Hafiz Md Saad, M., Rozaireen Nik Rosdi1, Sarah Alisa Abdul Razak, N., … Mohd Ridzuan, A. (2018). Road traffic accident in Malaysia: Trends, selected underlying, determinants and status intervention. International Journal of Engineering & Technology, 7(4.34), 112–117.

Pai, C.-W., & Saleh, W. (2007). An analysis of motorcyclist injury severity under various traffic control measures at three-legged junctions in the UK. Safety Science, 45(8), 832–847.

Sundara, P., Hainin, M. R., Puan, O. C., & Zamli, K. Z. (2015). Influence of darkness dry and darkness rainfall on Malaysian expressway for traffic characteristics using Greenshield's model. Journal of Basic and Applied Scientific Research, 5(11), 34–42.

Sundara, P., Puan, O. C., & Rosli, M. (2013). Impact of highway darkness on traffic flow characteristics. Journal of Basic and Applied Scientific Research, 3(11), 1–8.