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# Factors Affecting on the Brake Response Time of Motorcycle

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**Abstract:** Vehicle collision accidents happen frequently. A study was conducted, and the findings indicated that warning systems (visual, auditory, or tactile) would reduce the number of collisions and improved brake response times. The purpose of this study is to factors affecting on the brake response time of following vehicle with respect to motorcycle. The survey was made using Google Form and sent to random 54 respondents in UTHM residents. A few factors that brought major influence to Brake Reaction Time such as Age, Gender, Drive Skills, Driving Experience, Road Accident Experient, Mistake while driving and leg riding position were chose as variable for this study. Software called SPSS is used to organize and evaluate the data that have been collected. Results indicate that, for the most of the factors listed, flashing or conventional brake lights appear to improve brake response time. This study significantly expands our understanding of how brake lights affect brake response time. All of the data have been discussed, and the majority of studies have shown that conventional brake lights indeed speed up drivers' responses. According to some statistics, flashing lights marginally slow down respondents' reaction times.

**Keywords:** Brake lights, brake response time, motorcycle, flashing brake light, conventional brake light

## 1. Introduction

Annually, accidents in roads are increasing around the world. In recent years, Asian countries have become major contributors to these accidents. Based on the Malaysian Institute of Road Safety Research (MIROS), the number of road accidents in Malaysia has risen over the last ten years [1-3]. Collisions between road vehicles, cars and pedestrians, road vehicles and animals, and road vehicles and geographical or architectural obstacles are all examples of road traffic accident. Road traffic incidents (RTAs) have proven to be a major global public health problem, killing nearly 1.2 million people each year and injuring nearly four times that number during the same time span [4-7].

According to statistical evidence, vehicle drivers are the most common cause of road accidents based on Kisilowski J and Zalewski J [8]. In Poland, it is estimated that 70 percent of deaths occur as a result of a driver's negligence. One of the characteristics that characterizes people behaviour in the event of a road accident hazard people reaction speed. In a nutshell, it's the time between when a risk arises and when the driver takes specific steps on the vehicle's controls to prevent an accident.

## 1.1 Brake Lamp

Brake lamp is one of the most basic and widely used safety features on most road vehicles. An electronic brake lamp system with improved warning effect is proposed. To achieve a high performances effect, make good use of the LED's advantages and the circuit design technique. The functional purpose of tail lamps, according to Standard 108, is to indicate the presence and width of the vehicle [3-6]. The main purpose of the brake lights is to signal braking. The

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tail lamps and brake lamps on the back of a vehicle must be red, symmetrical and as far apart as feasible on the rear of vehicle [9].

Motorcycle brake lights are designed and configured in such a way that they switch on automatically as the engine started. It is critical to do research to establish how existing motorcycle designs influence crash and collision causes and to put appropriate countermeasures in place [10-11]. With a single-point, single-bulb taillight, motorcycles are more difficult to be detected in the traffic than automobiles. With latest technology, motorcycles are now equipped with flashing LED brake lamp for much better visuality to rear driver.

The modified motorcycle brake lamps flashing at 1.5 Hz were found to be 80ms (10% faster) than the conventional in non-flashing ones. A flashing frequency of approximately 4Hz has been proven to be the optimum for use as an imminent warning signal [11] [1], which was provable by the expert assessment in a Wierwille study [12-13]. Motorcycles are now fitted with flashing LED brake lamps, which provide the rear driver with significantly improved visibility. Depending on the country and its legislation, certain motorcycles may already be equipped with such a system, although most motorcycles do not yet have this function.

## 1.2 Brake Response Time (BRT)

The brake reaction time (BRT) is a period time between the moment the driver perceives the presence of an object or hazard in the road ahead and the moment the driver applies the brakes. One of the functions of BRT is used to analyse stopping sight distance, which defines the road design necessary for a certain design speed [13]. As a result, the rear driver's response is necessary to avoid an undesirable rear end accident. Above all, the BRT is used to assess the required road design for a certain design speed and evaluate the stop distance.

## 1.3 Importance of Brake Lamp

The brake light system was introduced to improve the safety and reduce accidents. Brake lamp is one of the most basic and widely used safety features on most road vehicles. An enhanced warning effect electronic brake lamp system is suggested. To achieve a high performances effect, the LED's advantages make good used and the circuit design technique and the lighting option see wider adoption until the following decade. Several patents have been issued for brake light design [14]. The method for controlling the intensity and frequency of brake lights based on vehicle deceleration based on Tewari [15].

In most driving situations, the driver will be either the lead or the ‘following' vehicle. It is critical for drivers to communicate with one another in order to avoid accidents, and lights are one way for them to do so. With a brake light, the rear driver can get all of the information they need to decide on their next action. With a brake light, the rear driver can see if you are slowing down or stopping the vehicle. They can usually be found near the wheels and they assist drivers to slowly turn the wheel until they have enough traction to apply the brakes. This brake light can be turned on or off by the driver and can also be a button inside the vehicle.

## 1.4 Factor that Influence the Brake Response Time

One of the most common types of collisions are rear-end collisions. The collisions occurred in 2017, over 1.819 million rear-end collisions, accounting for 30.2 percent of all reported collisions in the United States [16]. In vehicle-following situations, rear-end collisions occurred. Typically, the characteristics of the driver, vehicle, roadway, and environment all have an impact on the occurrence and severity of a collision. Driving experience, mental/physical health age and gender are all driver characteristics (or human factors). According to research, the majority of rear-end collisions are caused by the driver's inability to perceive and/or react to the actions of the lead vehicle, as well as following a lead vehicle too closely [17]. According to studies, the primary contributing factor in rear- end collisions is driver perception and reaction to the lead vehicle's action [18]. The Factors that could be the influence of BRT is mental processing time, movement time, driver’s response time, age, gender, experience and etc.

# 2. Methodology

The main objective of this study is to perform a survey based on factors affecting on the brake response time of following vehicle with respect to motorcycle. The survey method and research instruments was used in this study. Self-administered questionnaires were given to the respondents by hand, and online. The best way to gather information needed to answer all of the research questions that were developed at the start of the study. According to Sekaran and Bougie in 2013, a brief questionnaire is a group of questions that are prepared and utilised by respondents to record their responses.

## 2.1 Development of Questionnaire Instrument

The structures and items of the research instrument are summarized in Table 2.1, along with their mapping to develop their questionnaire. This questionnaire divided three parts for the respondents answer all the questions. In this

study there are three sections of the questionnaire namely Part A: Respondent and Organization Profile; Part B: Contextual Factors; and Part C: Views on flashing and conventional brake lamp.

**Table 1 - The structures and items of the research instrument**

| **The structures instrument** | | **items of the research instrument** | | |
|---|---|---|---|---|
| Variables | Factors | Item Code | Items [Mapping with brake response time Elements] | |
| Independent Variable 1 (IV1) | Personal Factor (PF) | PF1 | Age of driver | To determine that the response time is slowed if the age factor is impacted. |
| | | PF2 | Gender of driver | To categorized the gender of the drivers. |
| | | PF3 | Experience on driving | Having skills can spontaneous reaction when to apply brake while stop the vehicle. |
| Independent Variable 2 (IV2) | Process Factor (PRF) | PRF1 | Position while driving | Feet position that is always willing (ready) to apply paddle brake. |
| | | PRF2 | Maintenance | Regarding vehicle systems of brake and the brake oil is filled accordingly |
| Independent Variable 3 (IV3) | Environmental Factors (EF) | EF1 | Road condition | Dirt and gravel roads may not provide excellent traction and braking distance |
| | | EF2 | Weather | Rainstorm can be influential to driver's vision |
| | | EF3 | Alcohol | Drunk while driving makes the driving lose consciousness or unfocused while driving a vehicle. |
| | | EF4 | Distraction | Radio and cell phone might distract driver while driving. |

## 2.2 Questionnaire

The questionnaire method was employed by the researcher to obtain data. According to Kumar (2019), researchers picked this strategy because it is more consistent, systematic, easy to analyse, and the fastest way to obtain information. The researcher distributes the questionnaire survey to respondents residing in Tun Hussein Onn Malaysia University (UTHM)'s residential area, in addition to acquiring information on emotional intelligence and work performance. The respondent be given time to answer the question and after two weeks, the researcher collect all of the responses.

As shown in Appendix A, the questionnaire for this research study is divided into three sections. In Part A: Demographic of respondents; Part B: Contextual Factors; and Part C: views on flashing and conventional brake lamp. The 5-point Likert scale was used to score the questions in Part B. (1: Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree). In Part C, the 2 -point Likert scale was used in this part. (1: Flashing brake lamp; 2: Conventional brake lamp). The central tendency bias refers to a rater's proclivity to rank the majority of objects in the middle of a rating scale.

# 3. Results and Discussion

## 3.1 Section A

### 3.1.1 Respondent Gender Distribution

Table 2 was a demographic respondent analysis for gender based on 54 respondents. Males accounted for 34 of all respondents, or 63% of the total. Females made up 20 which was 37% of the total. As a result of this questionnaire, the majority of respondents who participated in this research were male.

**Table 1 - Respondent gender distribution**

| Gender | Frequency | Percent (%) |
|---|---|---|
| Female | 20 | 37 |
| Male | 34 | 63 |
| Total | 54 | 100 |

### 3.1.2 Respondent Age Distribution

Table 3 was a descriptive respondent analysis for age based on 54 respondents. The number of those aged 18-29 was 9, accounting for 16.7% of all respondents. The number of people aged 20-24 was 34, representing 63.0% of the total. The number of those aged 25-29 was 11, accounting for 20.4% of all respondents. According to the results of this questionnaire, the majority of those who participated in this study were between the ages of 20-24 years.

**Table 3 - Respondent age distribution**

| Age | Frequency | Percent (%) |
|---|---|---|
| 18 – 19 | 9 | 16.7 |
| 20 - 24 | 34 | 63.0 |
| 25 - 29 | 11 | 20.4 |
| Total | 54 | 100 |

### 3.1.3 Respondent Drive Skills Distribution

Respondent drive skill can be defined as the ability of a person to safely and effectively operate a motor vehicle. This includes the ability to control the vehicle, understand and obey traffic laws, and anticipate and respond to potential hazards. It also includes the ability to make decisions quickly and accurately in order to avoid collisions and other dangerous situations. Based on 54 respondents, Table 4 was an analysis of descriptive respondent for drive skills. The number of respondents had high skill was 16, accounting for 29.6% of the total. For medium skill was 35, representing 64.8% of the total. The number of people had low skill was 3, representing 5.6% of the total. As a result of this questionnaire, the majority of respondents who participated in this research were had medium skills.

**Table 4 - Respondent drive skills distribution**

| Drive Skills | Frequency | Percent (%) |
|---|---|---|
| High | 16 | 29.6 |
| Low | 3 | 5.6 |
| Medium | 35 | 64.8 |
| Total | 54 | 100 |

### 3.1.4 Respondent Experience Driving Distribution

In this group, the respondents are divided into a few subgroups in order to determine each respondent's experience level as a driver. It is well known that driving experience has a significant impact on braking reaction time. While

driving, a driver gains more and more knowledge about brake time and develops an understanding of when to brake properly. Based on 54 respondents, Table 5 was an analysis of demographic respondent for kind of experience driving. The respondents with experience 1- 4 years had 27, representing 50% of all respondents. While, 5-9 years were 22 and 40.7% respectively. Respondents had experience above 10 years was 5, for a total of 9.3%. As a result of this questionnaire, the majority of respondents that participated in this research was people with experience 1-4 years.

**Table 5 - Respondent experience driving distribution**

| Experience Driving | Frequency | Percent (%) | Valid Percent (%) | Cumulative Percent (%) |
|---|---|---|---|---|
| >10 years | 5 | 9.3 | 9.3 | 9.3 |
| 1 - 4 years | 27 | 50.0 | 50.0 | 59.3 |
| 5 - 9 years | 22 | 40.7 | 40.7 | 100.0 |
| Total | 54 | 100.0 | 100.0 | |

## 3.1.5 Respondent Road Accident Experience Distribution

Respondent road accident experience is the personal experience of a respondent in a road accident. This includes any physical, emotional, or psychological trauma that the respondent may have experienced as a result of the accident. It also includes any financial losses or other damages that the respondent may have incurred. Table 6 was a descriptive respondent analysis for road accident experience a based on 54 respondents. The number of those had road experience was 27, accounting for 50% of all respondents. The number of respondents does not have road experience accident was 27 too, representing 50% of the total. According to the results of this questionnaire, the same percentage value of both respondent road accident experience which was 50%.

**Table 6 - Respondent road accident experience distribution**

| Road Accident Experience | Frequency | Percent (%) | Valid Percent (%) | Cumulative Percent (%) |
|---|---|---|---|---|
| No | 27 | 50.0 | 50.0 | 50.0 |
| Yes | 27 | 50.0 | 50.0 | 100.0 |
| Total | 54 | 100.0 | 100.0 | |

## 3.1.6 Respondent Mistake While Drive Distribution

Table 7 was a descriptive respondent analysis for mistake while driving based on 54 respondents. The number of respondent who do mistake while driving was 38, accounting for 70.4% of all respondents. The number of respondents less do mistake while driving was 16, representing 29.6% of the total. According to the results of this questionnaire, the majority of respondents that participated in this research was participated who choose yes.

**Table 7 - Respondent mistake while drive distribution**

| Mistake While Drive | Frequency | Percent (%) | Valid Percent (%) | Cumulative Percent (%) |
|---|---|---|---|---|
| No | 27 | 29.6 | 29.6 | 29.6 |
| Yes | 27 | 70.4 | 70.4 | 100.0 |

| | | | |
|---|---|---|---|
| Total | 54 | 100.0 | 100.0 |

## 3.2 Section B

The objective for this section was to identify safety the behaviour of respondent while testing brake. Next, the researcher explains in this section about behaviour of respondent unsure respondent ready while testing brake.

**Table 8 - The mean score and standard deviation based on behavior while testing brake**

| Item Code | Item | DS | D | N | A | SA | Mean Score | Standard Deviation |
|---|---|---|---|---|---|---|---|---|
| B1 | Do relaxing activities while driving | 1 (1.9%) | 4 (7.4%) | 14 (25.9%) | 25 (46.3%) | 10 (18.5%) | 2.278 | 1.934 |
| B2 | Deliberately driving closely behind another vehicle | 8 (14.8 %) | 12 (22.2 %) | 23 (42.6%) | 8 (14.8%) | 3 (5.6%) | 3.259 | 2.912 |
| B3 | Enjoy the fun of driving at setlimits. | 0 (0.0%) | 3 (5.6%) | 16 (29.6%) | 30 (55.6%) | 5 (9.3%) | 2.315 | 1.886 |
| B4 | On deserted highways, Iusually drive at orslightly below theset speed limit | 0 (0.0%) | 6 (11.1 %) | 21 (38.9%) | 21 (38.9%) | 6 (11.1%) | 2.500 | 2.108 |
| B5 | While driving, I tried to calm myself down | 0 (0.0%) | 0 (0.0%) | 18 (33.3%) | 24 (44.4%) | 12 (22.2%) | 2.111 | 1.700 |
| B6 | I daydream to fill time whiledriving | 11 (20.4 %) | 11 (20.4 %) | 19 (35.2%) | 10 (18.5%) | 3 (5.6%) | 3.315 | 3.000 |
| B7 | Lost in thoughtand distracted, I was unaware of the vehicles in front of andbehind me | 9 (16.7 %) | 15 (27.8 %) | 17 (31.5%) | 10 (18.5%) | 3 (5.6%) | 3.315 | 2.988 |
| B8 | Correct hair or makeup while driving | 12 (22.2%) | 16 (29.6%) | 16 (29.6%) | 8 (14.8%) | 2 (3.7%) | 3.519 | 3.174 |
| B9 | Disturbed or Busy, and suddenly realized | 8 (14.8 %) | 7 (13.0 %) | 19 (35.2%) | 14 (25.9%) | 6 (11.1%) | 2.944 | 2.674 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | the vehicle in front had sloweddown the vehicle, and had to apply the brakes abruptly to avoida collision | | | | | | | |
| B10 | When driving in bad weather like rainstorm can be influential my vision | 0 (0.0%) | 0 (0.0%) | 12 (22.2%) | 23 (42.6%) | 19 (35.2%) | 1.870 | 1.478 |
| B11 | Keep calm while driving | 0 (0.0%) | 0 (0.0%) | 14 (25.9%) | 21 (38.9%) | 19 (35.2%) | 1.907 | 1.528 |
| B12 | When drive I loveto hear radio and play phone | 2 (3.7%) | 9 (16.7 %) | 21 (28.9%) | 16 (29.6%) | 6 (11.1%) | 2.722 | 2.380 |
| B13 | I have driving skills and canknow the exactdistance following thefront vehicle | 0 (0.0%) | 3 (5.6%) | 21 (28.9%) | 19 (35.2%) | 11 (20.4%) | 2.296 | 1.925 |
| Total | | | | | | | 2.642 | 2.284 |

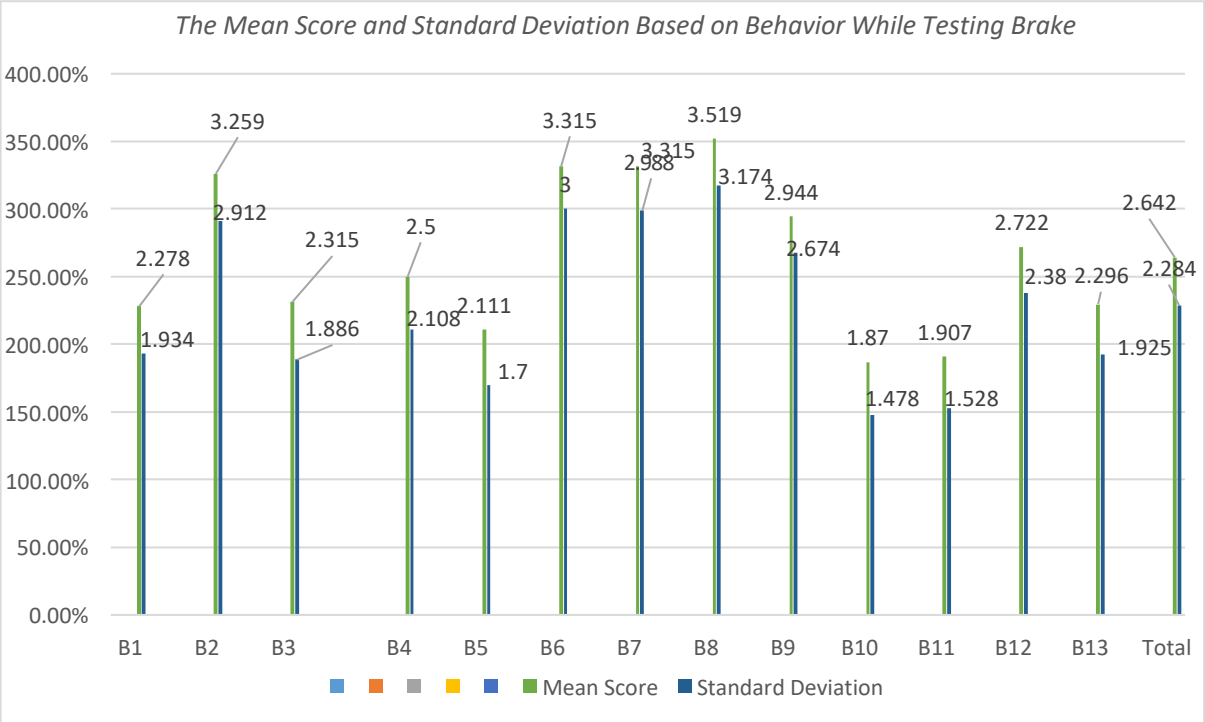


**Fig. 1 - The graph of the mean score and standard deviation based on behaviour while testing brake**

The chart presents 13 items code that used that shown in Table 8 and Figure 1 that shows the graph of the mean score and standard deviation based on behaviour while testing brake. B8 shown the maximum mean score (3.519) while B10 is the lowest (1.87). Overall of this section, the researcher proved the level of safety the behaviour of respondent

while testing brake related to the brake light of motorcycle was the low level. This is because the total means score was in the average 4.00 below which the total mean score is 2.642 while the standard deviation is 2.284.

## 3.3 Section C

### 3.3.1 Evaluation Views on Brake Light Selection

Figure 2 shows the percentage of respondent based on 54 respondents who take part on this survey. In situation above, majority respondents choose conventional brake light was 37 instead of flashing brake light which was 17. The percentage conventional how always use on their motorcycle was 68.5% more than flashing brake light which was 31.5%.

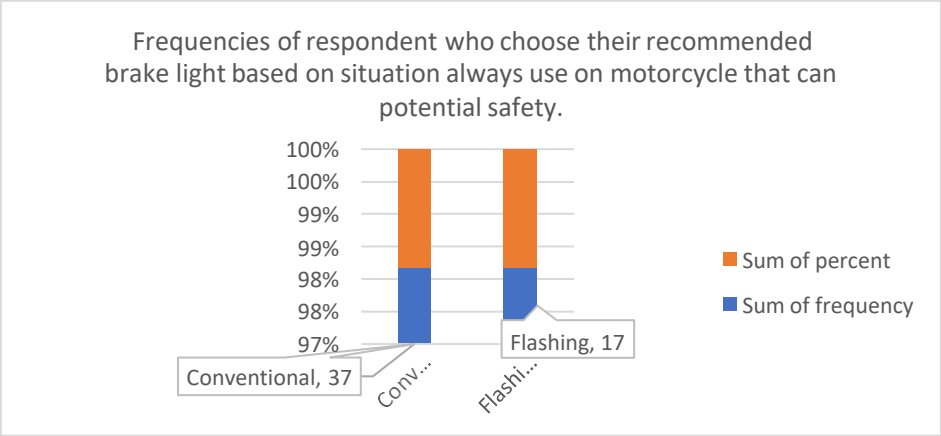


**Fig. 2 - Frequencies of respondent who choose their recommended brake light based on situation always use on motorcycle that can potential safety**

The percentages of two type of brake light which was conventional and flashing, in a sample of 54 respondents are shown in Figure 3. Out of 54 people who took the survey, 28 or 51.9% were conventional, while 17 or 48.1% were flashing. Majority on this survey choose conventional brake light based on situation when driving, the motorcycle in front pressing the brake, which light brake more alert.

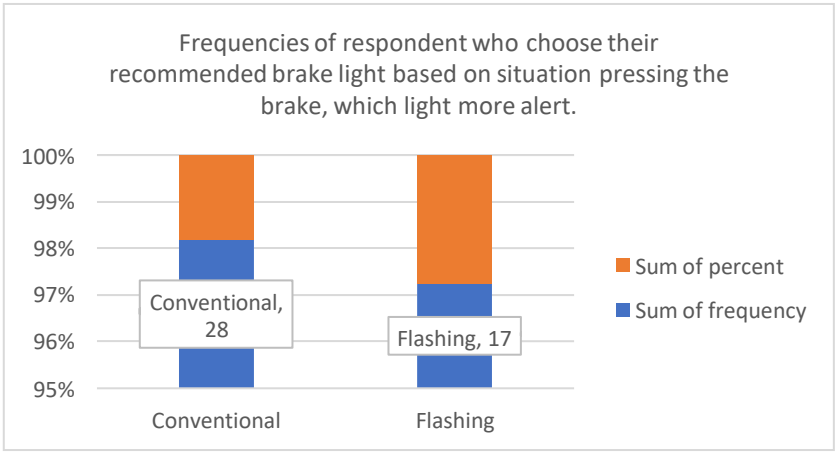


**Fig. 3 - Frequencies of respondent who choose their recommended brake light based on situation pressing the brake, which light more alert**

### 3.3.2 Evaluation on Brake Response Time Based on Sight Distance

Figure 4 shows the percentages of conventional and flashing brake lights in a sample of 54 respondents. And there are 54 people participated in the survey, with 36 responding conventionally (66.7%) and 18 responding flashing brake light (33.3%). According to the results of this survey, the majority of drivers prefer the conventional brake light since it is more noticeable when motorcycle is slowing down, conventional brake more efficient when speed decreases.

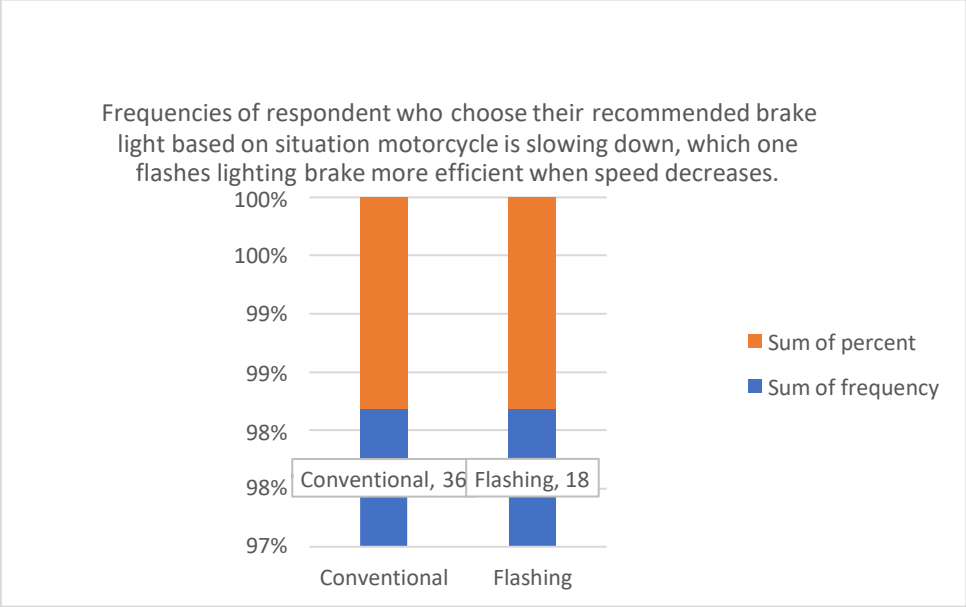


**Fig. 4 - Frequencies of respondent who choose their recommended brake light based on situation motorcycle is slowing down, which one flashes lighting brake more efficient when speed decreases**

Figure 5 shows the percentages of conventional and flashing brake lights in a sample of 54 respondents. There are 54 people participated in the survey, with 33 responding conventionally (61.1%), and 21 responding flashing (38.9%). According to the results of this survey, the majority of drivers prefer the conventional brake light since it is more noticeable from a distance and can calculate the distance to braking a vehicle.

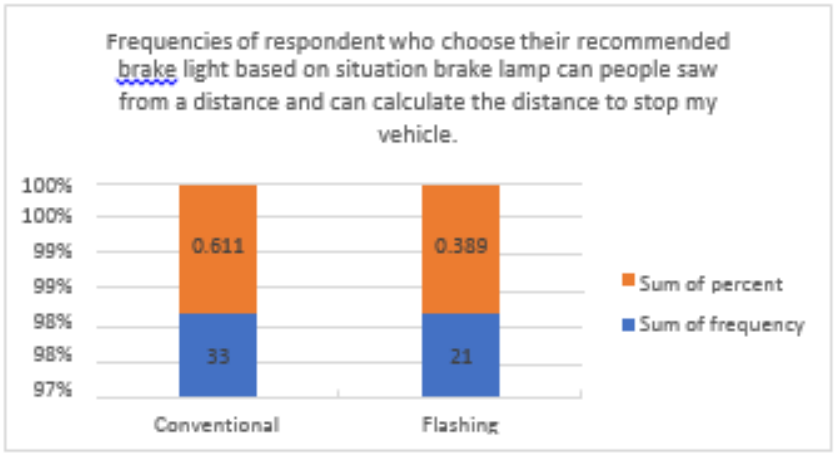


**Fig. 5 - Frequencies of respondent who choose their recommended brake light based on situation brake lamp can people saw from a distance and can calculate the distance to stop my vehicle**

### 3.3.3 Evaluation on Brake Response Time Based on Selected Driving During the Day or Night

The Figure 6 shows the percentage of respondents based on 54 participants in this survey. The majority of respondents preferred a conventional brake light (39) over a flashing brake light (15). The number of people who always use a conventional brake light on their motorcycle was 72.2 percent higher than the percentage of people who always use a flashing brake light, which was 27.8 percent.

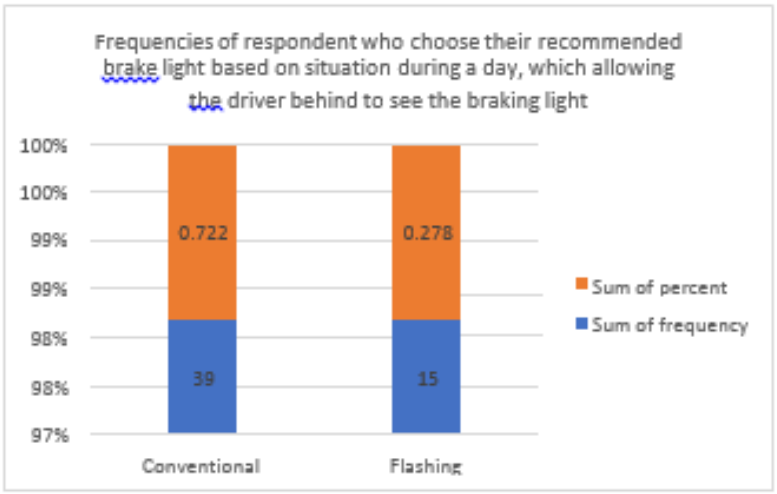


**Fig. 6 - Frequencies of respondent who choose their recommended brake light based on situation during a day, which allowing the driver behind to see the braking light**

Figures 7 shows the percentage of responders based on the 54 people that participated in this survey. The majority of people (34) who responded to the survey preferred flashing brake lights over conventional brake lights (20) in the scenario described below. The proportion of motorcycle riders who always use the flashing brake light on their motorcycle was 63 percent greater than the motorcycle riders who always use the conventional brake light which was 37 percent. According to the majority of responses, many respondents prefer used flashing brake lamp on this situation.

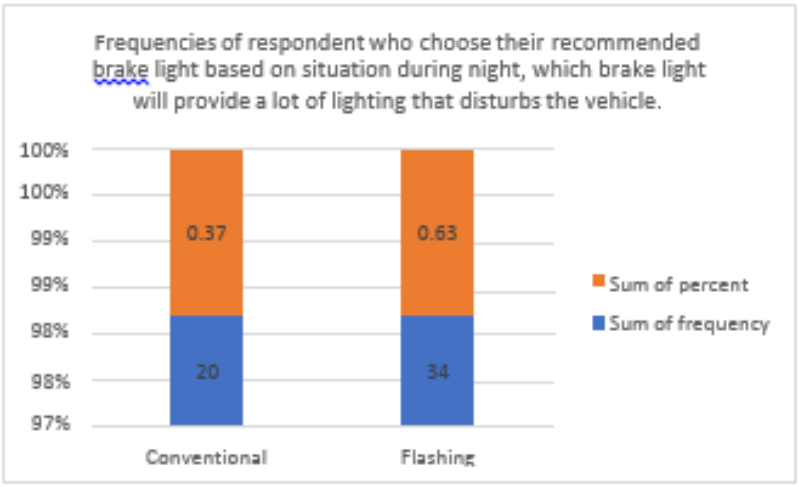


**Fig. 7 - Frequencies of respondent who choose their recommended brake light based on situation during night, which brake light will provide a lot of lighting that disturbs the vehicle**

### 3.3.4 Evaluation on Brake Response Time Based on Velocity when Braking

The percentage of respondents is shown in Figure 8 based on 54 respondents to this survey. In the scenario below, the majority of responders choose conventional brake lights (37) over flashing brake lights (17). The proportion of riders who always use their motorcycle's conventional brake light was 68.5 percent higher than the percentage of riders who always use their motorcycle's flashing brake light, which was 31.5 percent. The majority respondents based on situation at velocity 100km/h on day light, at distance 50 meters are more alert while braking.

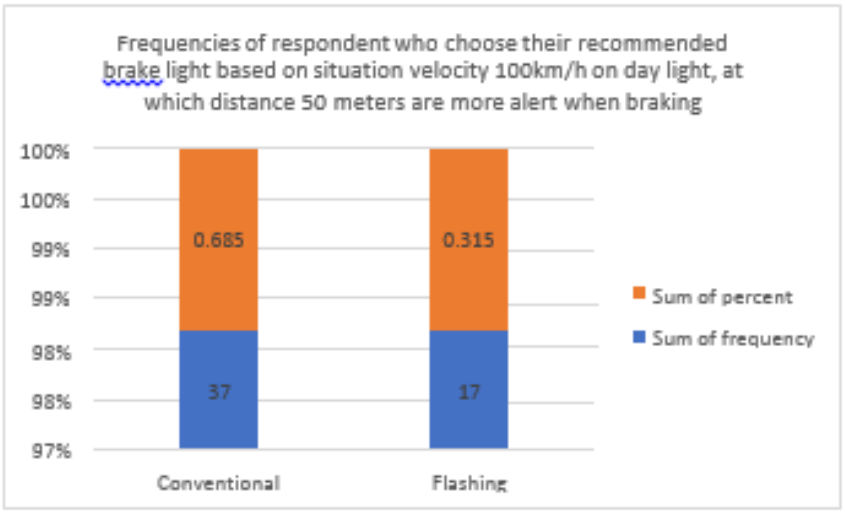


**Fig. 8 - Frequencies of respondent who choose their recommended brake light based on situation velocity 100km/h on day light, at which distance 50 meters are more alert when braking**

Respondents who choose their recommended brake light on Figure 9. Figure 9 shown the data distribution based on speed of 80 km/h at night and a distance of 40 meters are more alert when braking more numerous. The number respondent that used conventional brake light was 31 with 57.31% while flashing brake light just 23 with 42.6%. The brake light type conventional became an option for respondent based on situation velocity 80km/h on night, at which distance 40 meters are more alert when braking.

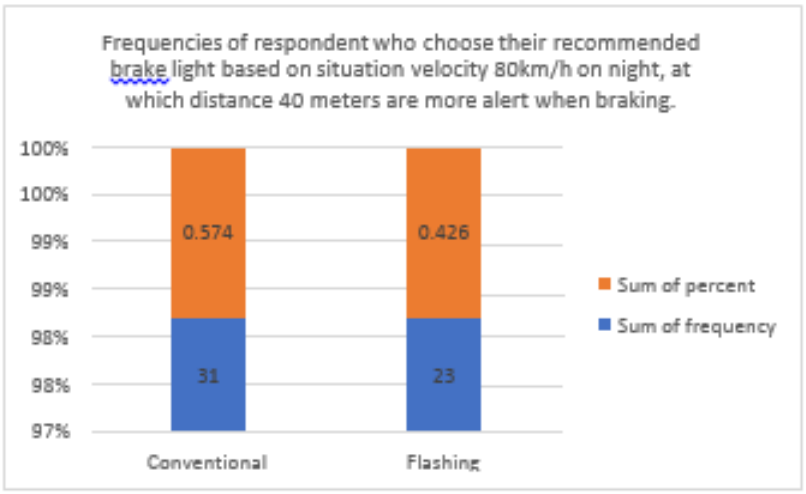


**Fig. 9 - Frequencies of respondent who choose their recommended brake light based on situation velocity 80km/h on night, at which distance 40 meters are more alert when braking**

## 4. Conclusion

According to the findings of this study, the rate of brake response time and efficacy of rear brake lights in University Tun Hussein Onn Malaysia area is low, and it is hoped that the relevant parties can improve this level so that it may continue to be applied to road users in the future. Next, researcher find out that the behavior one of the important factor in safety need to identify. It can prove that the residents in UTHM area are level of safety the behaviour of respondent while testing brake related to the brake light of motorcycle was the low level in the average was below than 4 which is score mean 2.642.

All of the data have been discussed, and the majority of studies have shown that conventional brake lights indeed speed up drivers' responses. According to some statistics, flashing lights marginally slow down respondents' reaction times.

Finally, from this study the researcher can identify that the residents in University Tun Hussein Onn Malaysia will know the true function of the brake lights and the effectiveness related with their type of brake lights (flashing or conventional). This can be proven where the students given 8 questions related motorcycle brake light's flashing or

conventional effectiveness on response time, the flashing was chosen by many UTHM residents which is 7 out of 8 questionnaires compared to conventional. For the survey choose one between conventional brake light and flashing brake light, many respondents choose conventional than flashing which was majority who choice conventional brake light.

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