Effectiveness of vehicle weight enforcement in a developing country using weigh-in-motion sorting system considering vehicle by-pass and enforcement capability

Mohamed Rehan Karim , Nik Ibtishamiah Ibrahim , Ahmad Abdullah Saifizul , Hideo Yamanaka

Trucks or heavy vehicles are dominant in transporting goods or materials from manufacturer to wholesalers and retailers before distributing it to other small businesses and end users. Table 1 shows the maximum permissible laden weight for each axle class inMalaysia. The axle is an important component of awheeled vehicle that maintains the position of thewheels relative to each other and to the vehicle body. Wheels and axles bear the weight of the vehicle including any cargo, as well as acceleration and braking forces. Section 19 (4) of the CVLB Act 1987 states that anyone who fails to comply with any condition stipulated under the CVLB license, which includes the maximum weight permissible for a lorry to carry, shall be guilty of an offense and shall, upon conviction, be liable to a fine of not less than MYR1000 (USD330) but not more than MYR10,000 (USD3300) or to imprisonment for a term not exceeding one year or both.

More than 51,045 km paved roads in Malaysia are well planned and maintained, and provide easy access throughout Malaysia [1]. The New Straits Times [2] reported that therewere 19.3 million registered vehicles on Malaysia's road and the government have spent MYR5 billion (USD1.6 billion) between 2001 and 2010 to sustain all the federal roads.

Following an attempt to reduce traffic congestion, all heavy vehicles were not permitted to enter several stretches on the North–South Expressway, starting from August 2, 2010 during morning peak hours [3]. The ban applies to vehicles, except busses, weighing 10,000 kg and above. Accordingly, those found flouting the law would be issued MYR300 (USD100) maximum fine and if offenders were to be charged in a court, they can be fined up to MYR1000 (USD330), jailed for three (3) months or both, as stipulated under Section 70(4) of the Road Transport Act 1987 [4]. However, such a move has very little impact since the heavy vehicles could use other alternative roads to get to their destination.

The Malaysia's manufacturing sales continued to gain positive double digit growth, an increase of 12.9% or MYR5.8 billion to reach MYR50.8 billion as compared with the same period in 2010 [5]. In order to stay competitive and efficient in handling cargo and following the positive growth in the GDP as well as manufacturing sectors in Malaysia, many of the transport companies have adopted truck fleet that are larger in terms of both loading and size. Besides gaining more profit through the increasing sale volumes, the movements of the transport companies, especially the overloaded trucks can cause damage to the road surface such as reducing the pavement service life and overall service level of the pavement system [6].

Problem of overloaded vehicles

Commercial vehicle safety has been an important focus of commercial vehicle enforcement agencies for some time [7]. Overloaded vehicles produced higher kinetic energy, resulting in greater impact forces and damages to other vehicles or to the infrastructure, especially when met with an accident and are more likely to be fatal. Many researchers have shown that the important reason for road damage is the vehicle load [8]. A study by the International Road Dynamics Inc. found that 10% increase in weight can accelerate pavement damage by over 40% [9]. Furthermore, overload could cause the main part of the vehicle to be damaged and malfunction. According to Jacob and La Beaumelle [10] there were several adverse consequences that may occur when the heavy vehicles exceed the maximum permitted limit, i.e. (i) truck instability because of the increased of height at the center of gravity and more inertia of the vehicle bodies, (ii) braking default because besides the system itself, it depends on the tire and suspension performance which is designed for the maximum allowable weight indicated on the vehicle documents, (iii) loss of motivity and maneuverability since the vehicles is under-powered, which resulted in lower speeds on up-hill slopes aswell as the risk of congestion, inefficient engine braking and over speeding on down-hill slopes, (iv) overheating of tire and high risk of tire blowouts, and (v) accident or loss control of the vehicles will result in higher risk and severity of a fire, especially when transporting flammable goods.

According to Marshek et al. [11] the damages on the road pavements will not be increased by increasing the number of axles and tires per axles because the load will be distributed evenly among the axles. Another study carried out by Paul and David [12] found that road damage is primarily caused by the heavier axle loads associated with large commercial vehicles but at the same time an increase in permitted GVW on commercial vehicles can save up to 5% in haulage cost. This statement was supported by Jarvis [13] who reiterated that the increase of vehicles' GVW on highways while at the same time keeping individual axle limits at the current level, will increase productivity, fuel conservation, air quality, infrastructure conservation and public safety, and at the same time reducing the carbon emission and traffic congestion.

Another study by Ardani et al. [14], found that the longitudinal cracking always occur at the middle between two tires and there are several primary cause for this situation, i.e. (i) improper construction practices, (ii) combination of heavy load repetition, and (iii) loss of foundation support due to heave caused by swelling soil.

Overloaded trucks may cause delays to other vehicular traffic and the experienced delay and the need to stay behind the slow-moving vehicle might increase frustration among the faster drivers and cause unsafe behavior [15]. As such, the presence of a significant number of overloaded trucks in a traffic stream may also create safety concern to other road users.

The vehicles/trucks that violate the weight limits in Malaysia are currently determined by static weighing at designated weigh stations. Currently, there are 52 static weigh stations in operation along the country's road network. Vehicles/trucks that appear to be overloaded are first identified through manual observations by the Road Transport Department officials on patrol along public roads and these vehicles/ trucks are asked to go to the specified static weigh station for the actual vehicle weight (Gross Vehicle Weight, GVW) to be determined. If the vehicle is found to be overloaded, the driver will be given a summon.

Objective

The aim of this study is to identify the effectiveness of using WIM sorting system in enhancing the operations of the current static weigh station in enforcing vehicle weight limit regulations. Specifically, this paper attempts to quantify the effect of overloaded vehicle bypassing the static weigh station facility as well as the enforcement capability of the weigh station system and facilities to enforce the weight limit regulations. In this paper, bypass is defined as the situation when the violating trucks do not pass through the stretch of road that has the static weigh station and WIM sorting system while enforcement capability is defined as the capability of the static weigh station system and facilities to enforce the weight limit regulations (Fig. 1).

Methodology

Currently, enforcement officers will identify through visual assessment whether a truck is suspected to be overloaded and direct the truck to come into the static weighing facility to be confirmed whether it is overloaded or otherwise. The enforcement officers could not make all trucks to come in for weight inspection because the number of trucks is just too large. More often than not, a truck may be found to be within the legal weight limit, and the long waiting time in the long queue during inspection procedure may end up to be a waste of time and resources.

A weigh-in-motion system would be an ideal solution to this predicament. The prospect of using the WIM system has been deliberated in another earlier paper presented at the ITS World Congress in Busan, Korea in 2010 [16]. Data from the WIM system has also been analyzed in a previous study on differential speed limit for heavy vehicles [18]. The WIM system was installed on a rural single carriageway two-lane road with straight and flat road geometry, named Federal Route 54, to capture all traffic data in the westward direction. The development of this system has been customized to suit the vehicle enforcement regulation in Malaysia. Furthermore, all sensors and hardware installed have been critically chosen to be reliable in Malaysian climate and environment, especially on temperatures and lightning conditions. The data obtained for this study is for January 2010 (1 month period).

The validation exercise and accuracy of the WIM system has been proven in an earlier paper presented at the ITS World Congress in Busan, Korea in 2010 [17]. In the validation exercise, comparison was made between GVW measurements made by the static weigh scale and that of the WIM system. Since the accuracy of the WIM system developed and installed at the study location is within +/−10% of the static weight, only those GVW data +10% above the legal weight limit were considered in this study.

An effectiveness study in using a WIM system as a weight screening or weight sorting facility was conducted for a period of one month in January 2010 at the static weighing station in Ijok on Federal Route 54 in Malaysia. The calibrated and validated WIM system was utilized for the purpose of identifying gross vehicle weight (GVW) violations for all categories of trucks in the traffic stream during that month.

Full text available at :

http://www.sciencedirect.com/science/article/pii/S0386111213000174