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Revisiting Automated Speed Enforcement System in Malaysia through Deterrence Framework

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ABSTRACT

The significant contribution of speeding (about 58% of road crash victims) to road safety in Malaysia demands continuous and effective countermeasures. While enforcement is effective to combat speeding and modify road users' behaviours, frequent review and update is necessary to ensure its relevance and effectiveness. This article reviews and documents the process of automated speed enforcement in Malaysia; before proposing an investigation framework of improvement clutching on the long-standing Classical Deterrence Theory (Gibbs, 1979) – perceived certainty of punishment, severity and swiftness of sanctions. Suggestions and steps to improve deterrence effect of automated speed enforcement in Malaysia conclude the discussion.

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1. Introduction

Road trauma injuries have become a major threat to one's health and life, diminishing quality of life and work and depleting the workforce, impacting on our society's growth and stability (Fu et al., 2013). Speed has been recognised as one of the critical predictors in road traffic injuries, increasing the likelihood of a collision and the severity of the injuries sustained as a consequence of those collisions. Excess speed is described as going faster than the posted speed limit (WHO, 2004). Driving at an inappropriate speed is described as driving at a speed that is not relevant to the current road and traffic conditions (Abdul Manan et al., 2018). Excessive and improper speed is responsible for a significant percentage of fatalities and disability in traffic crashes (Huth et al., 2014).

In Malaysia, speeding is one of the main causal factors of road crashes. Figure 1 shows the number of at fault drivers involved in road crashes (i.e., the bars), and its percentages (i.e., the line) related to speeding for 20 years from 1999. Using statistics from the Royal Malaysian Police (2020), the trend line refers to combination of drivers who were explicitly at fault for speeding, and other inferred speeding behaviours -- dangerous overtaking, dangerous driving, dangerous turning, driving too close, and not conforming to traffic lights. On average for these 20 years, 58% (SD ± 10.4) of at fault drivers involved in road crashes were attributed to speeding. The trend increased from 42.3% in 1999 and peaked at 76.8% in 2012 before going down aggressively in the next three years. Since 2015, the percentages of at fault driver related to speeding remained stagnant at 52% despite variations in the total at fault drivers.

Increases in speed have a larger influence on higher crash fatalities, with even slight changes in speed having significant consequences (Job & Mbugua, 2020). A 1 km/h increment in average speed generally leads to a 3% increase in the chance of a crash causing injury with a 4% to 5% increase in the likelihood of a deadly collision (WHO, 2004). Higher speed minimises the ability to stop in time, reduces manoeuvrability in critical situations, and consequently increases the risk of crash and injury (Elvik, 2010). Also at high speeds, drivers will find it hard to negotiate curves and corners, limiting the driver's peripheral vision and causing other road users to miscalculate the gaps (Job & Mbugua, 2020). Hence, regulating vehicle speed can effectively reduce crash risk and lower the injury severity when they do happen. There are various management strategies to address speeding - legislation, public awareness and enforcement are among others (Sakashita et al., 2021).

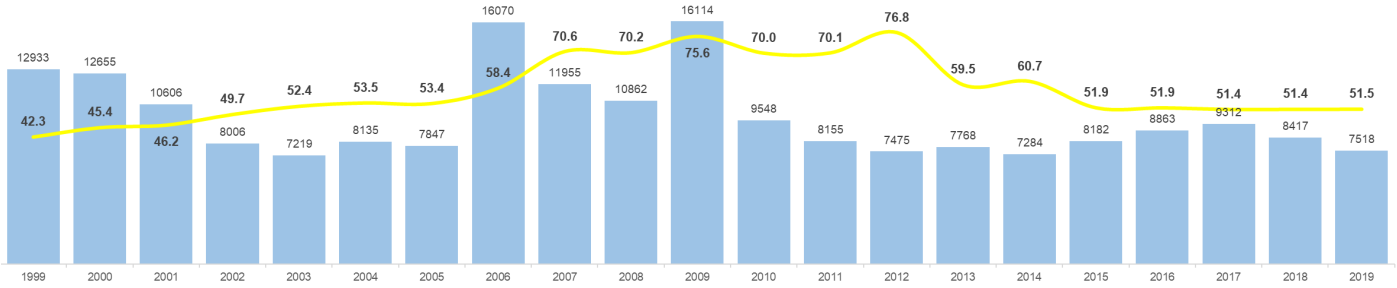

Figure 1: 20-year trend of speeding-related crashes in Malaysia.

2. Deterrence Theory

Road safety enforcement strategies normally rely on the Classical Deterrence Theory which posits road users will avoid offending behaviour(s) if they fear its perceived consequences; specifically, the perceived certainty, severity and swiftness of punishment (Homel, 1988). In the context of speeding, perceived certainty of punishment refers to the likelihood drivers perceive he or she to be caught and punished if driving beyond the specified limit. For effective deterrence, drivers have to believe the likelihood of being apprehended and punished are high enough that could prevent them from offending (Grasmik & Bryjak, 1980).

Perceived severity of punishment entails the deliberate infliction of some form of pain on individuals to deter them from offending and/or prevent reoffending (Scheid, 1997). While some studies found a weak negative correlation between perceived severity of punishment and illegal behaviours, some counterintuitively found otherwise (Davey & Freeman, 2011). Homel (1988) suggested, rather than habitual offenders, those who have never committed an offence are more likely to be deterred with perceived severity of punishment.

Perceived swiftness of punishment refers to the period of time between the commission of an offence and the imposition of a penalty (Gibbs, 1979). While Truelove et al. (2017) emphasised the value of rapid punishment, its contribution to the overall deterrence is unclear. Relative to the other aspects of the theory, this component is the least being studied. This is partly because legal system normally takes time (Babor et al., 2003). Nevertheless, the time between stimulus and response is critical for learning new behaviours (Nagin & Pogarsky, 2001).

While these three aspects of the classical deterrence model all contribute to the overall deterrent effect achieved, previous research suggests perceived certainty of punishment to have the most deterrent effects on offending behaviours (Freeman et al., 2017; Truelove et al., 2017).

3. Automated Speed Enforcement

The goal of traffic enforcement is to improve road safety by preventing road users from committing offences that result in crashes and injuries (Gibbs, 1979). Enforcement operations should primarily serve as a deterrent to road users who are prone to committing traffic violations by escalating road users' 'perceptions threat of being caught' (Sakashita et al., 2021). To achieve this, enforcement officers adopt whether static and/or mobile traffic enforcement strategies of using either marked or unmarked enforcing statutory vehicles. Although mobile policing with marked police cars is useful, static and highly visible, policing appears to be the most successful strategy for minimising road violations and crashes (Walter et al., 2011). Walter et al. (2011) reported that before a static enforcement, 57% of drivers were found to violate the posted speed limit by 25 km/h, whereas in the final week of the enforcement, the speeding cases dropped by 9%. Surprisingly, even after completion of the enforcement activity, the positive effect continued to exist within 8 km proximity of the enforcement site.

The degree of enforcement effectiveness varies across countries (Goldenbeld & Schagen, 2005), as it strongly depends on political will, good and ethical enforcers practice, efficient enforcement campaigns, educational schemes for public awareness, rigorous penalties for law offenders (Wali et al., 2017) and public perceptions (Zambon, 2008). Understanding these variations could point to the key aspects that may influence the effectiveness of such programmes (Wali et al., 2017). The fatality indicator variable, fatality per thousand registered vehicles (FPTRV) of less than 2.25 indicate effective speeding enforcement implemented in that country (Wali et al., 2017). Among numerous considerations influencing the enforcement level include the total number of enforcers and the constraints on enforcers' time for non-traffic responsibilities (Walter et al., 2011). When comparison across different countries' level of compliance took place, the discrepancies appear to be due to different social desires to follow the law rather than to different traffic rules (Vereeck & Vrolix, 2007).

Automated Enforcement (AE) is a broad term that refers to any technology that recognises and records traffic violations with minimal human assistance (Job et al., 2020). Speed camera is one of it. Coupled with increased enforcement action, its implementation is one of the most effective, evidence-based, and low-cost ways to lower speeds, hence saving lives and injuries (Li et al., 2017; Wilson et al., 2010). A study in the Australian state of New South Wales reported that the installation of 28 units of automated speed cameras in that district reduced speeding by 71% and consequently declined local fatalities by 89% (Job & Sakashita, 2016).

4. Increasing Deterrent Effect of Automated Speed Enforcement

In Malaysia, speed cameras have come into force since 23 September 2012, incorporated as one of the significant programmes in Road Safety Plan Malaysia 2006 – 2010 (MIROS, 2016). To date, there are 29 units of automated speed cameras being installed at crash-prone localities across Malaysia as shown in Table 1 (Sarani et al., 2012). Most of these locations (i.e., 24) were at certain points of highways with 110 km/h speed limits. Out of the remaining cameras, three were at 90 km/h limit stretches, one at a 80 km/h location, and another at a 70 km/h spot.

The implementation of the Awareness Automated Safety System (AwAS) has effectively deterred speeding behaviour by more than 92.2% at the enforced sites after six months of installation, relative to only 51% before its installation (MIROS, 2016). While this is an encouraging effect, it is limited only within the camera vicinity; compliance with the posted speed limit at observed locations without AwAS is below 50% (Kamil et al., 2013).

Table 1: List of camera locations and the corresponding speed limit it enforces (*Source:* JPJ, 2021).

State	Location	Speed limit (km/h)
Johor	KM151.4 Lebuhraya PLUS - Pagoh (North bound)	110
	KM146.8 Lebuhraya PLUS - Pagoh (South bound)	110
	KM1 Lebuhraya PLUS - Johor Bahru (North bound)	110
	KM1 Lebuhraya PLUS - Johor Bahru (South bound)	110
Melaka	KM214.4 Lebuhraya PLUS - Alor Gajah (South bound)	110
	KM214.4 Lebuhraya PLUS - Alor Gajah (North bound)	110
	KM184.2 Lebuhraya PLUS - Jasin (North bound)	110
	KM185 LLebuhraya PLUS - Jasin (South bound)	110
Selangor	KM18 Lebuhraya GCE (North bound)	110
	KM18 Lebuhraya GCE (South bound)	110
	KM28.4 Lebuhraya ELITE (North bound)	110
	KM17 Lebuhraya ELITE (South bound)	110
	KM6.6 Jalan Kajang Puchong (SKVE)	80
	KM301.6 Lebuhraya PLUS, Kajang	90
Putrajaya	KM1.6 Lebuh Sentosa	70
Kedah	KM96.3 Kuala Muda - Kuala Muda (South bound)	110
	KM97.2 Lebuhraya PLUS - Kuala Muda (North bound)	110
	KM174 Lebuhraya PLUS - Bandar Baharu (North bound)	110
Pulau Pinang	KM166 Lebuhraya PLUS - Seberang Perai Selatan (South bound)	110
Perak	KM375.9 Lebuhraya PLUS - Slim River (North bound)	110
	KM204.6 Lebuhraya PLUS - Taiping (North bound)	110
	KM299.9 Lebuhraya PLUS - Kampar (North bound)	110
	KM382.8 Lebuhraya PLUS, Behrang (South bound)	110
	KM85.5 Jalan lpoh - Kuala Lumpur, Sungkai	90
Negeri Sembilan	KM21 Lebuhraya Kajang - Seremban (LEKAS) (South bound)	110
	KM21 Lebuhraya Kajang - Seremban (LEKAS) (North bound)	110
Terengganu	KM256.1 - Lebuhraya Pantai Timur 2	110
	KM288.6 - Lebuhraya Pantai Timur 2	110
Kelantan	KM17 Jalan Gua Musang - Kuala Krai	90

Figure 2 summarises the process flow of AwAS. The framework incorporates the process from when driver violates the speed limit until they receive the punishment. The AwAS camera captures the image of offending vehicle along with the speed it travels before transmitting it to JPJ. When certain conditions are met, JPJ officer will issues speeding summons to the vehicle owner. Upon receiving the letter, offenders are offered to pay the compound within 60 days from the summon issuance date. Failure to do so leads to the prosecution of the case to the court within 5 to 7 days from the expiry date of the offered compound. Similarly, if the offenders do not receive the summon, the case will proceed as a court matter as well. The offender is required to present before the court to continue the case. Arrest warrant and blacklisting follows in the case of his or her absence to the court. Otherwise, the offender has an option to whether plead guilty or not. The former situation brings about the offenders to pay the fine; whereas the latter continues to a trial. If the magistrate in charge found him or her to be not guilty, the offender is free to go without explicit punishment; else, the court decides a necessary punishment for the offence. With the exception of 'no punishment', the other conditions lead to incurring of demerit point (i.e., KEJARA); and following is the KEJARA ruling.

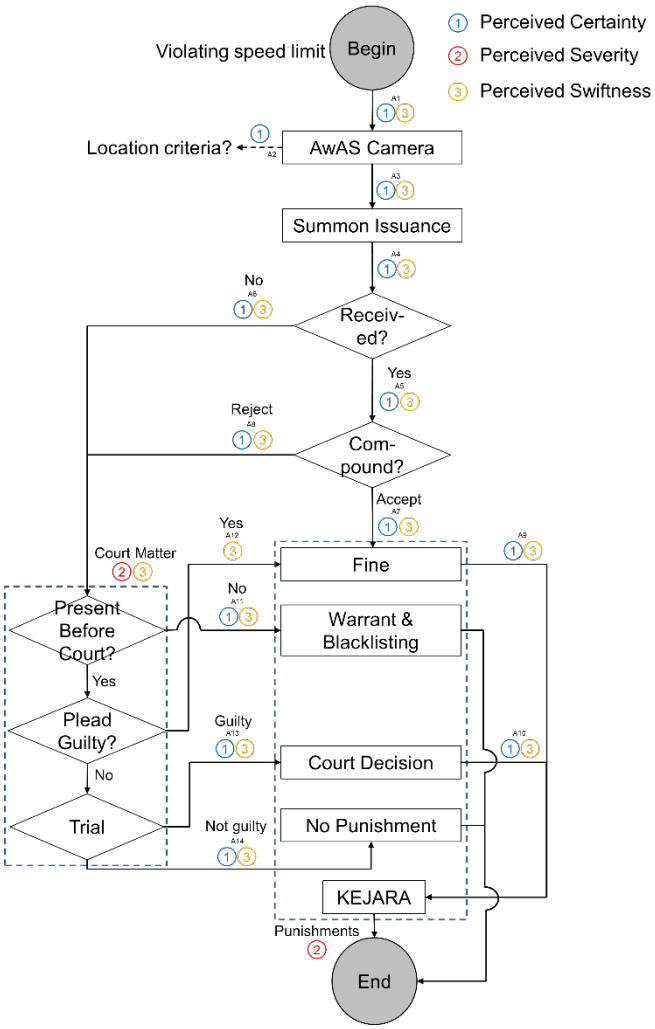

Figure 2: Automated speed enforcement process flow in Malaysia.

Furthermore, the arrows (i.e., certain stage of the flow), and blocks in Figure 2 are accompanied with encircled numbers. These numbers correspond to the three components of the deterrence theory framework: number 1, 2, and 3 are for perceived certainty, perceived severity and perceived swiftness of punishment, respectively.

Table 2 provides details of these components for the numbered arrows, along with the relevant questions for each of the processes.

Table 2: Deterrence theory concepts of the numbered arrows

Stage/ Block	Questions pertinent to perceived certainty of punishment	Questions pertinent to perceived severity of punishment	Questions pertinent to perceived swiftness of punishment
A1	How likely is every offence being caught?	NA	How prompt is the booking after speeding happens?
A2	Where is the location of AwAS to increase certainty? How many AwAS are required to reach the CCL?	NA	NA
A3	How likely is every speeding offence being captured?	NA	How quick is the summon to be issued for every offence?
A4	How likely are the offenders to receive the summons?	NA	How quick are the offenders to receive the summons?
A5	How likely are the offenders to decide accepting the compound?	NA	How quick are the offenders to make the decision accepting the compound?
A6	How likely are the offenders get prosecuted if they do not receive the summons?	NA	How quick is the prosecution to occur if the offenders do not receive the summons?
A7	How likely is every summon to be paid?	NA	What is the maximum day for offender to accept compound? How quick is the payment made after receiving the summon?
Punishments	NA	What are the punishment received? How severe the received punishments? What happen if they refused to pay compound within the time offered?	NA
A8	How likely are the offenders get prosecuted if they reject the summons?	NA	How quick is the prosecution to occur if the offenders reject the summons?
A9	How likely are the offender accumulates KEJARA points for every offences committed?	NA	How quick are the points accumulated after punishment has been handed down?
A10	How likely are the offender accumulates KEJARA points for every offences committed?	NA	How quick are the points accumulated after court decision has been handed down?
A11	How likely are the offenders will be punished if they fail to give cooperation during prosecution?	NA	How quick will the offenders being blacklisted and warrant is issued if they refuse to present to court?
A12	NA	NA	How quick is the process from pleaded guilty until summon is paid?
Court matter	NA	How tedious/stressful/consuming (time, money, energy, commitment) is the court process?	How quick is the court trial happen if offenders refuse to be pleaded guilty?
A13	How likely are the court trials resulted in proved to be guilty cases?	NA	How quick is the process from proved to be guilty until fine is paid?
A14	How likely are the court trials result in faulty cases?	NA	How quick is the process from proved innocence until case settlement?

Note: CCL i.e., critical certainty level corresponds to the minimum value of perceived certainty for deterrence effect to happen.

Most of the stages in the AwAS process flow are linked to perceived certainty and perceived swiftness of punishment; whereas perceived severity of punishment corresponds only to the 'Punishment' and 'Court matter' blocks.

We propose the scope of punishment to include various forms, besides the direct (explicit) action to inflict some form of pain to the offenders. The psychological burdens (or reward, in the context of 'not guilty' after trial) such as stress, cognitive dissonance, annoyance, nuisance, frustration and fear, *inter alia*, can contribute to the psychological pain and may serve as motivation to stop speeding.

For instance, even before receiving the final decision from the magistrate (i.e., the actual punishment), the offenders may already bear the stress, frustration, fear, and other psychological burdens when thinking of the potential event in the court. In addition, the effort to attend court itself requires use of resources including money and time that may act as other forms of (indirect) punishments.

As individual differences may mediate and/or moderate the degree of these psychological burden/relief, any attempt to expand the scope of punishment to include these factors need to be considered the individual factors or constructs such as personality and other dispositions. The following equation (1) summarises this proposal of perceived severity of punishment, PS.

$$PS = PS_s + PS_F + PS_B - PS_X + PS_K \quad (1)$$

with,

PS_S : Perceived severity of being summoned to court
PS_F : Perceived severity of paying fine
PS_B : Perceived severity of being blacklisted
PS_X : Perceived reward of not guilty
PS_K : Perceived severity of KEJARA

The psychological burden, and other indirect costs for each component of PS may not be homogenous.

Considering the AwAS flow, the perceived certainty of (actual) punishment (PC) encompasses various stages (from A1 to A14 in Figure 2, and Table 2). Therefore, the likelihood to receive the

punishment after committing offences is a complex aggregation of likelihood for each stage within the process flow. Consider this scenario: Even when the likelihood of A2 until A14 is high, the overall PC is lower if the likelihood to be apprehended (i.e., A1) is low. The following equations (2 until 2.7) captures the aggregation of individual likelihood for the overall PC.

$$PC = PC_F + PC_B + PC_G - PC_X + PC_K \quad (2)$$

with,

PC_S : Perceived severity of being summoned to court
PC_F : Perceived severity of paying fine
PC_B : Perceived severity of being blacklisted
PC_X : Perceived reward of not guilty
PC_K : Perceived severity of KEJARA

Equations for each component:

$$PC_F = (PC_S A12) + (PC_A A5\ A7) \quad (2.1)$$
$$PC_B = PC_S A11 \quad (2.2)$$
$$PC_G = PC_S A13 \quad (2.3)$$
$$PC_X = PC_S A14 \quad (2.4)$$
$$PC_K = (PC_S A9) + (PC_S A10) \quad (2.5)$$

with,

$$PC_A = A1\ A2\ A3\ A4 \quad (2.6)$$
$$PC_S = (PC_A A6) + (PC_A A5\ A8) \quad (2.7)$$

These equations assume the A*X*s with (*X* = 1, 2, 3, …, 14) as the likelihood for the following stage to happen once the prior stage is completed.

Similar to PC, perceived swiftness of punishment (PQ) shares the same concept, but focusing on the perceived delay the offenders to experience the punishment after committing the offence. Therefore, the mirrored aggregation of PQ follows the same equations (3 until 3.7).

$$PQ = PQ_F + PQ_B + PQ_G - PQ_X + PQ_K \quad (3)$$

with,

PQ_S : Perceived severity of being summoned to court
PQ_F : Perceived severity of paying fine
PQ_B : Perceived severity of being blacklisted
PQ_X : Perceived reward of not guilty
PQ_K : Perceived severity of KEJARA

Equations for each component:

$$PQ_F = (PQ_S A12) + (PQ_A A5\ A7) \quad (3.1)$$
$$PQ_B = PQ_S A11 \quad (3.2)$$
$$PQ_G = PQ_S A13 \quad (3.3)$$
$$PQ_X = PQ_S A14 \quad (3.4)$$
$$PQ_K = (PQ_S A9) + (PQ_S A10) \quad (3.5)$$

with,

$$PQ_A = A1\ A2\ A3\ A4 \quad (3.6)$$
$$PQ_S = (PQ_A A6) + (PQ_A A5\ A8) \quad (3.7)$$

This time, the A*X*s with (*X* = 1, 2, 3, …, 14) corresponds to the perceived time to receive the punishment.

In short, the full deterrence effect of AwAS can be encapsulated in equation (4).

$$Deterrence = PS\ PC\ PQ \quad (4)$$

5. Conclusion and Recommendations

The study intends to review the automated enforcement system in Malaysia, specifically towards speeding (i.e., AwAS) in the light of Classical Deterrence Theory. The analysis provides a clearer framework and suggestions on how to improve the effectiveness of AwAS by considering each aspect of the theory: perceived certainty, severity and swiftness of punishment to speeding.

To increase the deterrence effect of speeding enforcement, the following actions are therefore suggested:

1. Measurement of the extent of PC, PQ and PS, as objective as possible, could allow for further investigations of the deterrence effect of present speeding enforcement. Specifically, the contribution of each section to PC, PQ, and PS, individually, may point the gaps within the system for improvement.
2. Relational model of the PC, PQ and PS in explaining speeding behaviour would provide the degree each component to contribute to speeding behaviour (i.e., their individual effect size). This includes establishing any relationship, and potential interactions among them towards speeding propensity, or preferably speeding behaviour.
3. Determination of CCL (see Table 2), i.e., critical certainty level corresponds to the minimum value of perceived certainty of apprehension for deterrence effect to happen. Coupling this information with the relational model in the above point could serve as the basis for further development or improvement of speeding enforcement strategies.
4. Focusing the above information within a local vicinity may further contribute to higher deterrence effect as local sub-culture may play a significant role in the perception formation within the community. The acknowledgement of these differences may lower the resistances to any enforcement activities.

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