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# Signal Sensing on Heavy Goods Vehicle (Hgv) Blind Spot Area for Construction Logistics

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***Abstract:*** ***This paper will explore the issues and the causes of accidents contributed by heavy goods vehicles (HGV) specifically instigated by blind spot. A blind spot is an area or zone that cannot be directly observe by the truck driver on their side mirror. Unfortunately, due to this, high number of accidents had happened because of HGV drivers were not alert or aware of another road user or pedestrian hidden in the blind spot area. This often occurred to heavy goods vehicle drivers. The aim of this paper is to understand the issue of HGV blind spot and identify the potential use signal sensing as an alert mechanism for the blind spot of a heavy goods vehicles. This is to detect other road users who are in the dangerous distance of the HGV. This study has revealed the holistic understanding of HGV blind spot issues and problem by finding the answer for research question initially outlined.***

***Keywords: Blind spot, signal sensing, construction logistics, heavy goods vehicle.***

## I. INTRODUCTION

Construction logistics is one of the important enablers to support rapid development and economy. Heavy good vehicle (HGV) or heavy trucks are often used in construction due to it provide the ability to move more and bigger materials to the construction sites. Based on the Department of Statistics Malaysia Press Release Gross Domestic Product Fourth Quarter 2017 [1] Construction industry had grown to 5.8% in 2017, hence demand on construction logistics has also increased. Construction logistics usually requires the use of heavy truck to carry all the construction materials such as rock, sand and cement. The impact of the increasing volume of heavy trucks on road safety are quite alarming [2][3]. The larger vehicles are, the much bigger of their blind spot. Blind spots are the areas around a vehicle that is invisible to the driver when looking through a windows or standards mirrors. This will lead to fatal consequences to hidden road user during maneuvering.

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Many automotive caompanies tried to develop an alternative solution to solve blind spot issues for heavy goods vehicle (HGV) as the percentage of injuries / death people fatality due to blind spot is continuously increased. In order to mitigate the blind spot issues, a lot of efforts has been carried out including cruise control, autonomous emergency braking with pedestrian monitoring, blind lane departure warning and blind spot monitor [2]. In Malaysia, statistics provided by Road Transport Department showed that accident involving heavy goods vehicle increase every year. Refer Table 1.

**Table 1: Statistics of Accidents Involving Heavy Goods Vehicles**

| Year | Type of Accidents | | | | |
|---|---|---|---|---|---|
| | Fatal | Serious | Slight | Damage Only | Total |
| 2009 | 662 | 392 | 500 | 15869 | 17423 |
| 2010 | 650 | 368 | 437 | 17280 | 18735 |
| 2011 | 605 | 222 | 336 | 16005 | 17168 |
| 2012 | 1087 | 485 | 661 | 34743 | 36976 |

(Source: Royal Malaysia Police, 2013)

Based on the crash configuration, it is noted that most crash that relate with blind spot issues are side collision, sideswipe collision and collision where a vehicle is squeezed by another vehicle [4].

**Table 2: Statistics of Accident Between HGV and Motorcyclist Based on Collision and Vehicle Type**

| Collision Type | | Angular/ Side | Side Swipe | Squeezed | Total |
|---|---|---|---|---|---|
| 2009 | T | 185 | 188 | 17 | 390 |
| | RL | 572 | 347 | 19 | 983 |
| | SL | 579 | 299 | 7 | 885 |
| 2010 | T | 210 | 181 | 9 | 400 |
| | RL | 589 | 367 | 18 | 974 |
| | SL | 584 | 306 | 6 | 896 |
| 2011 | T | 190 | 170 | 6 | 366 |
| | RL | 521 | 340 | 23 | 884 |
| | SL | 476 | 263 | 10 | 749 |

T – Trailer, RL – Rigid Lorry, SL – Small Lorry.

Moreover, Table 2 shows the statistics of accident between heavy goods vehicle and motorcyclist based on collision type and heavy goods vehicle type [4]. The statistics also exhibited that most of the accidents were happened from the type of rigid lorry, most frequently happened at the straight road followed by T/Y junction, curvy roads and cross junction. The statistics is shown in Table 3 [4]Technology advancement has help to increase road safety.

Technology has continuously improving and continues to prevent road accidents and reduce the risks faced by road users every day. Ideally, the future of transport should provide a safer, more efficient road system that eventually expected to see a near-zero road accidents.

Signal sensing is one of the technology that potentially will able to detect incoming or nearby vehicles or other road user while driving. By identifying the blind spot area correctly and understand the feature of sensing technology required, will have potentially make blind spot less dangerous.

**Table 3: Statistics of Accidents Based on Road Design**

| | Fatal | Serious | Slight | Damage Only | Total |
|---|---|---|---|---|---|
| **Straight** | 285 | 130 | 167 | 910 | 1492 |
| **Curve** | 64 | 22 | 29 | 115 | 230 |
| **Round-about** | 0 | 1 | 2 | 15 | 18 |
| **Cross-Junction** | 39 | 10 | 23 | 131 | 203 |
| **Junction Y/T** | 77 | 46 | 66 | 478 | 667 |
| **Staggered Junction** | 1 | 0 | 1 | 5 | 7 |
| **Gradient Intersection** | 0 | 0 | 1 | 4 | 5 |
| **Unknown** | 5 | 3 | 3 | 6 | 17 |
| **Total** | **471** | **212** | **292** | **1664** | **2639** |

A study on the potential of signal sensing on HGV need to conduct; to reduce the numbers of accident related with HGV blind spot and to recommend HGV service provider or owner on installing signal sensing device on their vehicles.

## II. LITERATURE REVIEW

In the course of the most recent decades, researchers have focused on how to improve in the safety of indirect vision of heavy goods vehicle. This is because the zone around the heavy goods vehicle that is visible through mirrors is limited. In terms of the location of blind spots, most HGV drivers perceived that the rear is the blind spot area of a truck without realizing that the front and both sides of the truck are blind spots as well. For a start, improving the design of rear view mirror in HGV could reduce the blind spot which in turns leads to reduce the possibility of the road accidents [5]. Due to large physical dimension, a HGV has an operating limitations such as large blind spots, long stopping distances, and limited manoeuvrability that compel other road users to put extra focus on safety. HGV involvement in fatal accidents creating a significant need to better understand the impact of this vehicle group to other road user.

### 2.1 Heavy Good Vehicles (HGV) Accidents

Heavy Good Vehicles (HGV) are commonly categorized into three (3) types: trailer, rigid and small truck. Table 4 shows the distribution of accident for the three (3) different types of HGVs involving other types of vehicles in Malaysia context [6].

**Table 4: Type of Truck and Other Vehicles Cross Tabulation**

| HGV Type | Other Vehicles | | | | Total |
|---|---|---|---|---|---|
| | Bus | Car | Motor | Cycle | |
| **Trailer** | 36 | 640 | 776 | 18 | 1470 |
| **Rigid** | 77 | 1852 | 3047 | 62 | 5038 |
| **Small** | 3 | 155 | 352 | 8 | 518 |
| | 116 | 2647 | 4175 | 88 | 7026 |

Based on the study, the most frequent type of HGV collide with other vehicles is the rigid truck, which having permissible gross weight of over than 2.5 tons. The highest number of collisions with other vehicles is involving motorcycles that has 3047 cases. In order to have better understanding on the how the accident commonly occurred, the collisions type for each vehicle when involve with HGV is shown in Table 5 [6].

**Table 5: Collision Type and Other Vehicles Cross Tabulation**

| Collision Type | Other vehicles (%) | | | | Total |
|---|---|---|---|---|---|
| | Bus | Car/ Van | Motor | Cycle | |
| **Head on** | 0.2 | 13.2 | 8.4 | 0.1 | 21.9 |
| **Rear End** | 0.9 | 11.6 | 16.1 | 0.2 | 28.8 |
| **Right Angle** | 0.0 | 2.0 | 3.7 | 0.1 | 5.9 |
| **Angular** | 0.2 | 7.7 | 17.2 | 0.4 | 25.6 |
| **Side Swipe** | 0.1 | 2.1 | 10.4 | 0.4 | 13.0 |
| **Others** | 0.0 | 0.3 | 0.5 | 0.0 | 0.8 |
| **Hitting** | 0.1 | 0.7 | 0.7 | 0.0 | 1.5 |
| **Out of Control** | 0.0 | 1.1 | 1.4 | 0.0 | 2.5 |
| **Total** | 1.7 | 38.8 | 58.3 | 1.2 | 100 |

As shown in both table from a different study (Table 2 and Table 6), angular collision is the highest contributor to accidents with HGVs. Data from Table 4 indicates that rigid truck caused the highest number of accidents at angular position and this supported by data from Table 6. Therefore, it is important to identify the blind spot for this specific type of HGV.

### 2.2 Heavy Good Vehicles (HGV) Blind Spots

According to MIROS, 2017, there are four (4) area of blind spot of an HGV shown in Figure 1. Based on Malaysian Institute of Road Safety Research MIROS study shown in Figure 1 above, the actual areas of the blind spot of a lorry is **a**, **d**, **e** and **g**. In this study, majority of the road user correctly identified **g** as a blind spot area, (72.9%) followed by 34.1% answered correctly for area **d**. However, still quite a number of road user has misidentified the wrong area as the blind spot. This shows that it is a better solution to use technology that could notify the HGV drivers about the potential risk of accident instead of leaving it up to the other road user to assume where would be the blind spot of the truck.

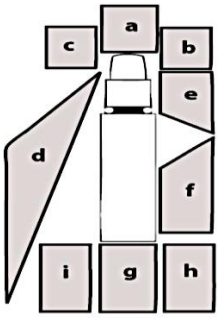



**Figure 1: HGV Blind Spots.**

Source: MIROS, 2017

### 2.3 Blind Spot Detection Method

Among the solutions in addressing the HGV blind spot problem was done by Transport Research Laboratory (2015). This research had led in implementing six (6) mirrors around the HGV cab [7]. Theatrically, the function of six (6) mirrors are to eliminate a large part of blind spot area. Unfortunately, too many mirrors around the HGV resulted a distorted image for the drivers even when the mirrors were correctly adjusted. In addition to this problem, the blind spots zone problems still remain as the driver unable to see cyclists or pedestrians [8]. A study that analyzed on sensor placement for vehicle's blind spot detection suggested to use a device that will warn the truck driver about the incoming vehicles in the blind spot zone by blinking a LED on driver's dashboard. The result from the study shows that the installation of sensor above the rear truck tire give a good performance in term of truck driver alerts of the presence of vehicle at the blind spot zone [9].

Another study was conducted to eliminate blind spot on heavy goods vehicles. The study shows that the catadioptric cameras, an integrated of mirrors and standard cameras can provide truck drivers with an image that allowing to observe the whole area of large goods vehicles and thus reduce fatal accidents, and helps drivers on manoeuvring tasks [10].

### 2.4 Blind Spot Monitoring Technologies

In recent years, with increasing concern on road safety, many auto manufacturers have approached solving blind spot problem in a slightly different manner. However, in general these approaches can be categorized into two (2): active and passive blind spot monitoring.

Active blind spot monitoring is a typical blind spot monitoring system that uses electronic detection device(s) mounted on the external sides of the vehicle that sends out either electronic electromagnetic waves that usually in the radar wavelengths or takes computer-processed images with a digital camera and analyzes them. However, a passive blind spot monitoring is a low technology warning system involve a special convex mirror in the corner of the current external rearview mirror that can see into areas where normal rearview mirrors could not.

Among the state-of-the-art features for HGV blind spot monitoring and control system that use signal sensing was design by Brigade Electronics [11] illustrated in Figure 2.

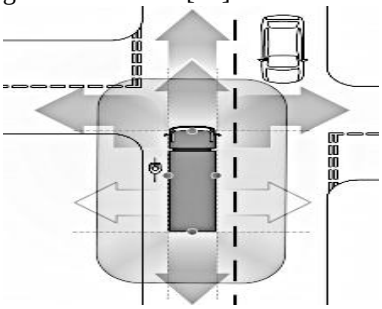
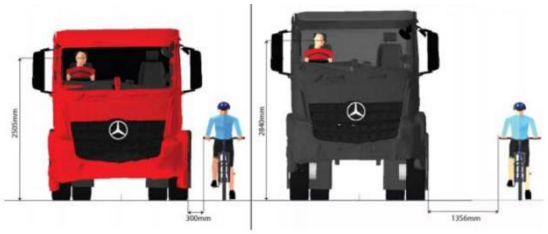


**Figure 2: Brigade Blind Spots Monitoring System**

1. Real time 360° camera system provides the driver with a real-time, 360° 'birds-eye-view' of the vehicle within a single image with four (4) camera images that are processed into a single, real-time picture on the drivers monitor.
2. Four sides scan sensors also known as Ultrasonic Obstacle Detection informs driver of distance between vehicle and obstacles, whether moving or stationary. An indicator will triggers and enables below a set speed to avoid unnecessary activation.
3. Side view camera monitoring system will allow the driver to see the nearside blind spot in the monitor. A dedicated side view can be triggered by the indicator, giving the driver a clear view of cyclists or other vulnerable road users nearby.
4. Reverse and warning alarm is a vital real-speech safety device to warn cyclists and pedestrians that vehicle is turning left. Used in conjunction with side sensors, it is triggered by the indicator and enabled below a set speed to avoid unnecessary activation.

### 2.5 Construction Logistics Road Safety

Construction vehicles are used to transport construction material (e.g. tippers carrying sand or concrete mixers). These vehicles are designed and configured for off-road conditions nonetheless very often operate in urban areas since this is where a lot of construction happens. Construction vehicles typically have larger direct vision blind spots than large or small distribution vehicles. This is due to the higher position of the driver which is 32 percent higher than normal distribution cabs. Moreover, the obscuration distance for pedestrians is on average nearly three times bigger. The obscuration distance for cyclists to the passenger side, is on average more than two times greater illustrated in Figure 3 [8].



**Distribution HGV** **Construction HGV**

**Figure 3: Comparison of Ground Clearance Between Distribution and Construction HGV**

In Malaysia, it has become a concerned that the use of HGV in construction sites has contributed a high risk in road safety. Although there are efforts from government to improve road safety, these efforts are handled by different agencies in various approaches shown in Figure 4.

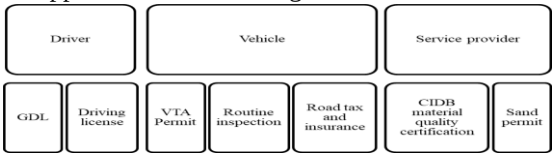



**Figure 4: Government Regulation to Ensure Road Safety**

Although the government has place a strict regulation to HGV operators, such as requirement to acquire GDL license and driving license to be qualified to drive vehicles carrying goods, VTA permit, road tax and insurance,

besides the need to undergo routine inspection every six months in PUSPAKOM for the vehicles and CIDB material quality certification as well as sand permit to ensure safe movement of construction materials; there is no regulation on installing safety devices (e.g. blind spot detector) or any mechanism for that matter on the vehicles as part of safety control [12].

## III. METHODOLOGY

Extensive literature research and reading were done through various sources including articles, journal, theses, official websites and reports.

Literature review helps in identifying the conceptual content of the research area and guides toward the theory development [13].

The objective of this study to explore five (5) subject matters: 1. Heavy Good Vehicles (HGV) Accidents, 2. Heavy Good Vehicles (HGV) Blind Spots, 3. Blind Spot Detection Method, 4.

Blind Spot Monitoring Technologies and; 5. Construction Logistics Road Safety. Subsequently, this study will achieve its aim which to identify potential use signal sensing as blind spot detector and potential collision alert mechanism for a heavy goods vehicles (HGV).

## IV. RESULT AND DISCUSSION

This study has well answered ten (10) questions in regard to the use of signal sensing in blind spot monitoring system for construction HGVs to avoid road accidents.

Table 6: Answers for Research Questions Achieved

| Questions | Y/N | Findings |
|---|---|---|
| What is the current situation on HGVs related accident? | Y | 36976 case in 2012 |
| What type of HGV cause accident the most? | Y | Rigid |
| What the of other vehicle involved the most during accident with HGV | Y | Motorcyclist |
| Where are the accident mostly happen? | Y | Straight road and T/Y Junction |
| What is the type of collision mostly happen? | Y | Angular side |
| Where are the blind spot of an HGV? | Y | Figure 1 – **a,d,e,g** |
| Does road users aware the correct blind spot? | Y | Most got it correct on **g** but quite a number got it wrong |
| What are technologies developed to cater blind spot problem? | Y | 360 camera, side camera, 4 side sensors and reverse and warning alarm |
| Why construction HGVs give higher risk? | Y | have larger direct vision blind spot |
| What authorities that regulate road safety? | Y | Figure 4 |

Table 6 summarizes the findings from this study. These findings are important in order to have better grasp on the subject matter of study so that a suitable solution can be proposed to rectify this problem.

## V.CONCLUSION

This study has revealed the current situation of the problem faced by road users caused by HGVs blind spot. Ten fundamental research question has been answered which then explained the overall situation of the problem studied. Study has revealed that accident caused by HGVs is high especially involving motorcyclist. This was mostly caused by the invisibility of the driver towards other road users at the blind spot zone. The smaller the vehicles (pedestrian, cyclist and motorcyclist) the more invisible they are to HGV drivers. These problems are bigger for HGVs for construction logistics. This is because the size and the height of the trucks are bigger and taller. Therefore, the trucks have a bigger blind spot zone. It has also uncovered that majority of road users have misconception of where an HGVs blind spot actually are. This puts the road users at high risk of getting into an accident with HGVs. Looking at the advancement of technology nowadays, there are ways of technology can aid in improving the level of safety by lowering the risk of accident due to blind spot. Signal sensing is one of the technologies. This technology can be used in the detector or scan sensors that able to informs driver of distance between vehicle and obstacles, whether moving or stationary. Others than that, there is $360^{o}$ and side view camera, and reverse and warning alarm system. Contemplating at Malaysian context, the situation is more worrying as there is no specific regulation in Malaysia that promote or enforce on installing safety devices (e.g. blind spot detector) or any mechanism for that matter on the heavy vehicles as part of safety control especially for construction logistics. Expending this findings, a more appropriate and thorough study can be conducted to provide better solution in overcoming the issue.

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