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Research Article

Speed Limit Compliance Index (SLCI): A Conceptual Method to Enhance the Efficiency of the Advisory Intelligent Speed Adaptation System

Seyed Mohammadreza Ghadiri,[1,2] **Riza Torkan**,[3] **and Ahmad Farhan Mohd Sadullah**[4]

[1]*School of Aviation Management & Logistics, Swiss Institute of Management and Innovation, Bahnhofstrasse 21, 6300 Zug, Switzerland*
[2]*VJR, Faculty of Civil Engineering, Universiti Teknologi Malaysia, Johor Bahru 81310, Johor, Malaysia*
[3]*Torkan Muhendislik Co., Istanbul, Turkey*
[4]*School of Civil Engineering, Universiti Sains Malaysia (USM), Nibong Tebal 14300, Penang, Malaysia*

Correspondence should be addressed to Seyed Mohammadreza Ghadiri; smrgh1@gmail.com

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Globally, as many as 50 million road users are injured in road traffic crashes and about 1.35 million of them die. Between 2002 and 2030, global deaths resulting from injuries caused by road traffic accidents are predicted to increase by over 40%. Speeding has a relatively eminent relationship with accident involvement and severity. The experiences of pioneers have revealed that the intelligent speed adaptation (ISA) system reasonably has brought a promising future to speed management and road safety. The findings from the earlier studies disclose that the effect of the advisory ISA on drivers' behavior, particularly their driving speed choice, is positive and that it is the most desirable system among the drivers. Nevertheless, the system does not have a long-lasting effect, and when the system is removed or deactivated, the effect gradually disappears. Speed limit compliance index (SLCI) is a conceptual method in the form of a novel performance-based indicator and a mathematical formulation that would be potentially a feasible solution to address the abovementioned defect, and it could be an effective countermeasure to improve the efficiency of such a system. This study mainly aims to discuss and illustrate the structure of this method.

1. Introduction

Globally, up to 50 million serious injuries sustained in road crashes and road traffic fatalities have reached 1.35 million cases annually, which can be translated into some 3,700 deaths per day [1]. Between 2002 and 2030, global deaths resulting from injuries are estimated to increase by over 40% due to the increasing number of road traffic accident victims [2].

Speeding is one of the major causes and contributors to the threat, severity, and catastrophic outcomes of motor vehicle collisions, according to statistics from all serious traffic accidents, and it is estimated that about a third of fatal accidents are caused by speeding [3–5]. If drivers had the ability to reduce their driving speeds, then the number of collisions and injuries would be reduced.

Much scientific evidence suggests that even slight reductions in driving speed lead to substantial reductions in traffic accidents [6–9]. The relationship between traffic injuries and fatalities and changes in vehicular speed have been investigated and modeled by several researchers around the world. For instance, Ágústsson [10] has shown that a 1 km/h driving speed reduction can reduce accidents with personal injuries by about 3%. Nilsson [11] asserted that the change in accident rate is associated with the change in mean speed through the power model. The power is mainly related to the result of the accident in the form of injury, severe injury, or fatality. The power model employs six different equations to estimate the effects of mean traveling speed changes on traffic safety (equations (1)–(6)).

$$\text{Number of fatal accident}: Y_1 = \left(\frac{V_1}{V_0}\right)^4 Y_0, \tag{1}$$

$$\text{Number of fatalities}: Z_1 = \left(\frac{V_1}{V_0}\right)^4 Y_0 + \left(\frac{V_1}{V_0}\right)^8 \cdot (Z_0 - Y_0), \tag{2}$$

$$\text{Number of fatal and serious injury accident}: Y_1 = \left(\frac{V_1}{V_0}\right)^3 Y_0, \tag{3}$$

$$\text{Number of fatal and serious injury accident}: Z_1 = \left(\frac{V_1}{V_0}\right)^3 Y_0 + \left(\frac{V_1}{V_0}\right)^6 (Z_0 - Y_0), \tag{4}$$

$$\text{Number of injury accidents (all)}: Y_1 = \left(\frac{V_1}{V_0}\right)^2 Y_0, \tag{5}$$

$$\text{Number of fatal accident (all)}: Z_1 = \left(\frac{V_1}{V_0}\right)^2 Y_0 + \left(\frac{V_1}{V_0}\right)^4 (Z_0 - Y_0), \tag{6}$$

where speed is V, an accident is Y, and the accident victim is Z. In addition, subscripts of 0 and 1 represent the observed values before and after a change in mean speed, respectively. Although the power model was reformulated by Elvik et al. [12], later to achieve the best estimates of the exponents, the original model was substantially supported and validated by them through meta-analysis research.

Curbing the driving speed would be a wise way to increase road safety, and one of the approaches to prevent the vehicle from traveling faster is to use features that discourage prolonged speeding. In fact, the need to increase road traffic safety is the most important concern, and the authorities around the world have dedicated substantial resources to addressing the speeding issue, primarily to enhance compliance with the permissible speed limits. Nowadays, numerous policy efforts such as educating drivers (training and campaigns), enforcement tools (police, automated enforcement system (AES), and cameras), or different types of physical engineering measures (road humps, road narrowing, and roundabouts) are employed to decrease the level of speeding infringements.

Although many of these traditional measures have been shown to be effective, the results of accident analysis indicate that there are still many efforts that need to be undertaken. A lot of these conventional speed control solutions have shown a lack of effectiveness in their site coverage, durability, or both. Previous research has found that measures such as police surveillance or speed cameras are only effective in reducing excessive speeds in the vicinity of the enforcement area, and even then, the effect is only temporary [13, 14]. Similarly, the roadway features (such as humps and road narrowing) that were designed to reduce excessive driving speeds are effective only in a small area [15, 16]. The main challenge with the effectiveness of campaigns is that their effects quickly decline and even gradually disappear right after the event [17, 18]. Therefore, to be more efficient, it needs to be repeated over time.

The intelligent transport system (ITS) is a generic term used to describe the enhanced technologies such as communication, telecommunication, sensors, information processing, and computing that are applied to address the issues of transportation services. The ITS emphasizes providing efficient, safe, secure, competent,

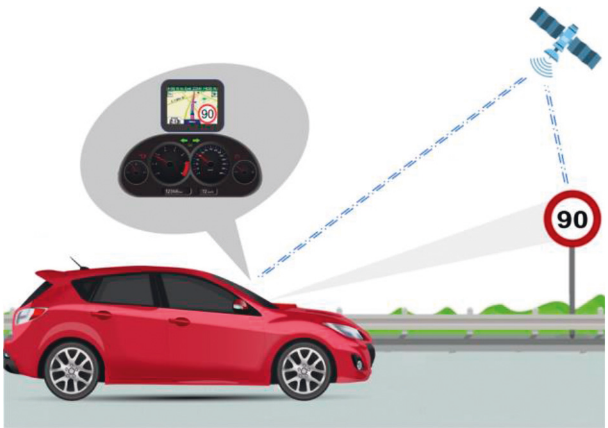

Figure 1: Visual illustration of the ISA system.

sustainable, and environmentally friendly movements, which apply to all modes of transportation, including road, rail, air, and sea [19]. The intelligent speed adaptation (ISA) is one of the subsystems of ITS, and the generic name for a driver support system refers to a variety of systems that are used to support drivers in their traveling speed control tasks. As a definition, ISA is a type of system that provides the possibility for the vehicle to know the permissible or advised speed limit for a stretch of the road. The system employs a global positioning system (GPS), including a digital mapping system, to determine where a vehicle is located and at what speed it is traveling. It makes the information available to the driver or limits the vehicle's maximum speed to the local speed limit. The ISA system activates when the driver trespasses the permitted speed limit of the road. Applying audio, visual, and/or haptic warnings reminds the driver about the speed limit violation and the need to adjust the driving speed according to the legal limitation (Figure 1).

The system can also be equipped with a speed limiter mechanism that can physically adjust driving speed when the driver exceeds the posted speed limit [20–23]. Generally, there are three major types of ISA intervention available [24]: advisory (informative), advisory intervention (sometimes called voluntary or driver select or supportive system), and mandatory system (also called limiting system).

In the informative type of ISA, information about the current permitted or legal speed limit of the road is provided to the drivers, and the system does not intervene in the driving speed. The advisory intervention provides information to the drivers or warns them by a haptic, audible means (e.g., beeping or a vocal message) and/or flashing in the event of a speed limit violation. This type of ISA allows the driver to override the system. In the mandatory intervention type of ISA, a physical intervention is applied to limit the driving speed according to the permitted speed limit of the road, and the system usually consists of an emergency failure function.

Previous ISA trial studies around the world have demonstrated the usefulness of ISA not only to reduce the risk and severity of traffic collisions but also to show the drivers' better interactions with the surrounding traffic as well as other road users. Furthermore, ISA could also result in a reduction in fuel consumption and, consequently, air pollution [22, 25–31].

In reality, mandatory ISA systems had a greater impact than advisory systems, despite the fact that advisory systems were more popular with drivers [32, 33]. For instance, a comparison of three types of ISA systems, including an informative system and a haptic throttle, was carried out with 24 subjects by Päätalo et al. [34] in Finland. The outcomes of this study revealed that while the restricting system was the most effective in reducing speeds, the advisory system had the highest acceptance and was deemed desirable. In another study, a large-scale web-based survey was carried out among 7528 respondents in Belgium (6370 people) and the Netherlands (1158 people) on the concern of the acceptability of ISA in September 2009 [35]. Seventy percent of the respondents wanted to have an informative or warning system, while 30% of them indicated that a restricting type of ISA is preferable. In France, the LAVIA project was initiated by the French Ministry of Transport in the year 2001 [36]. The findings showed that of the three tested systems (informative, advisory or driver select, and mandatory), the mandatory system was deemed less acceptable than the other types and even considered dangerous.

The world's largest trial on ISA, with about 5000 ISA-equipped vehicles, was carried out during 1999–2001 in four cities in Sweden [37]. The findings confirmed that warning systems were more preferable than active gas pedal by the test drivers as well as the general public earlier to the trial study. The result of the External Vehicle Speed Control (EVSC) project for both simulator and on-road studies in the UK declared that drivers favored an advisory system more than a mandatory system [24]. The positive effect of the advisory system on drivers' behavior was also confirmed via a field study by Adell et al. [38] in Italy and Ghadiri et al. [31, 39] in Malaysia.

A previous study on the advisory system confirmed that this system has a significant preliminary effect and that the effect diminishes slightly over time. For example, in their trial study in Malaysia, Ghadiri et al. [31] found that when the advisory ISA system was deactivated, the drivers returned to their habitual speeding behavior. Almost all ISA studies declare that there is no long-lasting effect on speeds when the system (either advisory or mandatory) is removed or deactivated, and the effect gradually disappears [26, 40, 41].

As per the lesson learned from the erstwhile studies, to achieve a lasting effect of the advisory ISA, the system should not be eliminated from the vehicle and it must operate as a permanent, functioning in-vehicle unit. Another way to increase the adaptability and usage rate of ISA would be to increase the drivers' motivation. Lindberg [42] investigated the effect of increasing motivation on increasing ISA demand. This experiment was carried out with ISA drivers in Borlänge, Sweden. Drivers used an advisory ISA, and they received a bonus for their participation, but this bonus was reduced during the study for each minute of driving above

Table 1: The summary results of the recent advisory trial study in some countries with incentives.

Location	Year of study	Light vehicles	Heavy vehicles	Speed zones (km/h)	Change in mean speed (km/h)	Change in 85th % speed	Reference
Borlänge, Sweden	2002	90	None	30–110	—	—	Lindberg [42]; Hultkrantz and Lindberg [46]
Denmark	2007	26	None	50–130	−0.8 to −6.2	—	Agerholm et al. [43]
Denmark	2008	153	Unknown	50–130	−3.6	−3.5 to −8.5	Lahrmann et al. [44]

the speed limit. The results showed that speed violations were reduced for drivers who received an economic incentive when compared to the control groups (drivers who did not receive a bonus). The researchers also found that this reduction was more for the drivers with higher bonuses compared with the lower-priced group.

In a Danish trial study, Agerholm et al. [43] employed an advisory ISA and involved twenty-six employees of a company in a competition for a prize from the management of their company. The prize was awarded to a low speeder driver for 1000 km of driving. They provided a web page for drivers to trace their driving performance compared with their colleagues. The result showed up to a 6.2 km/h reduction in mean free-flow speed, while speeding by more than 5 km/h was reduced from 60% to 75%. They also found that when the identification key was not used by the drivers, the speeding increased.

In another study in Denmark, the "Pay as you speed" project offered a 30% discount on the drivers' insurance premium for 153 participants. This study also confirmed the positive effect of motivation on increasing the effectiveness of an advisory ISA. The result showed a 3.6 km/h reduction in mean speed from 3.5 to 8.5 km/h in the 85th percentile speed and a 77% reduction in speeding by more than 5 km/h [44, 45]. Table 1 provides the results of some advisory trial studies with incentives.

The above findings clearly show that for the advisory ISA, if the drivers are motivated and encouraged to follow the speed limit, the system's usefulness will be improved, and it will work more efficiently. Although the incentive solutions may not be that much feasible for large-scale implementation, they could ascertain the importance of motivating the drivers and, subsequently, increase the effectiveness of the ISA system.

2. Speed Limit Compliance Index (SLCI) Conceptualization

Earlier studies on ISA showed that the limiting systems (such as "Dead Throttle" and "AAP") were the most effective ISA systems in reducing excessive speeds, while other advisory systems (such as beep, flashing, and vocal warning) had the greatest acceptance [32, 34]. However, for those very supportive systems, the effect was also not long-lasting and it decreased over time [24, 25, 47]. It has also been emphasized that when making an attempt to introduce measures to enhance traffic safety, they must also address drivers' internal motives to increase their acceptance and to last over time [48].

According to Summala's theory [49], drivers are motivated to greater risky behavior to attain certain benefits, such as emotion. Furthermore, drivers also underestimate the risk of an accident compared with the more general risk of traffic accidents [20]. For instance, in a study by Hatfield and Job [50], the respondents were asked to answer the following question: "at how many km/h above the speed limit would the crash risk double?" The responses indicated an average of 25 km/h for urban roads and 30 km/h for rural roads, while 5–10 km/h is the correct answer [51].

Speed limit compliance index (SLCI) is a prototype formula, and it is extracted from the fact that nobody likes to lose. It provides a self-evaluation mechanism for the drivers to monitor their level of safe driving skills concerning speed limit compliance. This mechanism potentially provides a competitive environment among the drivers and will increase their motivation to achieve the highest score possible by following the speed limit.

In other words, each time they exceed the speed limit, they will consequently lose a certain score that affects their level of speed limit compliance or safe driving skill. But if they adjust their driving speed according to the limit, they will have a chance to repair and improve their score too. The similar logic is used in computer game applications. The key thing here is that almost all ISA devices can capture the speed, and this can be stored in their database, and using this formula, the SLCI can be calculated at any time.

In a nutshell, SLCI provides this opportunity for all drivers to consider their speeding behavior themselves, feel the risk of their actions better, and try to improve them willingly. In fact, nobody can criticize the drivers' behavior and help them improve their driving behavior better than themselves. Although this method can be employed for the other types of ISA, the advisory systems are preferable because of their lower cost and their acceptability.

3. The Concepts of SLCI and the Formula Proposition

To form the SLCI formula, first, it is assumed that the initial score for the drivers is equal to 1, i.e., 100% compliance or safe driving skill concerning the speed limit. This is similar to the preliminary bonuses that were given in earlier studies [42]. For each offense, the driver loses a point according to the formula (this point is called a "penalty score" or "α"). No speed offense results in a "Zero" penalty score. Thus, the total score will remain 1. This means that the penalty score will function upon committing a speeding offense.

The fraction of a penalty score or "α" has two parts: the amount of offense in the numerator and a controller in the

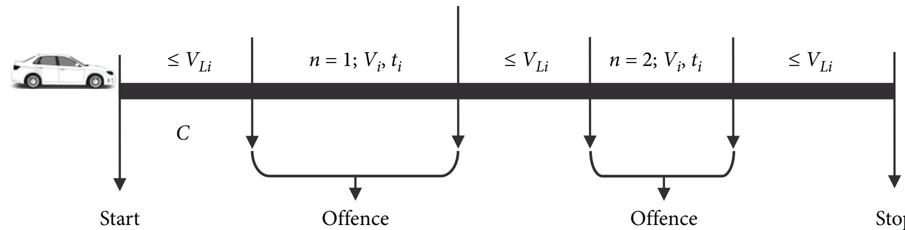

Figure 2: Schematic illustration of SLCI parameters for a trip on a section of road.

denominator, which reduce the effect of offense. For any offense, the numerator and consequently the penalty score will increase. But driving according to the speed limit will increase the denominator and thus decrease the penalty score. The denominator, or controller, provides an opportunity for the drivers to fix their scores and lessen or eliminate their speeding offenses, and it motivates them to use the ISA system, which assists them in following the speed limits carefully.

Mainly, SLCI is affected by the total distance that the drivers drive above the speed limit, and it is related to the elapsed time and the amount of speed infringements. According to the literature, further speed has an exponential relationship with accident risk, and for a small increase in driving speed, this risk is increased exponentially [8, 10, 52, 53]. Moreover, a conventional theory says that the probability of an injury crash is proportional to the square of the speed, based on kinetic energy considerations.

$$KE = \frac{1}{2} \times M \times V \wedge 2, \quad M = \text{mass}, V = \text{velocity}. \tag{7}$$

Considering the above formula, to increase the effect of speed offenses, the amount of speed above the speed limit is powered to 2. It means that, for a small increase in speed infringement, the amount of offense in the penalty score's fraction will be increased to power 2. However, any increase in penalty score, or "α," will decrease SLCI, that is, in this formula, the time and speed of offense are negatively associated with SLCI (equations (8) and (13)).

The controller in the denominator of the penalty score fraction consists of the speed limit of the road and the total distance from the start point up to the benchmark (where the SLCI is calculated), excluding a proportion of the distance traveled over the speed limit (equation (10)). The point here is that not the whole traveled distance over the speed limit is considered as the driving experience, and it must be lessened according to equation (10).

How far a driver drives the vehicle can be taken into account as his/her driving experience, which means that with increasing driving experience, the negative effect of the offense on SLCI should be decreased. But the question is, even driving above the speed limit should be taken into account as his/her driving experience? Certainly, unsafe driving is not a positive experience; therefore, to consider this fact, the safe speed (speed limit of the road) instead of the current speed is entered into the formula to calculate the distance for driving above the speed limit situation (equation (10)). Hence, driving experience is positively associated with SLCI, while it is negatively associated with "α" (equations (8) and (13)).

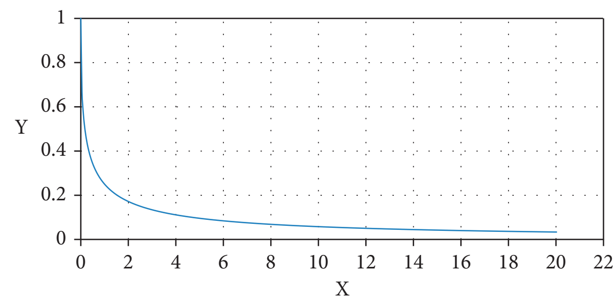

Figure 3: The graphical illustration of equation (11).

Another parameter in the SLCI formula is "n" or the number of offenses. This parameter is negatively associated with SLCI. The negative association is considered in the formula when "α" is calculated (equation (9)). Figure 2 shows the concept of SLCI for a stretch of road.

In Figure 2, V_{Li} is the speed limit, V_i is the maximum driving speed during each speeding offense, $(V_i > V_{Li})$, t_i is the elapsed time during each speeding offense, n is the number of speed offenses up to the point (benchmark), where the index is calculated, and m is the total distance from the beginning to the benchmark, including the covered distance while driving under or equal to the speed limit and a proportion of the distance while driving over the speed limit according to equation (10).

Briefly, the associations between the parameters to make a SLCI formula are presented as follows:

$$\begin{gathered} \alpha \propto V_i^2, \\ \alpha \propto t_i, \\ \alpha \propto \frac{1}{V_{Li}}, \\ \alpha \propto n, \\ \alpha \propto \frac{1}{m}. \end{gathered} \tag{8}$$

The prototype formula for the penalty score or "α" is formed as follows:

$$\alpha = \frac{\left(\sum_{i=1}^{n} t_i \left(V_i - V_{Li}\right)^2 / V_{Li}\right)}{m}. \tag{9}$$

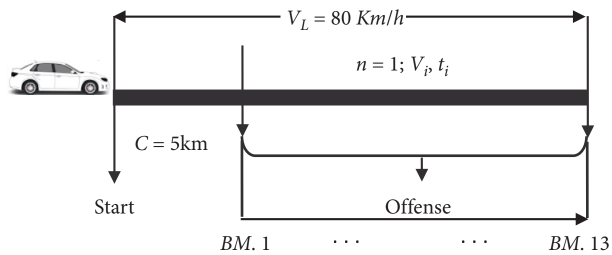

Figure 4: Schematic illustration of the parameters of the example.

Table 2: The breakdown data of the example.

BM	t_i (h)	D (km)	V_i (km/h)	$t_i * (V_i - V_{Li})$	m (km)	α	SLCI (^2)	SLCI (^4)	SLCI (^6)
1	0	5	0	0	5	0	1	1	1
2	0.017	6.340	80.833	0.014	6.326	$2.744E-05$	0.990	0.979	0.969
3	0.033	7.694	81.667	0.056	7.639	$9.091E-05$	0.981	0.963	0.945
4	0.050	9.063	82.5	0.125	8.938	$1.748E-04$	0.974	0.949	0.924
5	0.067	10.444	83.333	0.222	10.222	$2.717E-04$	0.968	0.937	0.907
6	0.083	11.840	84.1667	0.347	11.493	$3.776E-04$	0.962	0.926	0.891
7	0.100	13.250	85	0.5	12.75	$4.902E-04$	0.957	0.916	0.877
8	0.117	14.674	85.833	0.681	13.993	$6.079E-04$	0.952	0.907	0.864
9	0.133	16.111	86.667	0.889	15.222	$7.299E-04$	0.948	0.899	0.852
10	0.150	17.563	87.5	1.125	16.438	$8.555E-04$	0.944	0.891	0.841
11	0.167	19.028	88.333	1.389	17.639	$9.843E-04$	0.940	0.884	0.831
12	0.183	20.507	89.1667	1.681	18.826	$1.116E-03$	0.936	0.877	0.821
13	0.200	22	90	2	20	$1.250E-03$	0.933	0.870	0.812

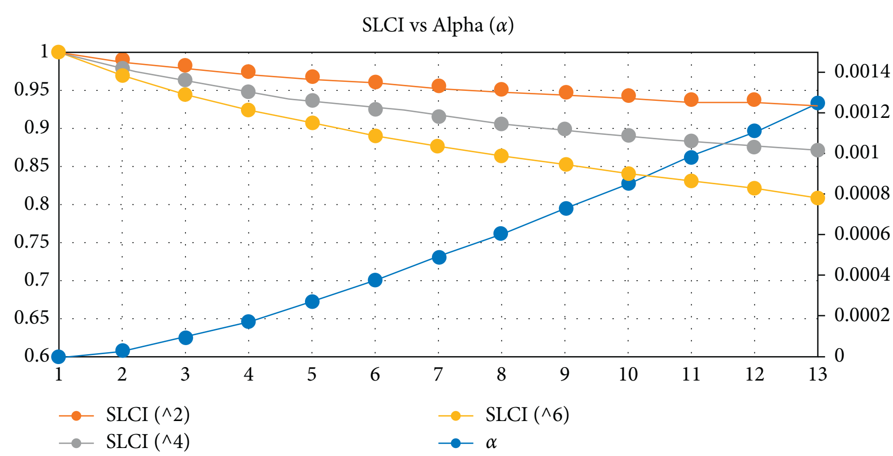

Figure 5: The graphical illustration of changes in SLCI according to different alpha values.

In this formula, V_i is the highest speed reached during the speeding offense. This means that if a driver drives 90 km/h in the 80 km/h speed limit zone and then decreases the driving speed to 85 km/h, the amount of speed that is used to calculate the penalty score will still be 90 km/h. The idea is to discourage the driver from increasing the driving speed during the speeding offense. This plays the role of a safety valve to avoid incremental speeding. Fortunately, "α" has no unit, and it provides the chance to use this formula for different speed units such as km/h, m/s, or mph, and no conversion for the unit is needed. "m" is the total distance from the beginning or start point to the benchmark where the index is calculated. It consists of traveled distance in a situation where the current driving speed is under or equal to the speed limit and a proportion of the traveled distance during the speeding event.

$$m = D - \sum_{i=1}^{n} t_i \left(V_i - V_{Li}\right), \tag{10}$$

where D is the total distance from the start point to the benchmark.

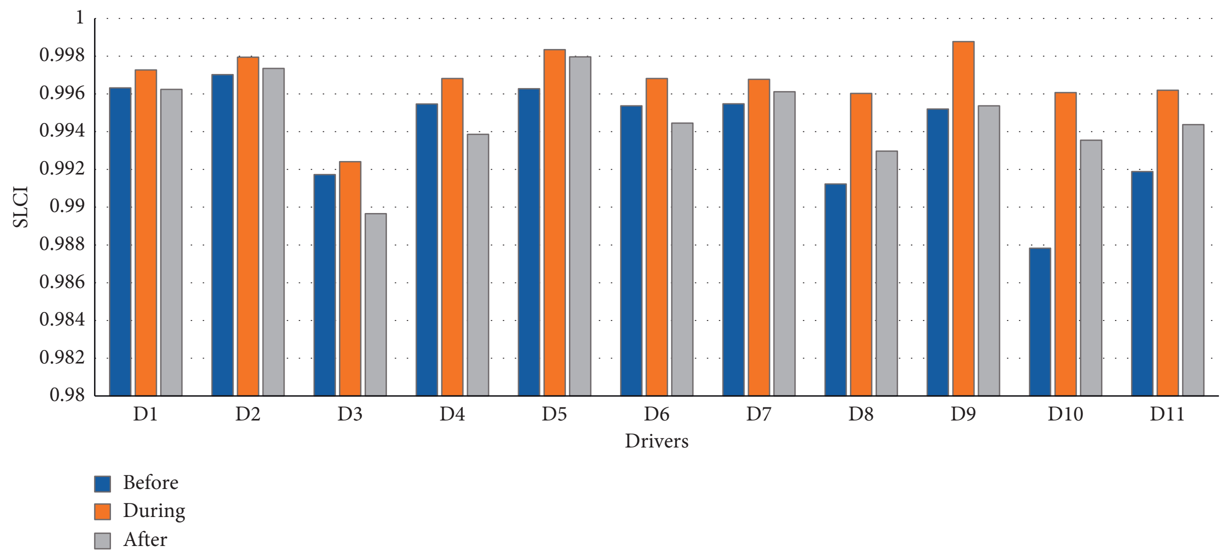

Figure 6: Speed limit compliance index (SLCI) for all 11 drivers regarding to three periods of study and for the segment III.

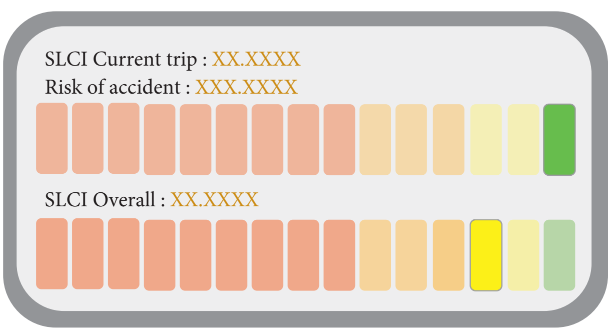

Figure 7: A schematic of SLCI and speed risk indicator.

Since the amounts of "α" are usually very small, to increase the sensitivity of "α," equation (11) is employed to form the main SLCI formula (Figure 3). In case if more sensitivity of the effect of "α" on SLCI is required, the exponential power can be increased to a greater value.

$$Y = \left(\frac{1}{1+\sqrt{x}}\right)\hat{2}. \qquad (11)$$

Hence, the prototype SLCI formula is formed as follows:

$$F = \left(\frac{1}{1+\sqrt{\alpha}}\right)\hat{2}, \qquad (12)$$

where F is the speed limit compliance index (SLCI) and α is the penalty score.

Accordingly, the full formula for SLCI calculation would be as follows:

$$F = \left(\frac{1}{\left(1+\sqrt{\left(\sum_{i=1}^{n}\left(t_i\left(V_i - V_{Li}\right)^2/V_{Li}\right)/D - \sum_{i=1}^{n} t_i\left(V_i - V_{Li}\right)\right)}\right)}\right)\wedge 2. \qquad (13)$$

In the following example, the effect of changes in driving speed on "α" and consequently on SLCI is investigated. Furthermore, the magnitudes of SLCI are also calculated and compared based on three different exponential powers (2, 4, and 6).

Suppose there is a car traveling on stretch of a road with a speed limit of 80 km/h (Figure 4). The amount of "α" and SLCI are calculated according to different speeding infringements at different times as given in Table 2 and Figure 5.

4. Calculation of SLCI for the Previous ISA Trial Study

To observe the effect of the presence of the advisory ISA on drivers' SLCI, this index was calculated for all drivers who participated in the previous ISA project in Malaysia [31]. The index was calculated for each of the three periods of the on-road study (system OFF (before), system ON (during), and system OFF again (after)), and data from segment III were also used (Figure 6). Although the result provides a better insight into the functionality of the SLCI, to investigate the positive effect of this method more precisely, a separate on-road study is recommended.

Figure 6 shows that ISA positively influenced drivers' SLCI, and for all drivers, it decreased less in the second period of the project when the system was activated. As it is expected, after removing the system in the third period of the project, the absence of ISA had a negative effect on drivers' SLCI, and for all drivers, it slightly decreased.

5. Conclusion

Road safety is an important issue, and without a doubt, road trauma is a terrible burden on the whole of society. It is generally agreed that vehicles' speeds are a highly significant factor in causing the occurrence of accidents and how serious the consequences of those accidents can be. Although the majority of drivers are aware of the harmful effects of speeding, driving above the speed limit is, however, one of the most frequent traffic violations. Furthermore, unintentional speeding is made up a large portion of the speeding offenses, and the drivers would perform better if they could get some technical assistance while driving on the road, especially in an unfamiliar area. Undoubtedly, the main advantage of everyone following the speed limit is that it saves people's lives.

With the advent of intelligent transportation system (ITS) technologies, a wide range of potential applications for assisting drivers and reducing accidents have become available. One of these applications is called intelligent speed adaptation (ISA). ISA can be an alternative and/or supplement to those traditional speed control measures, and it can range from being a warning to intervening.

Since 2000, interest in research on ISA has increased worldwide, and the ISA concept has spread across the world. Previous studies have all shown that the implementation of ISA has the potential to significantly reduce the incidence and severity of road trauma. ISA has been mostly investigated in three European countries, including Sweden, the Netherlands, and the UK, regarding the scale and number of carried out studies. Substantial safety benefits from these studies encouraged other nations from different continents to join the ISA community.

Despite the benefits of ISA, the main problem with this system is its short-lasting effect. After removing the system or using it for a long time (even for the supportive system), the effect of the system gradually decreases or disappears. Furthermore, previous studies on different types of ISA have shown that the more effective system (more restricted ISA, such as a mandatory system) has lower acceptance. To increase the safety effect of the system, drivers' motivation to use this system and to follow the speed limit must be increased. One solution is to increase the drivers' enticement to use the ISA system. Indeed, if the drivers are unwilling to use the system, even the limiting system will be useless.

The speed limit compliance index tries to increase drivers' motivation and to encourage them to use the system and to assist them in driving safely. This is a dynamic formula that gives the drivers an opportunity to repair their speeding offenses. It is expected that this formula will more accentuate the role of the ISA system because the drivers need the system's assistance to prevent them from speeding offenses, even unintentional ones.

SLCI, indeed, can be used in other types of ISA, but since the advisory system is a popular system, this method is more recommended. The results of SLCI can also be used by police agencies or insurance companies, and it will definitely help to get more benefit from this formulation. For any speeding offense, SLCI can assist police officers in making better judgments to distinguish between an unintentional speeder and an offensive driver. Drivers' SLCI can continually be calculated when they are driving on the stretch of road, and it can be shown on the system's display. It is suggested that three different indicators be used to increase the awareness of drivers: two for SLCI (one for the current trip and one for the whole trip from the first day of driving) and one for speeding risk. The speeding risk can be calculated [52]:

$$y = 0.0139x^2 + 0.0140x. \quad (14)$$

In this formula, "y" is the relative risk and "x" is the vehicle speed difference from the mean speed in mph. Color spectrum or color code indicator is used, which means "Red" refers to danger or high risk, "Amber" refers to warning, "Yellow" refers to caution, and "Green" refers to a safe situation. It can also be used to show the risk and SLCI visually. It is a more effective way to comprehend the risk, particularly for illiterate drivers. A schematic view of such an indicator is shown in Figure 7.

The introduction of ISA through vehicle fleets may also increase public understanding and acceptance of the technology before it is implemented in private vehicles. SLCI is a prototype formula, and the authors believe that to establish a sophisticated formula, indeed, more research studies are needed. Aside, SLCI is a novel idea to improve the effect of ISA, particularly advisory systems, through increasing drivers' motivation to keep the speed limit willingly, not forcibly.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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