

**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH
TECHNOLOGY****REAR END COLLISION: STATUS, DRIVERS' PERCEPTION AND IMPACT OF
REAR LIGHT CONFIGURATIONS ON DRIVER REACTION TIME****Jahid Hasan*, Dr. Mohammad Muhshin Aziz Khan, Shanta Saha, Syeda Kumrun Nahar,
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ABSTRACT

Both the reconnaissance and the experiment surveys are conducted in this study. Hit pedestrians, head on, and rear end are found to be the major causes of the total fatal road accidents. Though pedestrians are being hit by the vehicles in almost 50% of the total road accidents, rear end collision contributes a significant fraction to it. More than two-third of the fatal road accidents caused by rear end collision takes place in national and city roads. Drivers consider ignorance about the traffic rule and carelessness as the top ranked reasons; and absence of appropriate lighting arrangement and negative attitude towards road safety are the second major sources of road accidents caused by rear end collision. However, they are only familiar with rear braking lights in straight line configuration. Driver reaction time is found to be shortest for the rear lights with rectangular configuration and has U-shaped relationship with drivers' age and experience.

KEYWORDS: Rear end collision, Reaction time, Braking light configuration

INTRODUCTION

Road traffic injuries place a heavy burden, not only on global and national economies but also household finances. Many families are driven deeply into poverty by the loss of breadwinners and the added burden of caring for members disabled by road traffic injuries. Worldwide, the number of people killed in road traffic crashes is estimated to be 1.3 million, with another 50 million injured each year. More than 85 percent of these casualties and 96 percent of total child deaths, occur in low and middle income countries. Road traffic deaths are predicted to increase by 83 percent in low-income and middle income countries (if no major action is taken) and to decrease by 27 percent in high-income countries over the next 20 years [1]. The economic cost of road crashes and injuries is estimated to be 1% of gross national product (GNP) in low-income countries, 1.5% in middle-income countries and 2% in high-income countries. The global cost is estimated to be US\$ 518 billion per year. Low-income and middle-income countries account for US\$ 65 billion, more than they receive in development assistance [2]. Road traffic accidents have now become a great social concern in Bangladesh and the situation is deteriorating. The annual economic wastage occasioned by traffic accidents is estimated to be in the order of 2 to 3 percent of the GDP. Each year, there are at least 3,000 fatalities and 3,000 grievous and simple injuries from around 3,500 police reported accidents on Bangladesh roads. Other sources estimated the fatalities as high as from 12,000 to 20,000 per year. Thus, the safety problem is very severe by international standards with some 60 to 150 fatalities per 10,000 motor vehicles in Bangladesh compared to around 25, 16, 2 and 1.4 in India, Srilanka, the USA and UK respectively [1]. According to the ART report, 2013, the factors contributing to road traffic accidents are commonly grouped into three categories – causes attributed to the environment, to the vehicle or to the driver. Analysis shows that in about 30% of cases contributing factors could be attributed to the environment, slippery roads, bad visibility etc. only 10% of contributing factors are attributed to technical issues related to the vehicles involved; tyre explosions or poor maintenance for example. However, in 90% of cases the major contributing factor is human error. A significant proportion of accidents are caused by a combination of the three categories: slow driver reactions during adverse weather conditions (speeding when visibility is low) [3]. Besides, there are many causes of increasing road accidents e.g. rapid growth in population, motorization, urbanization and lack of investment in road safety are the main causes. Violation of traffic laws by the drivers and pedestrian, unplanned roads and highways, incompetent traffic system; faulty vehicles on road are also the possible explanation of increasing road accident in recent years. The Swedish Road Administration classified the accident type distribution for long and regular vehicle combinations as turning, bicycle/moped, pedestrian, intersecting, head on, overtaking, single, train/ tram, rear end, etc. [4]. A rear-end collision is an accident where a vehicle hits the rear of another vehicle, which may be travelling at a lower speed, parked or turning off the road [4]. According to NHTSA report, 28% accidents are rear end

collision [5]. Some of the factors that can cause, or contribute to causing, rear-end collisions are speed, tailgating and inattention, driving under the Influence, unsafe lane change, weather conditions, road conditions, and defective vehicles [6]. Furthermore, rear-end collisions in the year 2004 were associated with over 25.7 billion U.S. dollars in medical costs and property damage. Of all rear-end collisions, approximately two-thirds are collisions that involve the lead vehicle being stopped, i.e. a vehicle struck while stopped at an intersection [7]. Many researches have been conducted on the causes and effects of road accidents from socioeconomic perspectives. Some of them tried to identify the causes behind the rear end collision. Dr. Gail et al.(2001) focused on optimization of rear signal pattern for reduction of rear-end accidents during emergency braking maneuvers. They tried to solve the rear end collision by increasing the illumination of rear light arrangement and change the position of light. Bullogh et al.(2001) worked on rear light configurations for winter maintenance vehicles for winter-based countries emphasizing on always flashing the rear light. Mortimer (1970), in his article on ‘Automotive Rear Lighting and Signaling Research’ showed that improvements in driver sensitivity to closure with another vehicle at night were obtained in simulation and field studies by an array of four presence lamps: two mounted high and two conventionally. As shown in the above literature, there are many reasons for causing road traffic accident. Of them, rear end collision has a significant contribution a significantly to total number of the road accidents occurring around the world and is a costly accident mode. Moreover, proper visualization of signal light can reduce these types accident. Rear light configuration is very important to avoid rear end collision as it serves two distinct purposes: providing a conspicuous signal to other drivers that the vehicle is on the road and offering cues about the vehicle’s driving speed, direction and distance, relative to other vehicles. However, lighting systems that are highly conspicuous are not always providing speed and speed cues, and vice-versa. Several factors affect visibility of a vehicle to other drivers: mounting location, temporal light characteristics, spatial light characteristics, luminous intensity. So far, no article has been published regarding the road traffic accidents caused particularly by rear end collision in Bangladesh. This article, therefore, tries

- to show the distribution of fatal road accident by collision and road class types in Bangladesh;
- to find out drivers’ perception of causes of rear end collision; and
- to investigate variation of the driver react time with rear light configurations.

METHODOLOGY

In this study both the reconnaissance and the experiment surveys were conducted. During reconnaissance survey, a total of 110 professional and nonprofessional drivers of different age and driving experience groups were interviewed face-to-face using a self-made semi-structured questionnaire. The main purpose of this survey was to understand their perception of causes of road traffic accidents and knowledge about the brake light arrangement used in the vehicles. In this case, professional drivers drive light, medium and heavy vehicles for rent and go for long trip both at day and night time, whereas non-professional drivers drive their personal cars only. Both driver groups drive on all classes of roads such as national, regional, feeder, rural and city roads etc. This is worth mentioning that a cross-sectional descriptive-type of study was also conducted in 2014–2015 in order to find out how the road traffic accidents by collision types and road classes were distributed within the aforesaid study period.

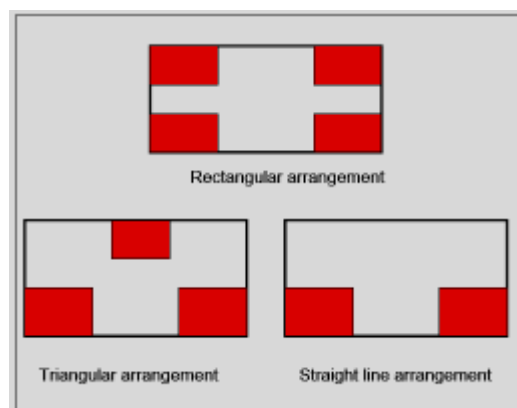


Fig. 2.1 : Different configurations of rear light arrangement

Experimental survey was carried out to investigate how the drivers’ reaction time varies with different braking light arrangements i.e. the systems upto four brake lights in three different configuration. In this study, 30 drivers (10 drivers from each of the age and the experience groups) were randomly selected for the experiment. As shown in the Fig. 2.1, rear lights with straight line, triangular and rectangular arrangements were mounted on the various types of vehicles (Minibus, Microbus, Private car and Motorcycle) and the response time of the

individual driver was determined. Each experiment was replicated three times at different driving speed and driving distance in order to average out the effects of the noise factors. Two vehicles set in the road was 10 – 20 meters away from each other. The distance travelled before the driver of the first vehicle pushed his brake was in the range of 15 – 25 meters. Besides, considering the clear visibility of the rear light arrangement on braking, the experiments were conducted at night.

RESULTS AND DISCUSSION

Demographic Characteristics

The demographic data of the respondents are given in Table 3.1. It shows that our sample consists of only male (100%) drivers. In fact, though female are frequently driving their own car in our country, very few of them is interested to be a professional driver because of their negative attitude. Of 110 drivers, 28% were identified as young adult (24-30 years), 44% as early middle age (31-40 years) and 28% as late middle age (41-50 years). Moreover, driving experience of the drivers were distributed as 1 – 10 years (30%), 11 – 20 years (50%), and 21 years & above (20%), which indicate the fact that majority of drivers were highly experienced.

Table 3.1 : Frequency distribution of different demographic variables

Demographic variables	Category	Frequency	Percentage
Age group	Young adult (24-30 yrs.)	31	28.0
	Early middle age (31-40 yrs.)	48	44.0
	Late middle age (41-50 yrs.)	31	28.0
Driver category	Professional	91	81.4
	Nonprofessional	19	18.6
Sex	Male	110	100
	Female	0	0.0
Driving experience	1 – 10 yrs.	33	30.0
	11 – 20 yrs.	55	50.0
	21 yrs. and above	22	20.0

Attributes of Fatal Road Traffic Accidents in Bangladesh

During data collection, 1754 records on fatal road accidents caused by collision were found in road safety cell of Bangladesh Road Transport Authority. Of these data, 256 records were on rear end collision. The data were collected from January 01 to February 15, 2015 using a prescribed format.

Frequency Distribution of Fatal Road Accident by Collision Type

Table 3.2 illustrates the frequency distribution of fatal road accidents caused by various types of collision. From the table, it is evident that hit pedestrians, head on, and rear end cause 81.6% of the total fatal road accidents, among which 47.6% of the road accident occur due to hit pedestrian i.e. pedestrians are being hit by the vehicles; other 34% are caused by head on (19.4%) and rear end (14.6%) collisions.

Table 3.2: Frequency distribution of fatal road traffic accident by collision type

	Frequency	Percentage	
Collision type	Head on	341	19.4
	Rear end	256	14.6
	Side Swipe	109	6.2
	Overturn	77	4.4
	Hit Objects	53	3.0
	Hit Pedestrians	835	47.6
	Others	83	4.7
	Total	1754	100

Frequency Distribution of Fatal Road Accident by Rear End Collision and Road Class

From the Table 3.3 showing the distribution of fatal road accidents caused by rear end collision in different road classes, it is clear that the most (45.6%) and the fewest (4.4%) fatal road accident due to rear end collision occur in national road and rural road respectively; and the rest (50.3%) are found to happen in regional (12%), feeder (14.2%) and city (24.1%) roads. It can also be seen for the table that more than two-third (69.7%) of the fatal road accidents caused by rear end collision take place in national and city roads.

Table 3.3: Frequency distribution of fatal road accidents by rear end collision and road class

	Rear end collision		
	Frequency	Percentage	
Road class type	National	117	45.6
	Regional	30	12.0
	Feeder	36	14.2
	Rural road	11	4.4
	City	62	24.1
	Total	256	100

Drivers' Perception of Causes of Rear End Collision

From the Table 3.4 presenting the drivers' perception of the fatal road accident caused by rear end collision, it is found that ignorance about the traffic rule, carelessness, absence of appropriate lighting arrangement, wrong attitude, no proper use of signal and signal light, and defective road construction and maintenance are the principal contributing factors of rear end collision. Both ignorance about the traffic rule (13%) and carelessness (13%) are considered to be the top ranked reasons, for which the rear end collision occur. Besides, absence of appropriate lighting arrangement (12%) and negative attitude towards road safety (12%) are found to be the second major sources of rear end collision. However, when the drivers are asked about rear light arrangement, a significant percentage respond that they are only familiar with rear braking lights in straight line configuration. As for other arrangements of rear light used in the vehicles, they think that those arrangements are made only for the decoration purpose. As one of the drivers interviewed, Mr. Quasem, quoted:

“Normally braking lights are arranged in a straight line. However, some vehicles are observed to be decorated with three or four rear lights. I don't think, these arrangements have any special purpose.”

Table 3.4: Distribution of drivers' responses to the question, “In your opinion, what is the prime reason for the rear end collision?”

	Frequency	Percentage
Ignorance about the traffic rule	14	13.0
Obstacles on the road	10	9.0
No proper use of signal and signal light	12	11.0
Absence of appropriate lighting arrangement	13	12.0
Carelessness	14	13.0
Defective road construction and maintenance	12	11.0
Defective vehicles	11	10.0
Inexperience	10	9.0
Negative attitude to road safety	13	12.0
Total	110	100

Variation in driver reaction time with demographic variables

Figs 3.1 (a) and (b) shows the variation in driver reaction time with different age groups and lengths of driving experience respectively. In both cases, driver reaction time is found to be shortest for the rear lights with rectangular configuration among the studied configurations. This indicate the fact that four rear lights with rectangular configuration (i.e. two lower and two high-mounted brake lights) help lessen driver reaction times and is expected to provide positive effect on road safety. However, the high-mounted brake light does remain an additional safety aspect for drivers of vehicles following several cars behind in a column when the two lower brake lights of the decelerating vehicle are concealed by the vehicle ahead while the high-mounted brake light remains visible through the vehicle ahead. From the Figs (a) – (b), it is also evident that the driver reaction time has U-shaped relationship with divers' age and experience i.e. the early middle aged drivers and the drivers with driving experience in the range of 11 – 20 years have shorter reaction time as compared with the other age and experience groups.

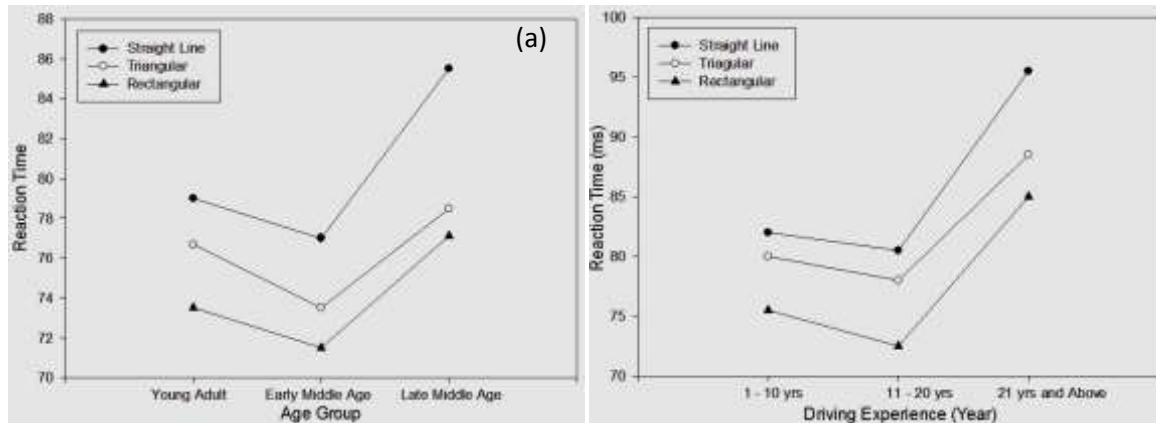


Fig. 3.1: Variation in drivers' reaction time with (a) age group and (b) driving experience

CONCLUSIONS

In this study, both the reconnaissance and the experiment surveys were conducted. Earlier one was to illustrate the actual scenario of the fatal road accidents caused by collisions. Later one was to examine how the drivers' reaction time varies with different braking light arrangements. Hit pedestrians, head on, and rear end are found to be the major causes of the total fatal road accidents. Though pedestrians are being hit by the vehicles in almost 50% of the total road accidents, rear end collision contributes a significant fraction to it. More than two-third of the fatal road accidents caused by rear end collision takes place in national and city roads. Drivers consider ignorance about the traffic rule and carelessness as the top ranked reasons; and absence of appropriate lighting arrangement and negative attitude towards road safety are the second major sources of road accidents caused by rear end collision. However, they are only familiar with rear braking lights in straight line configuration. Driver reaction time is found to be shortest for the rear lights with rectangular configuration and has U-shaped relationship with drivers' age and experience.






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