

# The Use of a Board Game to Train Heavy Vehicle Drivers About Preventing Braking Failure Procedure



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**Abstract— Background:** Fatalities in road traffic are worse than COVID-19. The fatality rate from traffic accidents remains stable. According to KNKT's report, from 2019 to 2021, there were 34 cases handled by KNKT with 216 fatalities, including 14 cases related to the brake system, which led to 66, or 30.56%, fatalities. The majority of drivers lack sufficient knowledge of braking systems and effective braking technique on the downhill road because they don't receive enough training to enhance their skills. **Methods:** A board game called "Awas! Rem Blong" (Beware! Braking Failure) was developed to measure heavy vehicle drivers understanding of the braking system and applying it downhill. Participant will take pre-test and instruction before playing the board game then they will take post-test. **Result:** All participants are 20 bus and truck drivers from 15 bus and truck companies. They never get any training in specific areas such as braking technique and braking systems. In all subjects, which are braking technique, pneumatic braking systems, and hydraulic braking systems, all participants showed an increase in their knowledge. **Conclusions:** The board game "Awas! Rem Blong" is indicated as a good tool to increase the knowledge of drivers about braking technique on downhill roads, pneumatic braking systems, and hydraulic braking systems.

**Keywords:** Traffic Accident, Board Game, Driver Training, Heavy Vehicle, Braking Failure

## 1. Introduction

### 1.1 Traffic Accident

Fatalities in road traffic are worse than COVID-19. Road traffic fatalities are increasing, hitting 1.35 million per year. The death rate fairly stable at around 18 deaths per 100,000 population over the last 15 years [1]. Compared to COVID-19, even though fatalities reach more than 2 million per year and there is an 89 death rate per 100,000 population, the death rate tends to decrease to a 0.0083 death rate per 100,000 [2], [3]. Decreasing COVID-19 death rates caused by invented technology like vaccines, etc. The automotive industry is also inventing so many technologies to prevent accidents or minimize their effects, but amazingly, the death rate has remained stable. In Indonesia, traffic fatalities have also remained stable over the past three years. From 2019 to 2021, the death rates per 100,000 population were 9.51, 8.71, and 9.35, respectively[4].

### 1.2 Heavy Vehicle Accident Cases

Komite Nasional Keselamatan Transportasi (KNKT) or the National Transportation Safety

Committee (NTSC) will come into the investigation of an accident if there are eight or more fatalities[5]. It means that KNKT is handling large cases of road traffic accidents and has data that will tell about the accident's cause. According to KNKT's report from 2019 to 2021, there are 34 cases handled with 216 fatalities out of 320,085 cases with 74,466 fatalities[6]. There are 14 out of 34 cases, or 41.17%, related to the brake system, which led to 66, or 30.56%, fatalities. Trucks are dominantly involved in the majority of accident cases, which are 11 cases out of 14. Human factors related to these accidents are involved in 11 cases, which are all about the competencies of the driver in understanding braking technique. Eight cases related to vehicle brake system condition and nine cases related to the slope of the road and there are eight cases of intersection factors between humans and road conditions.

### **1.3 Driver Competency**

The majority of drivers lack sufficient knowledge of effective braking technique because they don't receive enough training to enhance their skills. On a flat road, using the brakes is as simple as pressing the pedal. However, applying the brakes on a steep road is more difficult. When driving downhill, the driver must begin using the sequence of braking techniques just before and during the duration of the slope. Most heavy vehicles have different braking systems compared to light vehicles. All light vehicles equipped with hydraulic brake systems and heavy vehicles equipped with pneumatic brake systems or a combination of hydraulic and pneumatic systems. Each driver should be familiar with the braking system that comes with the vehicle so that they can do a pre-trip inspection before a journey to make sure it's in excellent working order.

### **1.4 Driver Training**

The driver of a heavy vehicle must have training in order to comprehend the braking system and the braking sequence technique on the way down. Effective training techniques should be refined and put into use to increase driver safety [7]. Educational programs should be put in place by management organizations and transportation firms to ensure professional drivers operate safely [8]. Improper braking technique might be a contributing factor in speed violations that lead to fatal accidents. Driver education and training programs that target risk-taking behaviors in addition to penalties and enforcement tactics may be able to assist drivers commit less repeated crimes of speeding [9]. It is feasible to target certain driver groups and successfully emphasize particular subsets of hazardous driving behaviors during training or traffic safety education by identifying which driver groups are most likely to engage in particular dangerous driving themes [10]. Road condition is one factor that contributes to accidents. An effective design of driver training with emphasis on the risk caused by certain roadways such as downhill, curve-right alignment, and unpaved shoulders should be recommended to reduce accidents [11].

It would be too dangerous to conduct emergency driving training in a real-life situation without enough prior knowledge. To reduce risk, game-based learning using board games can be used as a tool for training and studying. Driving simulators offer realistic, safe, and controlled environments, making them a popular tool for studying driver behavior [12]. But even though a simulator could provide a realistic experience, developing one could be very costly.

The purpose of this study is to evaluate how well heavy truck drivers comprehend how to brake

in the proper order on the downhill and how the braking system works using a board game. Prior research has extensively used board games because of their capabilities. Board games are used to study physics, water resources, resuscitation, etc.[13]–[15]. According to existing research, board games are very creative communication tools that make difficult-to-understand sustainability issues more visible and intelligible[16]. Board games may be used in both formal and informal contexts to further explore learning and ideas like motivation and computational thinking since they reduce complicated problems and systems[17]. The use of board game simulations for clinical training is supported by the improvement in performance and knowledge [15].

**2. Methods**

A board game called "Awas! Rem Blong" (Beware! Braking Failure) was developed to measure heavy vehicle drivers understanding of the braking system and applying it downhill. It can only be played with two players. The board game has three parts for learning: braking technique, inspection of pneumatic systems, and inspection of hydraulic systems. First, all players will take the pre-test to collect baseline information about their knowledge of braking technique and the braking system. There are 12 questions, divided into 4 questions about braking technique, 4 questions about pneumatic systems, and 4 questions about hydraulic systems. Even though there are braking systems with a combination of pneumatic and hydraulic systems, usually called air-over-hydraulic systems, understanding both systems is the same. After the pre-test was taken, players were given directions on how to play the game. Players should place cards in the sequence of the learning row alternatively. A player who gets the "crash" card twice will be eliminated from the game. A post-test using the same questions as the pre-test was conducted after the game was played. The results from the pre-test and post-test will be analyzed using a paired sample t-test.

**3. Results**

**3.1.Participants**

Twenty people are participating in this study, representing 15 bus and trucking companies. The participant's age distribution ranges from 30 to 52 years old, with an average age of 40.85 and an average of 15 years of driving experience. All participants are men and never get training in specific areas such as braking technique and brake systems.

**3.2.Braking Technique Sequence**

The result of the comparison test shows that drivers knowledge of braking technique on downhill is increasing significantly from 57.5 to 91.25, or 33.75 average points. It is also confirmed by t value -5.311. Despite the fact that the average score in braking technique has significantly increased, the sequence of braking on a downhill road should be 100% correct without any mistakes. The reason behind it should be 100% correct because the sequence of braking matters.

**Table 1:** Pre-Test and Post-Test on Braking Technique Result

	Mean	N	Std. Deviation	Std. Error	t-Value
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Pre-Test Braking Technique	57.5	20	27.023	6.043	-5.311
Post-Test Braking Technique	91.25	20	18.629	4.166	

The driver should remember the sequence of braking that should be applied on a downhill road: applying engine brake by switching gears down before entering the slope, then applying exhaust brake, retarder (if any), and the last one, service brake, by stomping the brake pedal. Even though retarder is noted as "if any," the driver should remember this procedure because it will be very helpful if he drives a vehicle that is equipped with retarder. Another reason for being 100% correct in answering the quiz about braking procedures is that drivers are at high risk if they jump or skip the sequence. For example, while driving downhill, if the driver, after applying the engine brake, jumps to the service brake along the slope, it will cause problems such as brake fading or vapor lock, which leads to braking failure.

### 3.3. Pneumatic Braking Systems

A pneumatic braking system is a braking system that uses air to push the brake shoe to the disc or drum and is widely used in heavy vehicles because it has the capability to give great braking power for vehicles with heavy loads. The result of the comparison test shows that drivers knowledge of pneumatic braking system is increasing significantly from 46.25 to 81.25, or 35 average points. According to t value -4.918, it is also confirmed significant.

**Table 2:** Pre-Test and Post-Test on Pneumatic Braking System Result

	Mean	N	Std. Deviation	Std. Error	t-Value
Pre-Test Pneumatic System	46.25	20	30.645	6.853	-4.918
Post-Test Pneumatic System	81.25	20	24.164	5.403	

Knowledge of the pneumatic braking system will help when the driver conducts a pre-trip inspection. The inspection is not mandatory in sequence, but in the game it is sequenced in order to simplify the game mechanics.

### 3.4. Hydraulic Braking Systems

All light vehicles use hydraulic braking systems for simple and economical reasons. All participants in this study are heavy vehicle drivers, so there is a possibility that they are not familiar with the hydraulic braking system except for those who were driving light vehicles before. The drivers knowledge of hydraulic braking system is increasing significantly from 28.75 to 86.25, or 57.5 average points. The t-value of -6.328 also confirmed the significance.

**Table 3:** Pre-Test and Post-Test on Hydraulic Braking Systems

	Mean	N	Std. Deviation	Std. Error	t-Value
Pre-Test Hydraulic System	28.75	20	32.722	7.317	-6.328
Post-Test Hydraulic System	86.25	20	22.176	4.959	

Understanding the hydraulic braking system is also very helpful for the driver when doing a pre-trip inspection. Like the pneumatic system, checking the hydraulic braking system has no

specific order, but in this game it is set to be in order. Knowledge of hydraulic systems has the biggest significance compared to the other two. It is probably because most of the drivers do not start with a light vehicle while learning about driving, so they are not familiar enough with hydraulic systems.

### 3.5. Overall Comparison

By combining all results, knowledge of braking technique on downhill, understanding pneumatic braking systems, and hydraulic braking systems shows an increase significantly from 44.17 to 91.25. The value of t is also confirmed by -8.538.

**Table 4:** Pre-Test and Post-Test on Braking Technique Result

	Mean	N	Std. Deviation	Std. Error	t-Value
Pre-Test Overall	44.17	20	21.981	4.915	-8.538
Post-Test Overall	91.25	20	17.579	3.931	

It shows that, on average, all participants have increased their knowledge of braking techniques on downhill roads, pneumatic braking systems, and hydraulic braking systems.

## 4. Discussion

Specific training is needed by management to increase driver safety [7], [8], [10], [11]. The board game "Awasi! Rem Blong" was designed specifically to meet effective training needs and could be used by organization management to train new drivers before they get trained with the real heavy vehicle, considering the low risk of board game. In the first stage, it increases knowledge for the driver, and it is expected that the knowledge can be applied before and while driving heavy vehicles. After all, it will reduce road traffic accidents and fatalities caused by heavy vehicle, because the effect of heavy vehicle accident could be vast. A dangerous truck, such as a tanker, will spill the oil, which could lead to fire and risk the environment around the scene. For a bus, the failure to apply braking technique will risk all the passengers. In short, for heavy vehicles, the failure of braking systems or applying braking technique will impact not only the driver but also the passenger, the environment, and other road users.

Board game could make training material easy to understand and simplify the systems in the real world and could improve performance and knowledge [15]–[17]. The "Awasi! Rem Blong" game simplifies understanding the process of braking on a downhill road by using a board and cards that are specifically designed. It is easier and less risky than bringing the driver directly to the vehicle and trying to brake on the downhill road before having enough knowledge. This game also simplifies understanding braking system items that should be checked before driving. Such as leakage of braking oil or air pressure. For example, after playing a board game, the driver will know what indicator to pay attention to when considering the leakage of air pressure before driving in detail on the vehicle. According to the result, it shows that the

knowledge of the drivers has improved, but their performance requires more time to observe.

## 5. Conclusion

In this study, the board game "Awas! Rem Blong" is indicated as a good tool to increase the knowledge of drivers about braking technique on downhill roads, pneumatic braking systems, and hydraulic braking systems. This game should be played several times within a session. Knowledge about braking system items to be checked is expected to increase, and the sequence of braking techniques will be 100% correct before the driver tries them in the vehicle. So it will reduce risk when applied in the real world.

## 6. Limitations and Suggestions for Future Research

This study was limited to driver training using a board game on only one level. Suggestion for next research: the results from this study should be compared with those of drivers who trained using a regular or traditional model. Another suggestion is that after playing the game, the level of difficulty has to be increased to make sure the knowledge is well remembered.

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